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Date: June 18, 1998
Refer to: EM/ER:98-203

Mr. Benito Garcia
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P.O. Box 26110
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0478
TA-53

SUBJECT: SUBMITTAL OF RFI WORK PLAN/SAP FOR TA-53 SURFACE IMPOUNDMENTS, PRS 53-002(a, b)

Dear Mr. Garcia:

Enclosed is a copy of the Los Alamos National Laboratory's Resource Conservation and Recovery Act Facility Investigation Work Plan/Sampling and Analysis Plan for Technical Area 53. A certification form signed by the appropriate officials is also enclosed.

If you have any questions, please contact Roy Michelotti at (505) 665-7444 or Joe Mose at (505) 667-5808.

Sincerely,

Julie A. Canepa, Program Manager
LANL/ER Project

Sincerely,

Theodore J. Taylor, Program Manager
DOE/LAAO

JC/TT/ss

Enclosures: (1) Submittal of RFI Work Plan/SAP for TA-53 Surface Impoundments, PRSs 53-002(a, b)
(2) Certification

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EM/ER File, MS M992

CERTIFICATION

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

Document Title: Submittal of RFI Work Plan/SAP for TA 53 Surface Impoundments, PRSs 53-002(a, b)

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RFI Work Plan and SAP for Potential Release Sites

53-002(a)
53-002(b)

and associated piping and drainages

at TA-53

June 1998

Environmental Restoration Project

A Department of Energy
Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY

LA-UR-98-2547

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List of Acronyms and Abbreviations

AAS	atomic absorption spectroscopy
AP	administrative procedure
BMP	best management practice
BOD	biological oxygen demand
BRET	Biological Resource Evaluations Team
BV	background value
CMI	corrective measures implementation
COPC	chemical of potential concern
DA	decision amount
DOE	Department of Energy
EQL	estimated quantitation limits
ER	Environmental Restoration
ESG	Environmental Surveillance Group
ESH-8	Environmental Compliance Group (now ESH-5)
ESRV	ecological screening reference values
FFCA	Federal Facilities Compliance Agreement
FIMAD	Facility for Information Management, Analysis, and Display
FSF	Field Support Facility
GCEC	gas chromatography electron capture
GC/MS	gas chromatography/mass spectroscopy
HRMB	Hazardous and Radioactive Materials Bureau
ICP/MS	inductively coupled plasma/mass spectroscopy
IWP	Installation Work Plan
LANSCE	Los Alamos Neutron Science Center
MDA	minimum detectable activity
NFA	no further action
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMSA	New Mexico Statutes Annotated
NOD	Notice of Deficiency
NPDES	National Pollutant Discharge Elimination System
OU	Operable Unit
PCBs	polychlorinated biphenyls
PE	performance evaluation
PRS	potential release site
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
QP	quality procedure
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
RPF	Records Processing Facility
SAL	screening action levels
SOP	standard operating procedure
SDWA	Safe Drinking Water Act
SSHASP	Site-Specific Health and Safety Plan
SVOCs	semivolatile organic compounds
SWMU	solid waste management unit

SWSC	Sanitary Wastewater System Consolidation
TA	technical area
TAL	target analyte list
TCLP	toxicity characteristic leaching procedure
The Laboratory	Los Alamos National Laboratory
TICs	tentatively identified compounds
TSCA	Toxic Substance Control Act
TSD	treatment, storage, and disposal
TSS	total suspended solids
VCA	voluntary corrective action
VOCs	volatile organic compounds
WP/SAP	work plan/sampling analyses plan

1.0 INTRODUCTION

Los Alamos National Laboratory (the Laboratory) is a multidisciplinary research facility owned by the Department of Energy (DOE) and managed by the University of California. The Laboratory is located in north-central New Mexico approximately 60 miles northeast of Albuquerque and 20 miles northwest of Santa Fe. The Laboratory site covers 43 square miles of the Pajarito Plateau, which consists of a series of fingerlike mesas separated by deep canyons containing ephemeral and intermittent streams that run from west to east. Mesa tops range in elevation from approximately 6200 ft to 7800 ft. The eastern portion of the plateau stands 300–900 ft above the Rio Grande.

The Laboratory's Environmental Restoration (ER) Project is involved in a national effort by the DOE to cleanup facilities that were formerly involved in weapons production. The goal of the ER Project is to ensure that DOE's past operations do not threaten human or environmental health and safety in and around Los Alamos County, New Mexico. To achieve that goal, the ER Project is currently investigating sites potentially contaminated by past Laboratory operations.

This work plan/sampling analysis plan (WP/SAP) describes a Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) for potential release sites (PRSs) 53-002(a) and (b) (three surface impoundments), to determine nature and extent of contamination to a pre-determined depth (12 ft). Contaminants carried forward from the resulting data assessment will be the chemicals of potential concern (COPCs) used to design the next phase of this investigation. Also located within the boundary of PRSs 53-002(a) and (b) is a drainage channel leading to a Los Alamos Canyon tributary, a possible drainage area leading to a Sandia Canyon tributary, and associated piping. An administrative boundary was defined as part of a previous RCRA closure plan development, between the New Mexico Environment Department (NMED) and the laboratory, for these PRSs. The administrative boundary only defined a stopping point for the PRS 53-002(a) inlet piping, which is manhole 53-163. The radioactive liquid waste line adminstrative inlet piping boundary for PRS 53-002(b) will be the northern fence line. These locations can be readily identified on Figure 2.1-1 in Section 2.1. Both PRSs and their associated features are located near the southeastern boundary of technical area (TA) 53 (Figure 1.0-1). Figure 1.0-2 shows the two northern surface impoundments, PRS 53-002(a), and the single southern impoundment, PRS 53-002(b), respectively. The piping and drainage channels associated with these PRSs are shown in figures presented in Section 2.1.1. Both PRSs were used for wastewater treatment from various TA-53 facilities and periodically from septic tanks from other areas of the Laboratory.

This RFI WP/SAP follows the March 1998 SAP outline developed by NMED. This RFI WP/SAP includes the following: (1) a description of the TA-53 environmental setting, (2) a description of the three surface impoundments and the associated drainage areas, (3) a conceptual model, (4) proposed sampling activities, and (5) a sampling and analysis implementation plan.

Guidance for the ER Project's overall approach to site investigation, as well as the general history of the Laboratory, is available in the Laboratory's ER Project Installation Work Plan (IWP) (LANL 1996, 55574). The IWP also includes the ER Project's Quality Assurance Project Plan (QAPP), which describes the requirements for personnel training, sample handling and custody, and data management review, validation, and verification. When appropriate, this RFI WP/SAP will reference the administrative procedures (APs), quality procedures (QPs), and standard operating procedures (SOPs) included in the QAPP.

The description, operational history, existing data, conceptual model, and sampling activities for PRSs 53-002(a) and (b) are addressed in Section 2.0 of this document. Because the conceptual model for the drainage areas is somewhat different than the surface impoundments, an additional conceptual model is presented for these areas and can also be found in Section 2.0. Table 1.0-1 provides a summary of the PRSs and surrounding areas discussed in this document.

TABLE 1.0-1
PRS DESCRIPTION

PRS	PRS TYPE	STRUCTURE	DESCRIPTION	MODULE VIII OF HAZARDOUS WASTE FACILITY PERMIT	SWMU /AOC	SECTION
53-002(a)	Two northern surface impoundments	TA-53-166	Waste water treatment lagoons from TA-53 operations and associated drainage channels	Y	SWMU	2.0
53-002(b)	Single southern surface impoundment	TA-53-166	Radiological waste water treatment lagoon from TA-53 operations	Y	SWMU	2.0

Before 1997, PRSs 53-002(a) and (b) were considered treatment, storage, and disposal (TSD) units regulated under RCRA, and thus requiring a closure plan. On July 21, 1997, in response to a request from LANL, the Hazardous and Radioactive Materials Bureau (HRMB) of NMED informed DOE that there was an approved change in status for the TA-53 surface impoundments. Under the Hazardous and Solid Waste Amendments (HSWA), the TA-53 surface impoundments were changed from TSD units to corrective action units. As a result, NMED requested a RFI WP/SAP for the TA-53 surface impoundments. Table 1.0-2 provides a chronology of correspondence between NMED and the Laboratory regarding the history of the TA-53 surface impoundments.

All of the items referenced in this document are included in the LANL ER Reference Library and the LANL public reading room. These documents will be provided to the DOE and NMED upon submittal of this document. Reference items that relate specifically to former Operable Unit (OU) 1100 will be included in the OU 1100 Reference Set. Items that relate to the entire ER Project are included in the general ER Project Reference Set.

TABLE 1.0-2
CHRONOLOGY OF CORRESPONDENCE BETWEEN NMED AND LANL REGARDING PRSs 53-002(a) AND (b)

Date	Correspondence	Synopsis of Correspondence
2/12/93	From the Laboratory To NMED	Submittal of interim status closure plan, rev. 0.
9/30/93	From NMED To the Laboratory	NOD[a] from NMED regarding February closure plan.
1/14/94	From the Laboratory to NMED	Response to 9/30/93 NOD. Plan had to meet clean closure as identified in NMED's closure regulations.
9/2/94	From the Laboratory To NMED	Laboratory submittal of closure plan dated 8/94, rev. 1.
10/28/94	From NMED To the Laboratory	NOD from NMED regarding 8/94 closure plan.
12/16/94	From the Laboratory To NMED	Laboratory response to NOD from NMED dated 10/24/94.
12/21/94	From the Laboratory To NMED	Laboratory submittal of revised figures to accompany the Laboratory response dated 12/16/94.
1/9/95	From the Laboratory To NMED	Laboratory submittal of attachments to accompany the Laboratory response dated 12/16/94.
3/10/95	From the Laboratory To NMED	Laboratory response to telephone conversation between Merlin Wheeler, Everett Trollinger, and NMED that took place on 1/24/95.
7/24/95	From NMED To the Laboratory	NOD from NMED based on the Laboratory's response (dated 12/16/94) to NMED's NOD (dated 10/28/94) and the Laboratory's further response (dated 3/10/95).
8/31/95	From the Laboratory To NMED	The Laboratory's Response to NMED's NOD dated 7/24/95.
4/22/96	From NMED To the Laboratory	NOD from NMED regarding remaining deficiencies.
5/3/96	From NMED To the Laboratory	NMED grants extension of deadline for submittal of revised closure plan. Closure plan must be submitted within 20 working days after land use/exposure scenario issue is resolved.
5/20/ 96	From the Laboratory To NMED	The Laboratory's request for extension of deadline for responding to NOD from NMED dated 4/22/96 and for the submittal of revised closure plan.
7/21/97	From NMED To the Laboratory	Change in the designation of the surface impoundments from TSD to corrective action. Initiated RFI WP/SAP.
12/10/97	From the Laboratory To NMED	The Laboratory requests extension for submittal of RFI WP/SAP until 4/30/98.
4/27/98	From the Laboratory To NMED	The Laboratory requests 60-day extension for submittal of RFI WP/SAP.
5/13/98	From NMED To the Laboratory	NMED denies the Laboratory's request for a 60-day extension and requests that the RFI WP/SAP be submitted by 5/30/98.
5/29/98	From the Laboratory To NMED	The Laboratory's requests extension for submittal of RFI WP/SAP until 6/19/98.
6/1/98	From NMED To the Laboratory	NMED approves request for extension until 6/19/98.

[a] Notice of Deficiency

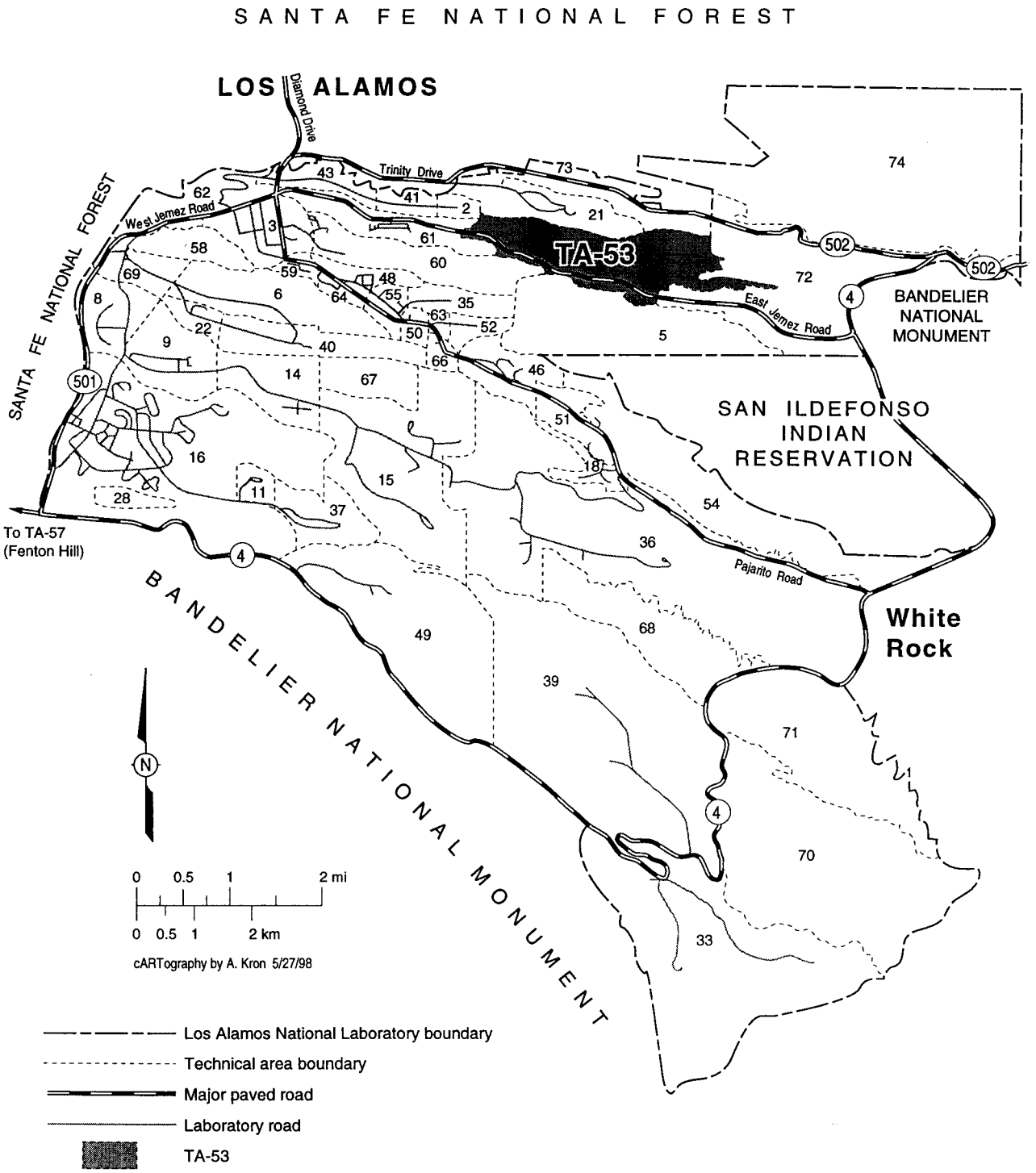


Figure 1.0-1 Location of TA-53 within the Laboratory boundaries

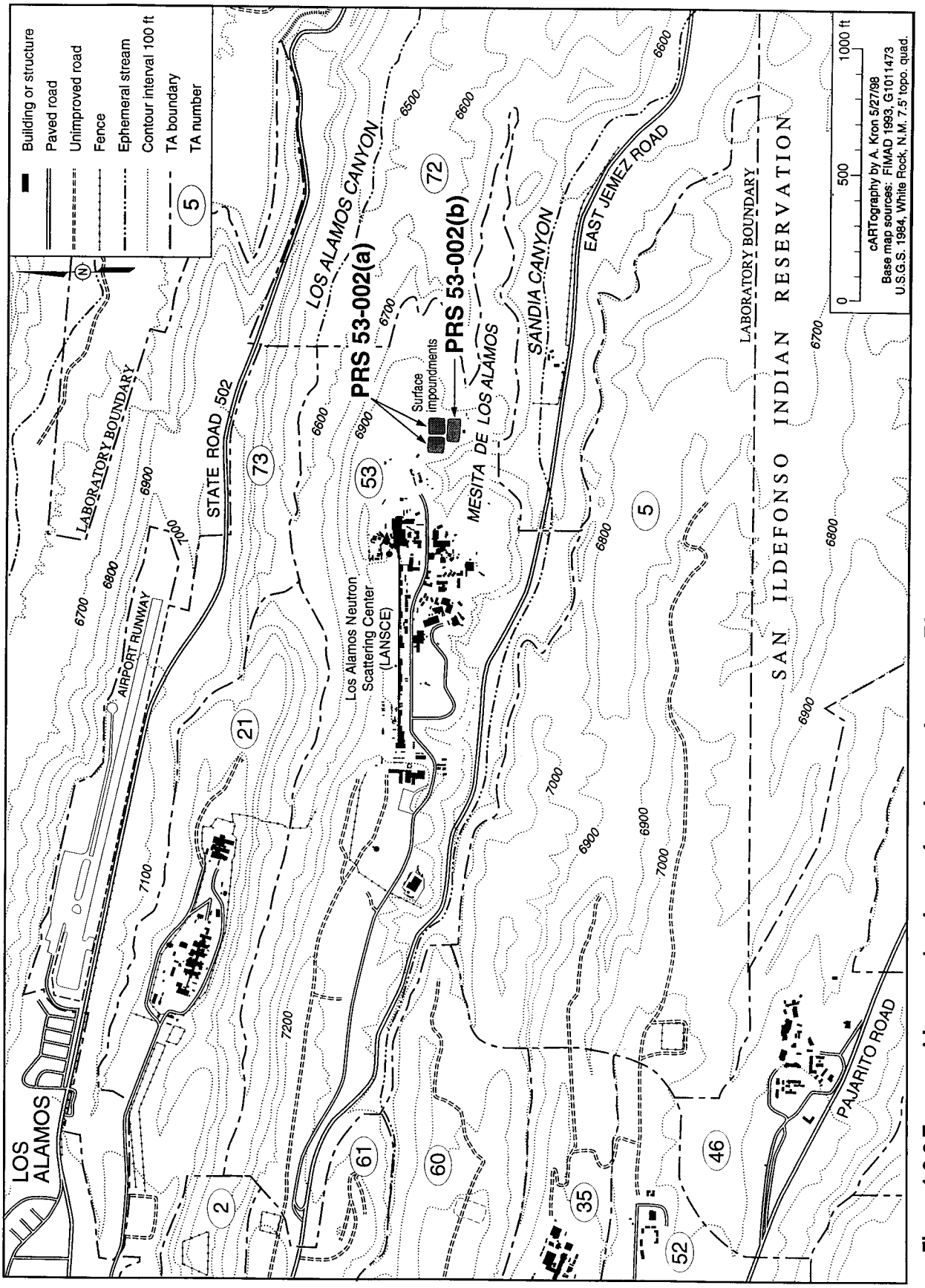


Figure 1.0-2 Topographic map showing surface impoundments at TA-53

1.1 Objective and Scope

PRSs 53-002(a) and (b) include three surface impoundments (Figure 1.1-1). PRS 53-002(a) comprises two northern surface impoundments and all associated drainages that were used to treat sanitary and radiological waste from TA-53 facilities, primarily the Los Alamos Neutron Science Center (LANSCE). The northern surface impoundments at PRS 53-002(a) were installed in 1969 and began operating in the early 1970s. These impoundments were constructed by excavating into the tuff, adding a clay liner on top of the tuff and spraying gunite (concrete) onto the crushed tuff berm. In 1992, when Sanitary Wastewater System Consolidation (SWSC) became operational, all sanitary waste was diverted from the northern surface impoundments. Both surface impoundments are currently inactive and dry.

PRS 53-002(b), the southern surface impoundment, was constructed and began operating in 1985. It was installed by excavating into tuff, overlain with crushed tuff and sand, and then overlain with a Hypalon ™ (rubber polymer) liner. The southern impoundment was constructed to treat both sanitary (1985-1989) and radiological (1985 to present) waste from TA-53 facilities. Currently, this surface impoundment contains liquid and sludge and it will remain active through 1998.

This investigation will determine if the surface impoundment liners (both the clay and Hypalon ™ liners) prevented contaminants from migrating to subsurface media. The migration of contaminants will be determined by sampling the sludge remaining in each surface impoundment, the clay liner in PRS 53-002(a), and finally the underlying material (sand and tuff) at various depths (to a 12 ft depth) below both liners and around the perimeter of the surface impoundments. A 12 ft depth is the maximum for this investigation due to the limited capabilities of the proposed sampling methods (ie. hand and/or power augering). However, existing data suggest that extent for most COPCs can be determined within the 12 ft depth. In addition, the historic drainage pathways associated with PRS 53-002(a) will be sampled to determine the lateral extent of contaminant migration. Should the extent of tritium or any other COPC not be determined in this investigation, sampling at depths greater than 12 ft will occur as a follow-up activity. The sampling plan for tritium will be designed using data collected from this investigation.

This RFI WP/SAP is designed to define the nature and extent (to a 12 ft depth) of contamination at the three surface impoundments and their drainage pathways by filling in data gaps and determining the need for corrective action using risk-based decision analysis. Refer to Figure 1.4-1 for the decision logic process used in this RFI WP/SAP.

This RFI WP/SAP is designed to answer the following questions:

- What is the nature, extent, and concentration of contaminants in the media (sludge, clay liner, sand layer, and underlying tuff [to a 12 ft depth]) associated with the TA-53 surface impoundments and in the sediment of the drainage pathways leading from PRS 53-002(a)?

- What is the extent (to a 12 ft depth) of historical transport or potential for future mobility, and what is the potential for down-canyon or vertical transport of contaminants into the vadose zone (to a 12 ft depth) or the sediment in the side canyons of Los Alamos Canyon and Sandia Canyon?

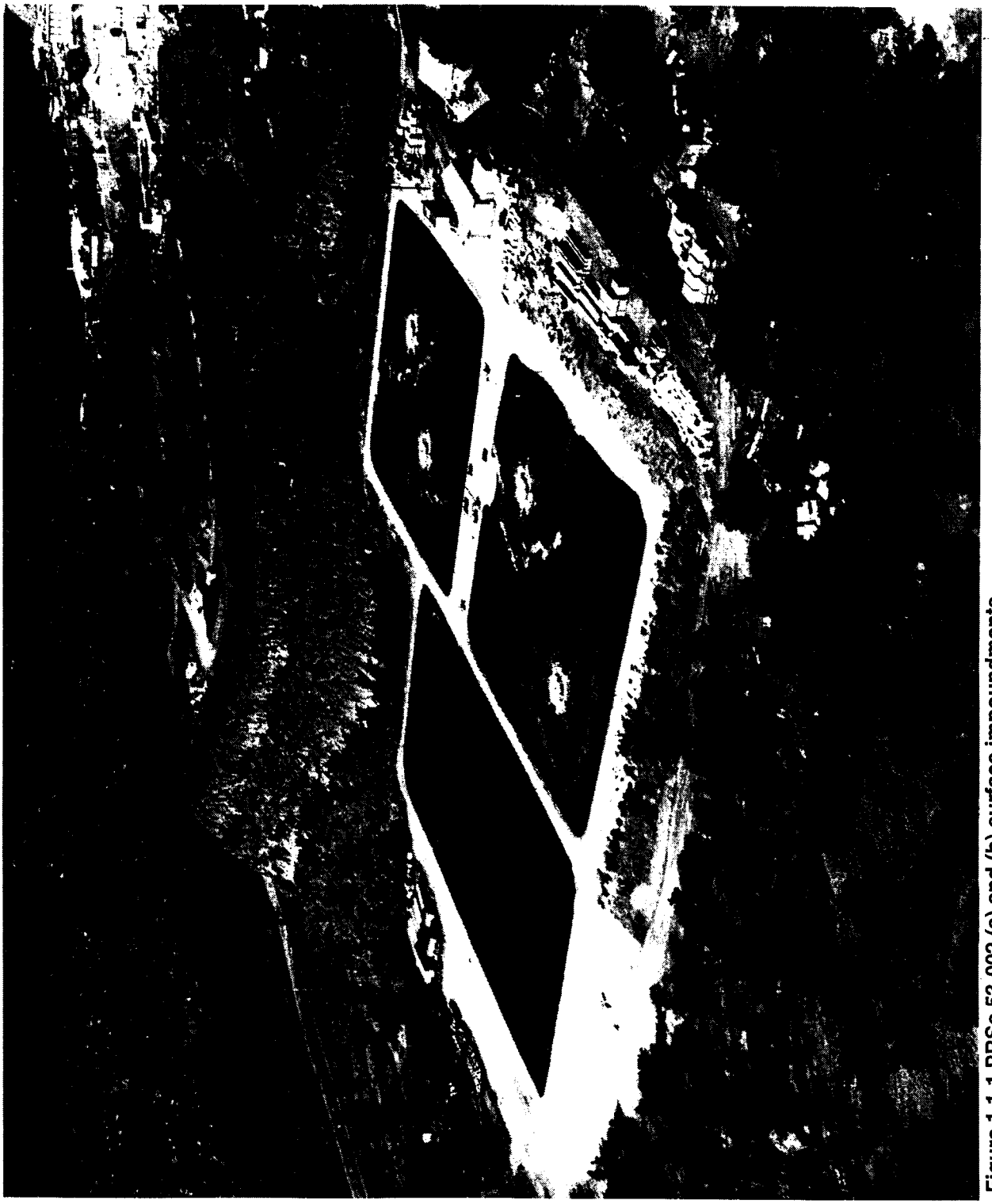


Figure 1.1-1 PRSs 53-002 (a) and (b) surface impoundments

- Do concentrations of potentially persistent bioaccumulators or other contaminants pose a potential unacceptable risk to ecological or human receptors?

- Do the sampling results of the investigation indicate that best management practices (BMPs), either temporary or permanent, or interim measures may be needed to mitigate contaminant transport or reduce unacceptable risks?

The data collected from these PRSs will be used to support any decision making process concerning TA-53. The data collected from implementing this RFI WP/SAP and the data collected during the 1994/1995 sampling campaign will be used two ways: to determine the extent (to a 12 ft depth) of contamination and to conduct both baseline human health risk and ecological screening assessments. Baseline human health and/or ecological risk assessment(s) may be conducted with these data for these PRSs and their area of influence. If the extent is defined and the data indicate that human health and ecological risks are negligible, and groundwater/surface water contamination do not constitute a risk, no further action (NFA) will be proposed for this site.

Before 1997 and the change in status of PRSs 53-002(a) and (b) from TSD units to HSWA corrective action units, several investigations were conducted to collect data for the RCRA closure plan. However, none of the previous sampling efforts completely defined the nature and extent of contamination for the entire area of PRSs 53-002(a) and (b) as previously defined. In addition, some of the historical data that have been collected were only used qualitatively, as quality assurance/quality control (QA/QC) procedures other than ER Project QA/QC procedures were used to validate the data.

1.2 Approach and Implementation

Because nature and extent have not been adequately defined for PRSs 53-002(a) and (b), the existing data cannot be used for risk-based decision-making. In addition, polychlorinated biphenyl (PCB) data collected at PRS 53-002(a) are inconclusive because of quality control problems and because limited or no data have been collected for PRS 53-002(b) or the surrounding drainages that are defined as the PRSs' boundaries. The various data gaps determined the necessity for a SAP for this site.

For each PRS and designated drainage area, a unique sampling strategy has been developed to adequately satisfy the data gaps. Because ER data currently exist for PRS 53-002(a), the COPC lists for the tuff samples is different from the COPC list for all other sampling areas. These sampling strategies will provide the necessary information to conduct baseline human health risk and ecological screening assessments. A summary of sample quantities to be collected and sample analyses to be performed is presented in Table 2.2-4 in Section 2.2.3.

Overview of Sample Collection for PRS 53-002(a), Northern Surface Impoundments
The sludge, bentonite clay liner, and underlying tuff of the northern surface impoundments that compose PRS 53-002(a) will be sampled. All media types will be collected from the same 17 locations at the northwestern and northeastern surface impoundments as in the 1994/1995 ER Project sampling campaign. Samples will be collected for PCB analyses from the sludge, clay liner, and at one depth interval into the tuff (underlying the clay liner). In addition, the tuff of both northern surface impoundments

will be sampled at two depth intervals in 20 total sample locations and submitted for the following analytical suites: semivolatile organic compounds (SVOCs), PCBs, target analyte list (TAL) metals and for radionuclide analyses for gamma-emitting isotopes, tritium, isotopic plutonium, and strontium-90. Ten percent of the samples will be analyzed for chromium VI. All surface and subsurface samples collected at this PRS will be grab samples.

Overview of Sample Collection for PRS 53-002(b), Southern Surface Impoundment
The southern impoundment, (PRS 53-002[b]), will be sampled in a two-step process. Initially, water and liquid sludge within the impoundment will be collected to characterize the media. Three water samples and fourteen sludge samples will be collected and submitted for the following analytical suites: VOCs, SVOCs, PCBs, reactive cyanide and sulfide, and TAL metals. Radionuclide analyses will be performed to detect tritium, isotopic uranium, isotopic plutonium, strontium-90, and gamma-emitting isotopes. Additionally, ten percent of samples will be analyzed for chromium VI, organochlorine pesticides and chlorinated herbicides. Once the sludge is dry, the sand layer (underneath the Hypalon ™ liner) and three depth intervals of underlying tuff will be sampled in the same fourteen locations. In addition, samples will be collected at two depth intervals within the berm surrounding the southern surface impoundment at eight locations. Sand, tuff, and berm samples will be analyzed for the same constituents as the water and sludge, except there will be no analyses for reactive cyanide and sulfide. All surface, subsurface, and water samples collected at this PRS will be grab samples.

Overview of Sample Collection for Lateral Extent around the Three Surface Impoundments
The soil/tuff surrounding the outer perimeter of the three surface impoundments will be sampled to determine the lateral extent (to a 12 ft depth) of contamination. Samples will be collected from twelve locations at three depth intervals. All soil/tuff samples will be submitted for the following analytical suites: VOCs, SVOCs, PCBs, and TAL metals. Radionuclide analyses will be performed to detect tritium, isotopic uranium, isotopic plutonium, strontium-90, and gamma-emitting isotopes. Additionally, ten percent of these samples will be analyzed for chromium VI, organochlorine pesticides and chlorinated herbicides. All surface and subsurface samples collected at this site will be grab samples.

Overview of Sample Collection for Sandia Canyon Tributary Area
Soil samples will be collected from an area south of the northwestern surface impoundment and the first bench below the mesa top of a tributary to Sandia Canyon. Samples will be collected from ten locations at the mesa top and two locations on the bench at two depth intervals, depending on the readings of radiological field screening results. Collected samples will be submitted for the following analytical suites: VOCs (below 6 in.), SVOCs, PCBs, and TAL metals. Radionuclide analyses will be performed to detect tritium, isotopic uranium, isotopic plutonium, strontium-90, and gamm-emitting isotopes. Additionally, ten percent of these samples will be analyzed for chromium VI, organochlorine pesticides and chlorinated herbicides. All surface and subsurface samples collected at this site will be grab samples.

Overview of Sample Collection for Influent Pipes and Discharge Lines
Soil samples will be collected underneath and adjacent to the influent pipes and discharge lines at 15 different locations. Samples will be collected in the sand bedding layer adjacent to and beneath the pipe. All pipe bedding material and tuff samples will be submitted for the following analytical suites: VOCs (below 6 in.), SVOCs, PCBs, and TAL metals. Radionuclide analyses will be performed to detect tritium, isotopic uranium, isotopic plutonium, strontium-90, and gamma-emitting isotopes. Additionally, ten percent of these samples will be analyzed for chromium VI, organochlorine pesticides and chlorinated herbicides. All surface and subsurface samples collected at this site will be grab samples.

Overview of Sample Collection for PRS 53-002(a) Decommissioned Outfall Area
Sampling for this area is divided up into five distinct sampling areas (areas A through E), all of which will be sampled at the surface, the soil/tuff interface, and the first interval (0-6 in.) below the soil/tuff interface. Three samples will be taken from areas A, D, and E, while ten samples will be collected from areas B and C. All areas will be submitted for the following analytical suites: VOCs (below 6 in.), SVOCs, PCBs, and TAL metals. Radionuclide analyses will be performed to detect tritium, isotopic uranium, isotopic plutonium, strontium-90, and gamma-emitting isotopes. Additionally, ten percent of these samples will be analyzed for chromium VI, organochlorine pesticides and chlorinated herbicides. All surface and subsurface samples collected at this site will be grab samples.

1.3 Background Issues

1.3.1 Regulatory Requirements

This investigation, including sampling and analysis, is conducted under the requirements of RCRA. For PRSs 53-002(a) and (b) the investigation is in accordance with the Hazardous and Solid Wastes Amendments of 1984 (HSWA) and follows the requirements in Module VIII of the Laboratory's Hazardous Waste Facility Permit (EPA 1990, 01585). Module VIII was issued to the Laboratory by the US Environmental Protection Agency (EPA) on May 23, 1990 and modified on May 19, 1994.

1.3.2 Other Issues

Remediation levels for PCBs will be developed according to the Toxic Substance Control Act (TSCA) regulations and RCRA guidelines. TSCA and RCRA allow for site-specific risk assessments to determine the potential impacts of PCB releases. TSCA policy provides the EPA with flexibility for sites that may require a different cleanup level due to factors associated with the site that make cleanup to the standard requirements impractical. This provision of TSCA affects and may require ecological and human health risk assessments for PRSs 53-002(a) and (b) if PCBs become an issue at this site.

Although radionuclides are not regulated under RCRA, they are regulated under the DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (proposed rule 58 FR 16268). Because it is more efficient and cost-effective to investigate all types of potential contamination during a single site characterization, radiochemical concerns for PRSs 53-002(a) and (b) are addressed as part of this RFI WP/SAP.

No other regulatory issues are applicable for the PRSs presented in the RFI WP/SAP at this time. This investigation may reveal additional regulatory drivers such as the need to obtain information regarding surface water, groundwater, or biological species uptake. If the need for collecting data from media other than what is proposed in this RFI WP/SAP arises, an addendum to this document will be prepared.

1.4 Data Quality Objectives Process

A series of steps have been defined to determine the course of action for this RFI WP/SAP. The initial step was to compile existing information on the northern and southern surface impoundments. After assembling and evaluating the existing information and previous data collected at this site, a conceptual site model was developed to demonstrate potential release and transport mechanisms, address contaminant concentrations and collocation possibilities, identify viable exposure pathways, and define the boundaries of the PRSs.

Two different conceptual exposure models were developed for this RFI WP/SAP: one for the surface impoundment underlying media and one for the drainages from PRS 53-002(a). Two models were developed because the surface impoundments were engineered to contain liquid which is different from the natural media surrounding the impoundments that are part of the PRS boundary. These two models describe the media receiving contaminants, the fate and transport of releases to environmental media, and the exposure pathways to be used in the human health risk assessment. This investigation will provide data to refine these models and will use the pathways presented in these models to estimate the potential risk associated with the site and the potential for future transport of contaminants. Furthermore, an ecological conceptual exposure model will be used to support ecological screening, uncertainty analyses, and, if necessary, future sampling for a baseline ecological risk assessment. See the ecological pathways conceptual exposure model in the ecological scoping checklist included in Appendix A.

Based on the conceptual model, the next step was to perform a human health screening assessment (Appendix F), which resulted in a list of COPCs that will be carried forward to a human health risk assessment. However, a human health risk assessment will not be completed until all data from this sampling campaign are evaluated and a complete data set is available. Figure 1.4-1 illustrates the developmental process of this RFI WP/SAP.

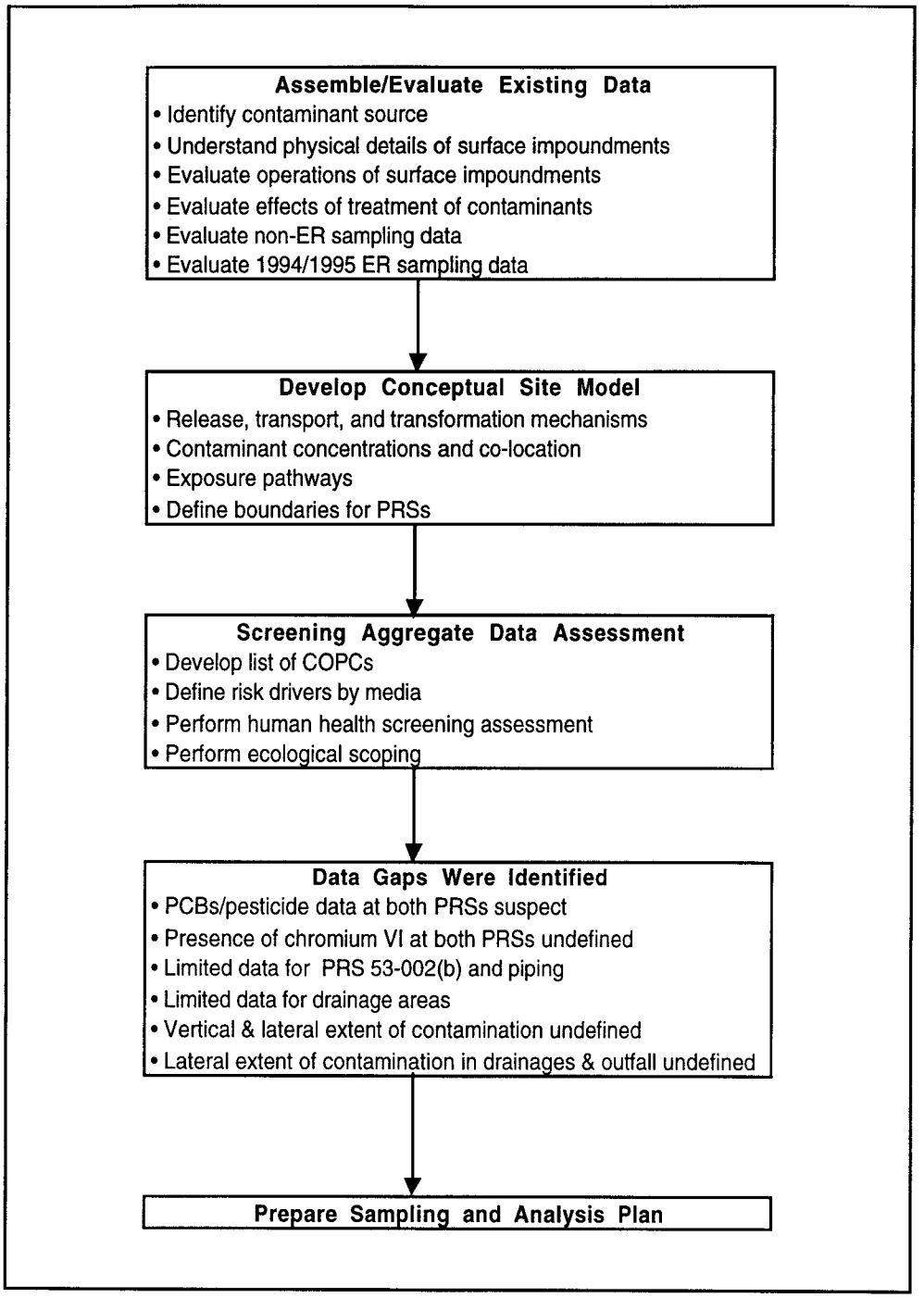


Figure 1.4-1 Summary of the process used to develop the RFI WP/SAP for TA-53, PRSs 53-002(a) and (b).

2.0 PRS 53-002(a) AND (b) NORTHERN SURFACE IMPOUNDMENTS AND SOUTHERN SURFACE IMPOUNDMENT, AND ASSOCIATED PIPING AND DRAINAGES

2.1 Characterization and Setting

2.1.1 Site Description

PRSs 53-002(a) and (b) comprise three surface impoundments collectively identified as TA-53-166, including adjacent piping and drainage areas at the east edge of Mesita de Los Alamos (Figure 2.1-1). Both PRSs are solid waste management units (SWMUs) listed in Module VIII of the Laboratory's Hazardous Waste Facility Permit. PRS 53-002(a) includes two northern surface impoundments and associated drainages and piping, while PRS 53-002(b) includes the southern surface impoundment. All three surface impoundments received sanitary and radioactive and industrial wastewater from various TA-53 facilities, as well as septic tank sludge from other Laboratory facilities. Currently the northern surface impoundments are inactive, dry, and partially covered with geotextile fabric to reduce potential airborne contamination. The southern impoundment is currently active and contains at least one foot of water and liquid sludge above the Hypalon™ liner. This impoundment is tentatively scheduled to be removed from service in late 1998.

The main activity at TA-53 centers around LANSCE and associated experimental areas. LANSCE produces intense sources of pulsed spallation neutrons, which provide the country's scientific community with the capability to perform experiments that support national security and civilian research. LANSCE comprises a high-power, 800-million-electron-volt, proton linear accelerator (linac); a Proton Storage Ring; production targets to the Manuel Lujan Jr. Neutron Scattering Center and the Weapons Neutron Research facility; and a variety of associated experimental areas and spectrometers. TA-53 also includes shops, warehouses, trailers for instruments and data logging, offices, and facilities for accelerator technology research. The surface impoundments are located near buildings TA-53-32, TA-53-621, TA-53-1071, and TA-53-1072. Structure TA-53-32 is a shed for the storage of miscellaneous nonchemical maintenance items. Structure TA-53-621 is a building used to store lead bricks used to operate the accelerator. TA-53-1071 and TA-53-1072 are storage facilities for oil used to operate the accelerator. The surface impoundments are enclosed by a 5-ft-high fence posted as a radiation controlled area. Access to the surface impoundments is via a paved road that is access-controlled at the entrance to TA-53. Twenty feet south of TA-53-32 is a locked fence gate that is key-controlled; this is the vehicle entrance area to the northern surface impoundments. An unpaved road extends from beyond the asphalt storage pad east of TA-53-32, around the east side of the surface impoundments, and ends on the south side of the southern impoundment at building TA-53-621. Figure 2.1-1 illustrates the surface impoundments in relation to TA-53 and its structures.

As stated previously the northern surface impoundments (northwestern and northeastern) are designated as PRS 53-002(a). The northern surface impoundments (constructed in 1969) are clay-lined, engineered structures designed to treat wastewaters (via retention of solids and evaporation of liquids) before discharge to a National Pollutant Discharge Elimination System (NPDES) permitted outfall, Serial Number 09S. Each impoundment is 210 ft in length by 210 ft in width by 6 ft deep and has a liquid storage capacity of approximately 1.6 million gal. To minimize the volume of water discharged to the outfall, two Aqua Aerobics™ surface turbine aerators were used in each impoundment for aeration and enhanced evaporation.

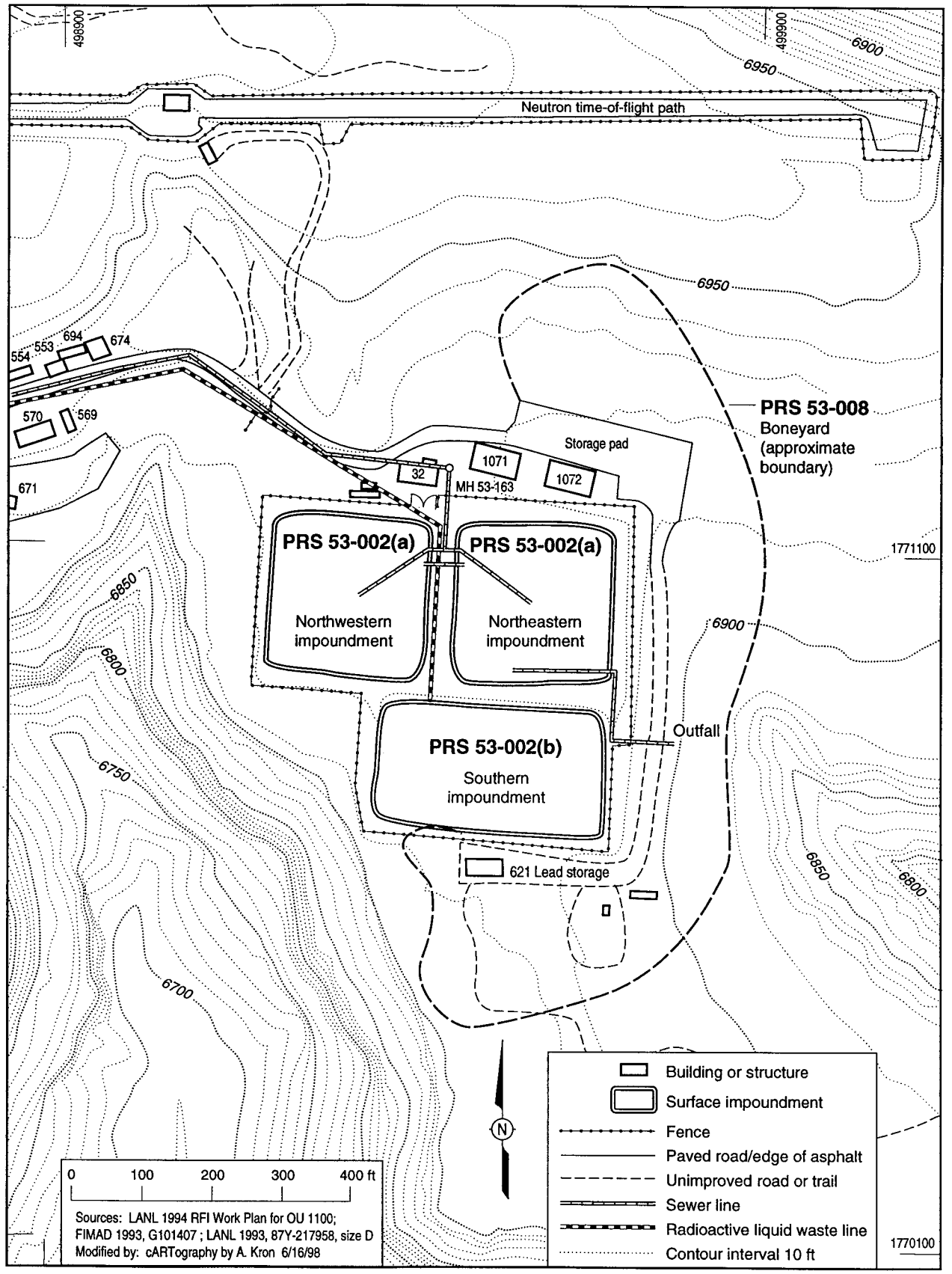


Figure 2.1-1. Current configuration of the TA-53 surface impoundment

The northwestern surface impoundment was constructed by excavating into native tuff, which was then pulverized and used as engineered material to construct the 2:1 (horizontal slope is twice that of the vertical slope) side slopes. The pulverized tuff (essentially a cohesionless soil) (Boyd 1966, 37866) was placed in layers and compacted to 90% of the maximum density as defined by the Modified Proctor (ASTM D1557) (LANL 1992, 29413) as the first layer of the engineered structure. The clay liner, the next layer of engineered material overlying the pulverized tuff, consists of a 4-in. layer of bentonite clay. The clay liner was compacted to 95% of the maximum density as defined by the Modified Proctor. Gunite (liquid concrete) was applied to the side slopes of the northern impoundments as a liner (4 to 6 in. thick) for the side walls. Figure 2.1-2 is a cross-section diagram of the surface impoundments.

The northeastern surface impoundment is similar to the northwestern surface impoundment. Because the surface grade naturally slopes from west to east, crushed tuff was used as fill beneath the northeastern surface impoundment to create a grade equivalent to the northwestern impoundment.

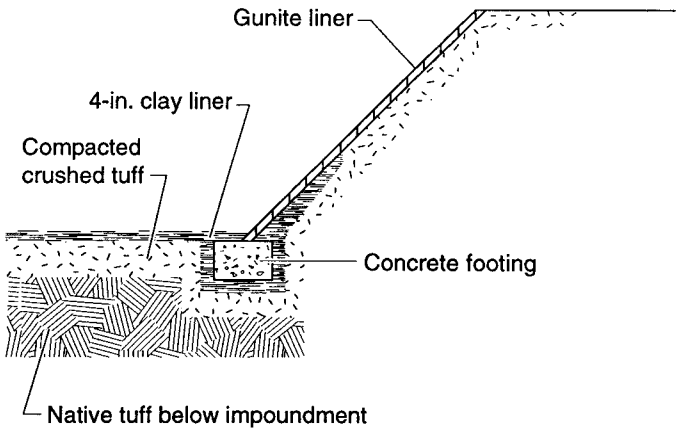
The initial design of the northern surface impoundments included an emergency overflow system that discharged into a south-lying drainage ditch. This overflow system consisted of an overflow pipe connecting the two surface impoundments and a discharge pipe that ran southward through the impoundment berm, terminating immediately after it emerged from the berm. The pipes and unlined ditch that accepted effluent discharges from 1970 to 1985 are depicted on Figure 2.1-3. An outfall structure with a blank weir plate was located at the junction of the discharge pipes.

The original 1968 grading plan for the northern surface impoundments was revised in 1971 to an as-constructed drawing (ENG C57815). The as-constructed drawing for the northern surface impoundments shows a drainage ditch exiting from between the two surface impoundments. The drawing shows the drainage ditch continuing south for approximately 100 ft, while turning slightly to the west toward a tributary of Sandia Canyon. In the drawing, the drainage ditch is shown to end on the 6914 ft contour, approximately 100 ft south of the northwestern impoundment. It is not known if a drainage ditch was ever used for discharges to Sandia Canyon; therefore, samples will be collected north and south of the southwest corner of the southern impoundment and on a bench leading to Sandia Canyon to ascertain whether any contamination exists in this area.

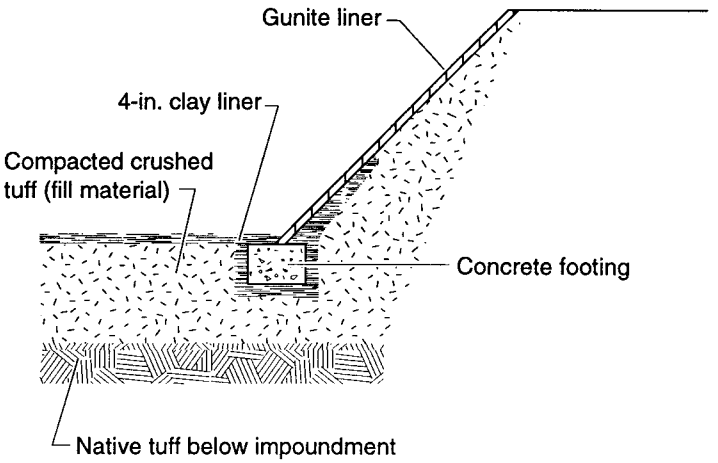
The grading plan for the southern impoundment also shows information pertaining to the unlined drainage ditch exiting from the northern surface impoundments. The drainage ditch exits from the south side of the northern impoundments, turns east, and terminates in the current rock-lined drainage area at the head of the tributary to Los Alamos Canyon (ENG C4472, no date). This drainage ditch was used to route wastewater discharge (Figure 2.1-3). A discharge pipe from the northeastern impoundment currently ends at an NPDES-permitted outfall that drains to a side canyon of Los Alamos Canyon. Because no complete information exists about the history and use of this discharge pipe, the drainage area and selected areas in the side canyon are included in this sampling plan.

In 1985, PRS 53-002(b), the southern surface impoundment, was constructed south of the two existing surface impoundments to accommodate excess wastewater from the northern surface impoundments. The southern impoundment is approximately 305 ft in length by 148 ft in width by 6 ft deep, with a liquid storage capacity of 2.5 million gal.

TA-53 Northwestern Surface Impoundment



TA-53 Northeastern Surface Impoundment



TA-53 Southern Surface Impoundment

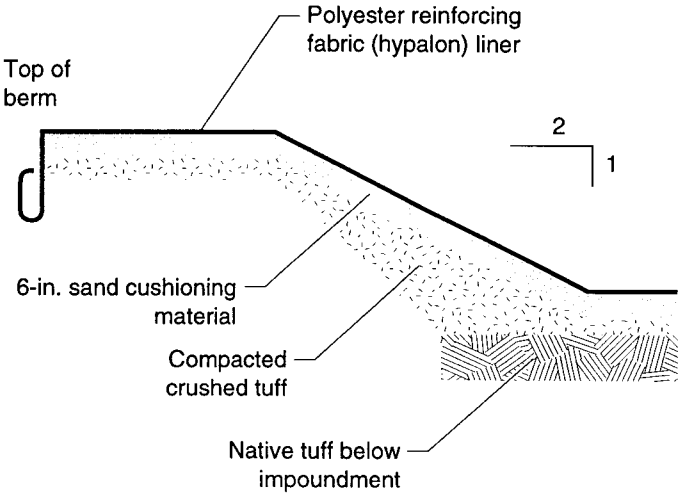


Figure 2.1-2. Cross section of surface impoundments

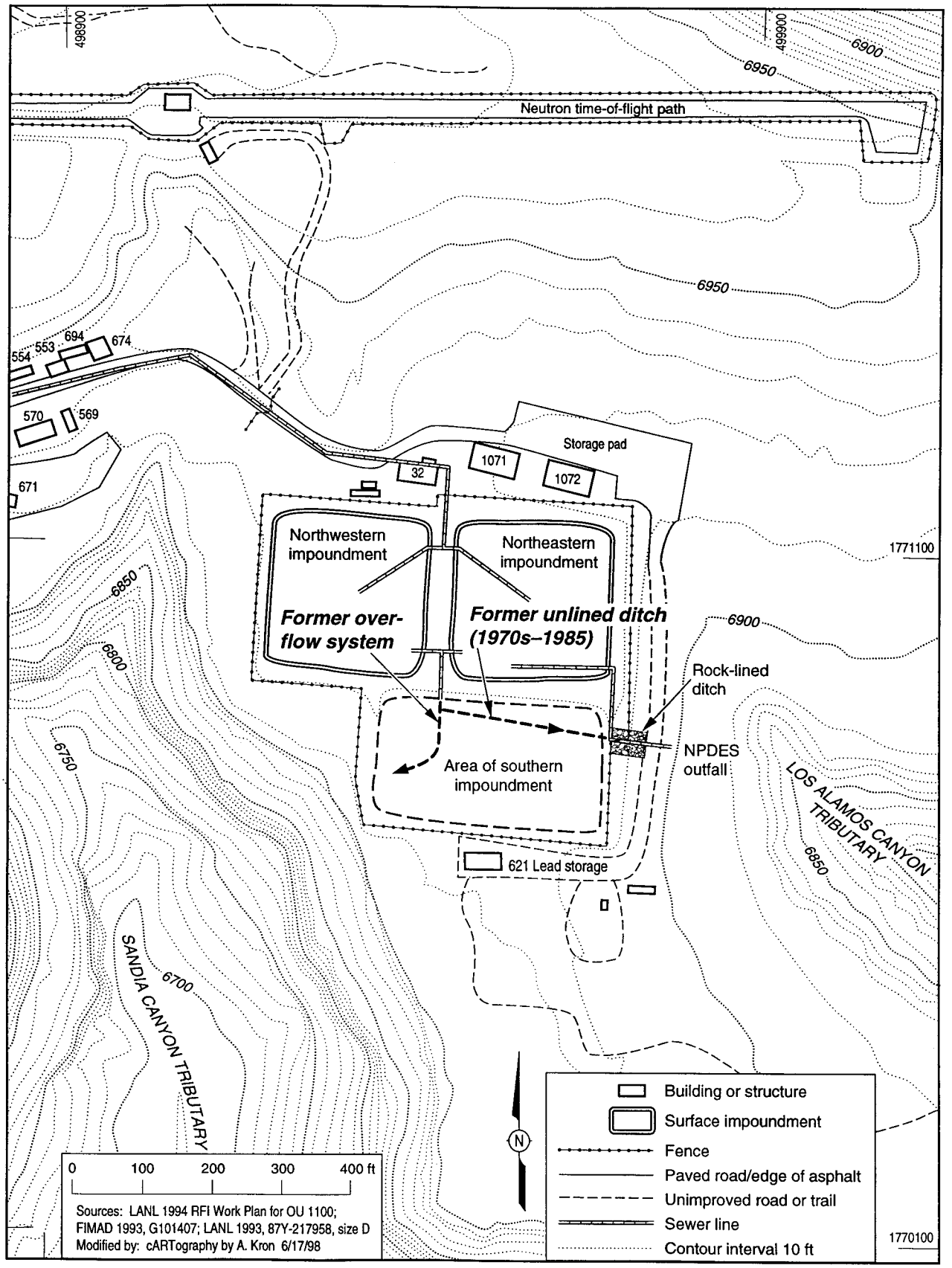


Figure 2.1-3. Location of former drainage pathways from northern impoundment

Similar to the northern surface impoundments, the southern impoundment was constructed by excavating into native tuff. The southern surface impoundment grading plan, ENG C 44772, shows that virtually the entire former northern surface impoundment's drainage ditch exiting to the Los Alamos Canyon tributary was obliterated during construction. The native tuff was then pulverized and used as engineered material to construct the 2:1 (horizontal:vertical) side slopes and bottom of the impoundment. The pulverized tuff (Boyd 1966, 37866) was placed in layers and compacted to 90% of the maximum density as defined by the Modified Proctor. The first layer of material over the excavated native tuff consisted of 12 in. of pulverized tuff and was compacted to at least 95% of the maximum density as defined by the Modified Proctor. A 6-in. sand layer was placed over the compacted tuff in the bottom of the impoundment. The sand was compacted to at least 85% of the maximum density as defined by the Modified Proctor. The sand served as a cushion to protect the final layer of material, a 36-mil Hypalon™ liner, from sharp points and edges (LANL 1992, 29413). The Hypalon™ liner was manufactured specifically for the southern impoundment and consists of 50-to 60-ft-wide sections of a rubber-polymer material seamed together to make a water-impervious liner that completely fits over the bottom and sides of the impoundment.

Land Use

TA-53 is an industrial area currently used for various experimental physics programs. The Laboratory does not anticipate any change from this industrial use in the future (LANL 1995, 57224). TA-53 is a controlled access area: only those individuals with Laboratory badges or those escorted by a badge holder are allowed beyond the checkpoint into the TA. These security measures, along with the locked gate at the road to the impoundment, effectively reduce the possibility of inadvertent site intrusion.

Relation to Other PRSs

PRS 53-008 is adjacent to the surface impoundments. It encompasses the area northeast, east, and southeast of the surface impoundments (Fig. 2.1-1). PRS 53-008, known as the "Boneyard," is used as a storage area for pieces of shielding equipment from the operations at TA-53. This PRS was sampled during 1995. Because the east trending drainage area from PRS 53-002(a) overlaps the area sampled as PRS 53-008, contamination detected in the drainage was incorrectly attributed to PRS 53-008. Because no other contamination was detected at levels requiring further action at PRS 53-008 (except for the three samples within the boundary of PRS 53-002[a]), no further sampling will be performed within the "Boneyard." The data collected in 1995 from PRS 53-008 will be presented in a future RFI report for PRSs 53-002(a,b), which will contain the information obtained from implementing this SAP. These three PRSs will be aggregated into one RFI report because of their close geographical proximity and the need to evaluate the entire area in the ecological screening assessment.

Other PRSs that influence PRSs 53-002(a,b) are the radioactive liquid waste holding tanks designated as PRSs 53-006(b,c,d,e). These tanks and associated drainlines previously emptied into PRS 53-002(a) and currently drain to PRS 53-002(b). The holding tanks and associated piping will be evaluated through a separate sampling and analysis plan and field campaign.

Physical Description

Geology. TA-53 is located on Mesita de Los Alamos, which is bounded to the north by Los Alamos Canyon and to the south by Sandia Canyon. Site-specific geologic stratigraphic and structure maps of the surface impoundments at TA-53 do not exist; however, the general stratigraphy can be inferred from the numerous boreholes that have been installed in the vicinity of the site. Mesita de Los Alamos is comprised of a series of unconsolidated sediments and volcanic rocks and is typical of a terrain produced by concurrent sedimentation and volcanism. In ascending order, the following rock units are present at Mesita de Los Alamos: the Tesuque Formation, the Puyé Formation, the Cerros del Rio basalts, and the Bandelier Tuff (Figure 2.1-4). The Tesuque Formation, consisting of siltstone and sandstone with conglomerate lenses and basalt layers, is overlain by conglomerates and sandstones of the Puyé Formation. Overlying and interfingering with the Puyé Formation are the Cerros del Rio dense basalt flows and scoria deposits. The Bandelier Tuff, which consists of numerous ashfall and ashflow units and overlies the Puyé Formation and Cerros del Rio Basalts, caps the mesa.

The Bandelier Tuff at Mesita de Los Alamos consists of the Tshirege, Otowi, and Guaje Members. The Tshirege Member has been broken out into distinct units. The units present at the TA-53 surface impoundments are Tshirege 2B, 2A, 1B, and 1A (Figure 2.1-5). The local thicknesses of these units are approximately 65 ft, 45 ft, 20 ft, and 23 ft, respectively.

The TA-53 surface impoundments were installed in Tshirege Unit 2b of the Bandelier Tuff. The geologic and hydrogeologic characteristics of this unit are expected to have the most significant impacts on subsurface fluid and contaminant mobility. Tshirege 2b is a moderately welded, cliff-forming unit. Cooling and tectonic fractures and fracture zones are common in the unit.

The Otowi Member underlies the Tshirege Member and varies from about 120 to 180 ft thick. The Guaje Member is approximately 35 ft thick. Underlying the Bandelier Tuff are the Puyé Formation and the Cerros del Rio Basalts, which have a combined thickness of at least 680 ft in the area near TA-53.

Groundwater Hydrology. Groundwater is known to occur in three distinct modes in the vicinity of the TA-53 impoundments. The regional aquifer directly underlies the impoundments at great depth. Intermediate depth saturated horizons have been observed near the impoundments, and shallow groundwater may occur in the Sandia Canyon alluvium south of the site and the Los Alamos Canyon alluvium east of the site. The depth to the regional aquifer at TA-53 is estimated to be 1000 ft below land surface, and it is the only known aquifer in the Los Alamos area capable of producing a municipal and industrial water supply. In the area of TA-53, the upper surface of the regional aquifer is contained in the conglomerates and sandstones of the Puyé Formation. The direction of groundwater flow in the uppermost aquifer in this region is to the east-southeast, from west of the Pajarito Plateau to the Rio Grande. The velocity of the groundwater ranges from 20 to 250 ft/year.

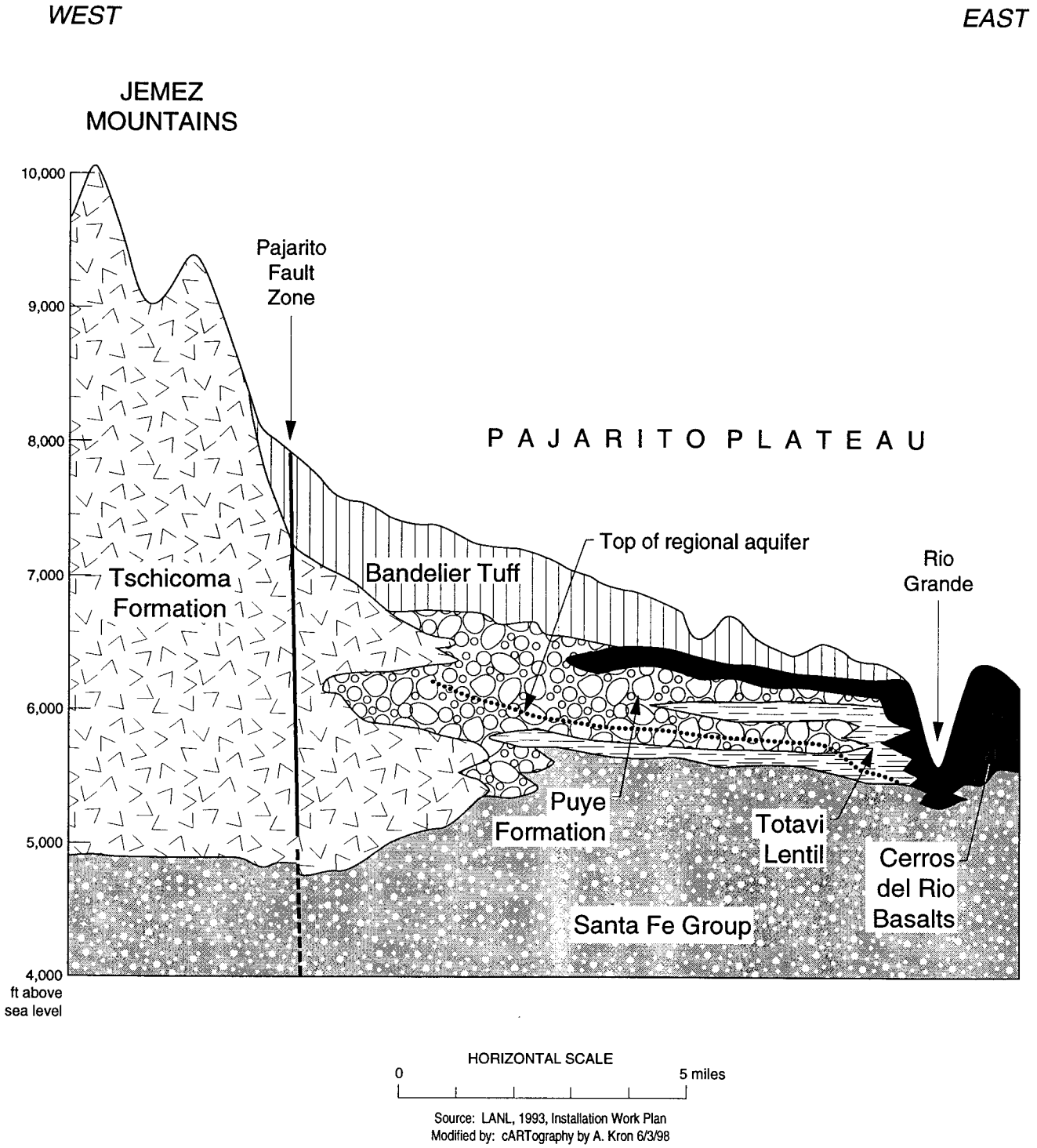


Figure 2.1-4. Geologic section showing stratigraphy

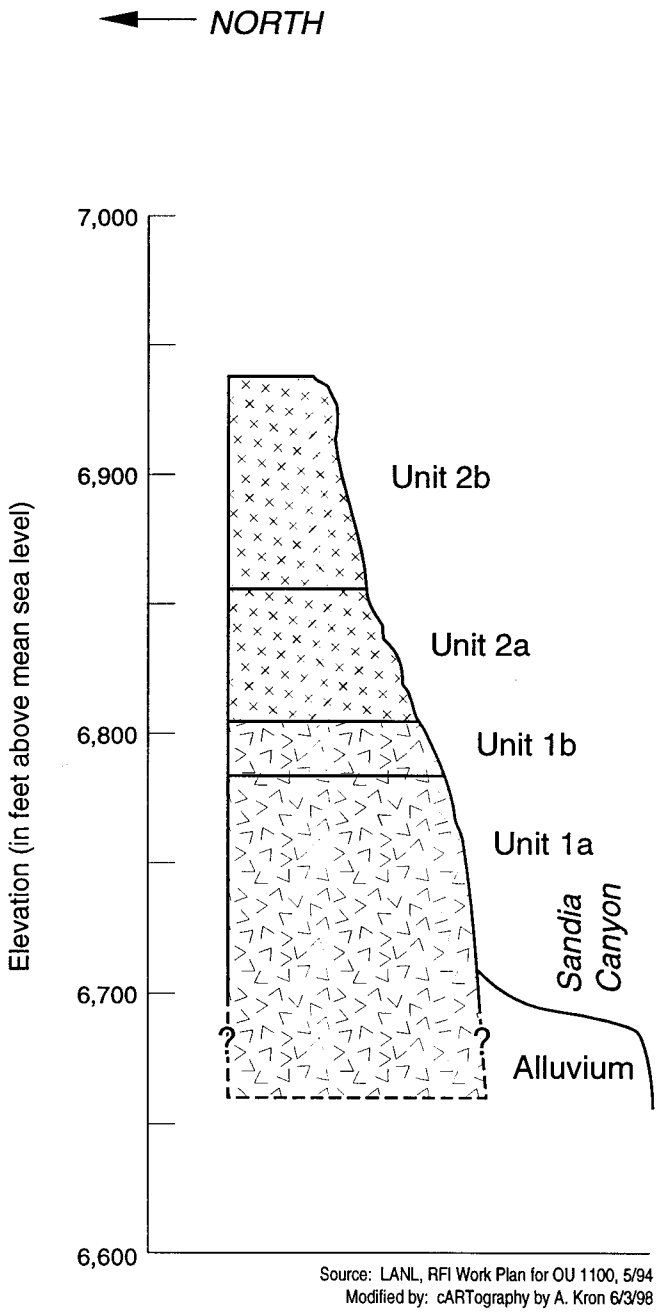


Figure 2.1-5. Stratigraphy of the Tshirege Member

The transmissivity of the regional aquifer at the PM-3 water supply well in Sandia Canyon, 3000 ft southeast of the surface impoundments, is approximately 320 000 gal. per day per ft. The regional aquifer was encountered at a depth of about 750 ft below the land surface at the Otowi-4 water supply well in Los Alamos Canyon, just northwest of the TA-53 surface impoundments.

There is evidence that intermediate saturated horizons may also exist beneath the TA-53 surface impoundments. Perched groundwater was encountered at a depth of about 450 ft in water supply well PM-1 when the well was being installed in 1965. This well is located near the eastern boundary of TA-53 in Sandia Canyon (Environmental Protection Group 1993, 23249). The saturated horizon is located in the Cerros del Rio Basalts and is separated from the top of the regional aquifer by approximately 298 ft of basalt and conglomerate. Otowi-4 also evidenced perched groundwater when it was installed in 1990 (Figure 2.1-6). Perched groundwater was encountered at a depth of approximately 253 ft, where water cascaded into the hole from a layer of large gravel within the upper section of the Puyé Formation above Cerros del Rio basalts. This saturated horizon is separated from the top of the regional aquifer by about 527 ft of conglomerate and basalt (Stoker et al. 1992, 12017). The lateral extent of these perched groundwater bodies is not known, but they are believed to be limited. It is not known if the perched groundwater at PM-1 is connected to the perched groundwater at Otowi-4. It is also not known if these intermediate-depth groundwater bodies are hydraulically interconnected with the regional aquifer.

An alluvial groundwater body of limited extent could potentially be present in the upper portion of Sandia Canyon. Two observation wells installed in Sandia Canyon indicate that an alluvial groundwater system does not exist in the lower reaches of the canyon (Purtymun and Stoker 1990, 07508). The two wells, SCO-1 and SCO-2, were installed near existing water supply wells PM-1 and PM-3 as required by the HSWA Permit (Figure 2.1.6). SCO-1 was drilled to a depth of 79 ft, and SCO-2 was drilled to a depth of 29 ft. The alluvium is about 18 ft thick in both boreholes. Both wells were completed at a depth of 20 ft, in weathered tuff (Purtymun and Stoker 1990, 07508).

Shallow, alluvial groundwater occurs in several canyons within the Laboratory's boundaries. The alluvial groundwater typically exists as a narrow ribbon of saturation along the canyon bottoms, and is perched on the underlying silts, clays, and/or tuff. The alluvial groundwater is typically of limited lateral extent and is recharged by surface water flow consisting of intermittent runoff and effluent discharges. The horizontal extent and the thickness of saturation vary throughout the year. Spring snowmelt and late summer runoff cause the water levels to rise and the groundwater to advance down the canyon. In early summer, fall, and winter, the water levels typically decline and the groundwater retreats up the canyon. These same hydrologic effects take place in response to variations in the flow of treated industrial/sanitary effluents. The water levels may vary by 10 ft or more in the course of a year (Purtymun and Stoker 1990, 07508). It has been assumed that there is no hydraulic connection between the alluvial aquifer and the regional aquifer; however, there are no conclusive data to support this contention (LANL 1993, 46402; LANL 1993, 46403).

Shallower saturated horizons have not been observed in any of the numerous other boreholes installed in the region of the TA-53 surface impoundments; however, saturated intervals have been identified in the Bandelier Tuff elsewhere at the laboratory and similar intervals beneath the surface impoundments cannot be ruled out.

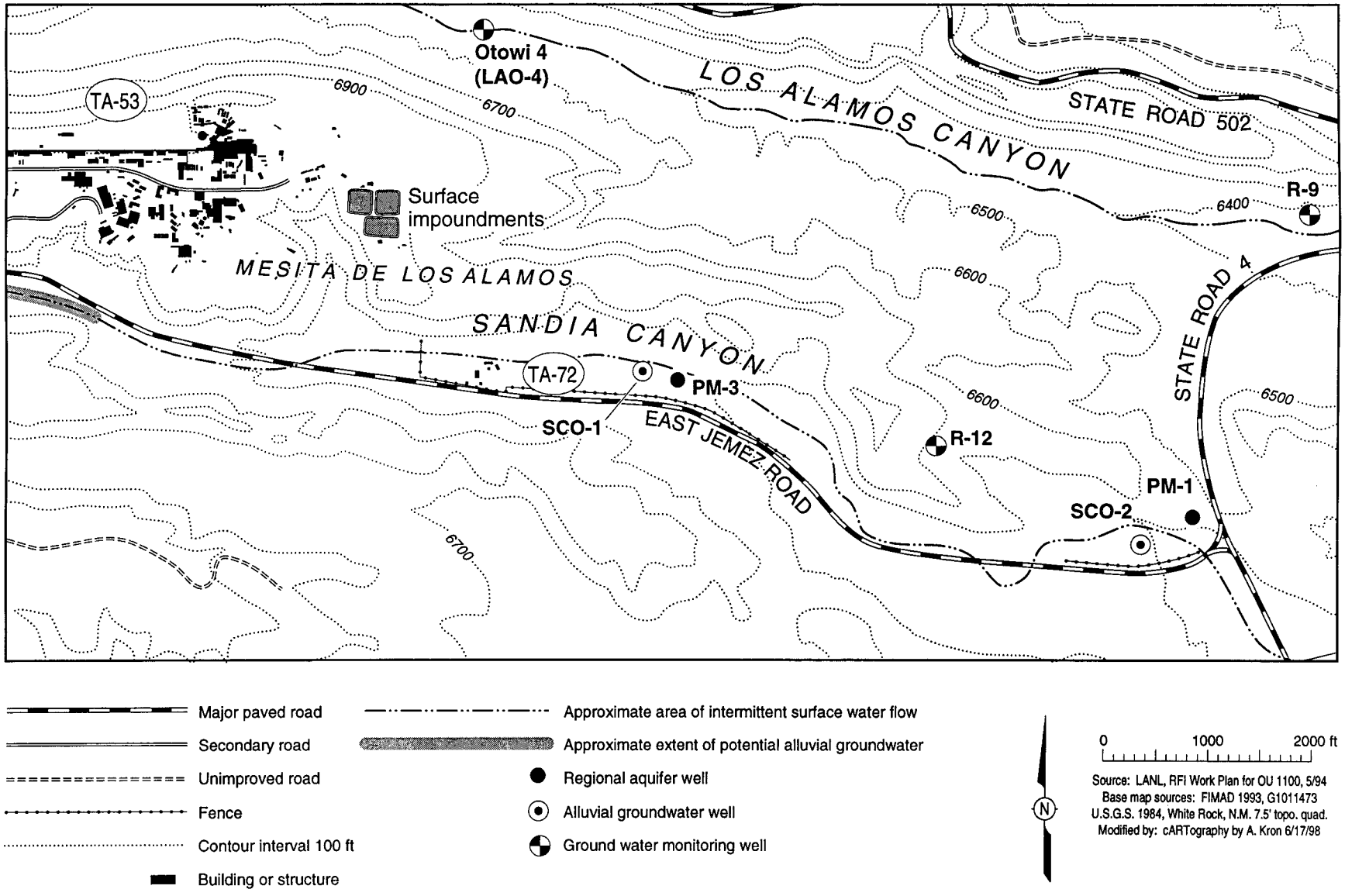


Figure 2.1-6. Approximate locations of groundwater wells

Eight boreholes were drilled and several monitoring wells (neutron-moisture access wells) were installed in 1991 in the area immediately surrounding the TA-53 surface impoundments in support of the Laboratory's groundwater monitoring waiver demonstration.

The data collected from the eight boreholes indicate that the Tshirege Member of the Bandelier Tuff in the vicinity of the TA-53 impoundments is very porous. The porosity values are at the upper end of the typical range for loose silts and sands and in some cases exceed the typical values for sandstone. The tuff at the impoundments is also fairly conductive under saturated conditions; the hydraulic conductivity values are within the typical range for loose silt and exceed typical values for consolidated sandstone. The moisture data suggest that the tuff is below saturation levels beneath the surface impoundments but the moisture values are relatively higher at the impoundments than what is typically observed in similar material at TA-53. Moisture values for the Tshirege Member at TA-53 typically range from 2% to 4% compared to the 5% to 18% range observed at the TA-53 impoundments. This may indicate that some leakage from the impoundments has occurred.

The 1992 groundwater monitoring waiver request was denied May 30, 1995 by NMED for the following reasons:

- There was no site characterization to determine the uppermost aquifer below the site, specifically the nature of perched water (if any) at the site.
- Potential vapor phase flow and fracture flow was inadequately characterized/ evaluated; saturated porous media flow was assumed as the only transport model.
- Using a mean annual precipitation to calculate evapotranspiration was not adequate to account for all possible water balance at the site, and recharge mechanisms were inadequately understood.

Data resulting from this TA-53 investigation will incorporate information gained from the ongoing hydrogeologic work plan implementation for groundwater information at the laboratory.

Surface Water Hydrology. None of the three surface impoundments are within the 100-yr floodplain boundary (LANL 1992, 29413). The surface impoundments are bordered on the north by Los Alamos Canyon and on the south by Sandia Canyon. The nearest perennial navigable streams are in both Los Alamos and Sandia Canyons. The upper reaches of both canyons also have perennial streams. Sandia Canyon has a smaller drainage area than Los Alamos Canyon, and both are subject to high runoff during periods of localized, high-intensity summer thunderstorms. Perennial flow is maintained in sections of Los Alamos and Sandia Canyons by the release of effluent from industrial waste treatment plants, sewage plants, and cooling water from a power plant. Stream loss because of infiltration into the underlying alluvium and evapotranspiration typically prevents surface flow in these canyons from discharging across the eastern boundary of the Laboratory. However, during periods of excessive storm runoff or snowmelt, surface flow may reach the Rio Grande (Stephens et al. 1993, 56863). Additionally, there is no debris in any watercourse associated with PRSs 53-002(a) and (b).

Storm Water Runoff and Erosion. Storm water runoff from the area surrounding the surface impoundments flows away from the surface impoundments and ultimately to Los Alamos and Sandia Canyons (LANL 1992, 29413). The southeast area is estimated to have less than a 10% grade by the ER Administrative Procedure (AP) 4.5 assessment (score of 47.8 for PRS 53-002[a] and 3.6 for PRS 53-002[b]); the assessment is located in Appendix B. The estimated vegetative cover surrounding the surface impoundments is currently 5%. At present, some erosion of the berms surrounding the three surface impoundments is occuring.

Assessment of Ecological, Cultural, and Biological Resources

As required by the National Historic Preservation Act of 1986 (as amended), a cultural resource survey was conducted during the summer of 1993 in the vicinity of TA-53. There are no cultural resources located within the area of the surface impoundments.

During 1993, field surveys were also conducted within TA-53 by the Biological Resource Evaluations Team (BRET) of the Environmental Protection Group (ESH-8). The field surveys were conducted to identify critical habitats for the state or federal sensitive, or threatened and endangered plant and animal species listed in Appendix C. This list consists of the threatened and endangered species that may be present but not necessarily found at TA-53, if suitable habitat are available. According to the Laboratory's Ecology Group (ESH-20), all of TA-53 is considered to be within threatened and endangered habitat. However the habitats associated with the PRSs discussed in this SAP are not suitable for threatened and endangered species and are considered to be developed (see the ecological assessment and scoping checklist in Appendix A).

An ecological scoping evaluation was conducted for the surface impoundments at TA-53, following the ecological screening process (ER Project 1998, 57916). A scoping evaluation of the PRSs and the surrounding area was conducted in conjunction with a site visit in February 1998. This evaluation, which is the first step in the ecological screening process, is equivalent to the problem formulation step described in EPA's *Framework for Ecological Risk Assessment* (EPA 1992, 48847) and *Ecological Risk Assessment for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA 1997, 48846). A summary of the ecological evaluation and the ecological scoping checklist are provided in Appendix A.

Based on the information provided from the ecological scoping checklist and the list of COPCs from PRS 53-002(a), including the presence of potentially persistent bioaccumulators, PRSs 53-002(a) and (b) are a potential source of ecological concern. The sampling investigations proposed for these PRSs as well as the associated PRS 53-008 and the adjacent canyon drainages are necessary in order to properly characterize this area for ecological risk. Although the ecological risk to the surrounding area cannot be evaluated separately for each of the surface impoundments or drainages, the elimination and/or management of these potential sources of contamination would prevent the dispersal of contaminants, reduce the physical disturbance of the surrounding area (e.g., erosion), and reduce the level of potential risk to ecological receptors.

2.1.2 Operational History

The northern surface impoundments were originally planned as wastewater retention surface impoundments. The surface impoundments received a variety of wastewater from throughout the Laboratory, including sanitary and radioactive liquid wastewater from lines serving 420 structures within TA-53 (including the accelerator), and direct discharges into the surface impoundments from vacuum trucks disposing septic tank sludge from throughout the Laboratory. Available information does not provide specific waste types associated with these practices. Wastewater characterization reports prepared for the Environmental Protection Group (ESH-8), do not identify any discharges of hazardous wastes to the sanitary sewer or radioactive liquid waste system. Certain facilities were identified as discharging drainage from a variety of equipment, including chillers, water heaters, pressure relief valves, air conditioners, boilers, compressors, and vacuum pumps. Septic tank discharge to the surface impoundments might have contained chemical or radioactive contamination and could have been a source of hazardous constituents to the surface impoundments. Septic sludge was not characterized before disposal, so no information exists concerning constituents that may actually have been disposed in the surface impoundments. However, based on the 1987 Comprehensive Environmental Assessment and Response Program (CEARP) report, the 1990 SWMU report, and the 1991 septic tank inventory list maintained by ESH-8, there is a potential for waste from these septic tanks to contain both radionuclides and hazardous constituents (LANL 1998, 58366).

The initial design of the two northern surface impoundments included an emergency overflow system that discharged to the south of the these surface impoundments. When the surface impoundments became operational in the early 1970s, it became clear that the original design was inadequate and discharges to another impoundment would be necessary. Approximately one year after the northern surface impoundments became operational, the blank weir plate connected to the overflow and discharge pipes was replaced with a notched weir plate to allow discharge and flow measurement. An automatic flow-measuring device was added to keep a continuous record of all discharges. The effluent from the discharge pipe flowed into an east-west trending ditch that drained eastward into a tributary of Los Alamos Canyon. It is not known whether any effluent ever flowed into Sandia Canyon.

The northern impoundment system was rated at a 120 000 gal. per day on a flow-through treatment basis. The system was operated in a batch mode, with discharges planned to occur two or three times a year to the Los Alamos Canyon tributary through an NPDES-permitted outfall (NPDES Serial No. 09S). The Laboratory received the permit in October 1978. When the decision was made to discharge to the outfall, effluent was sampled according to EPA Form 2C instructions. Parameters included biological oxygen demand (BOD), pH, and total suspended solids (TSS).

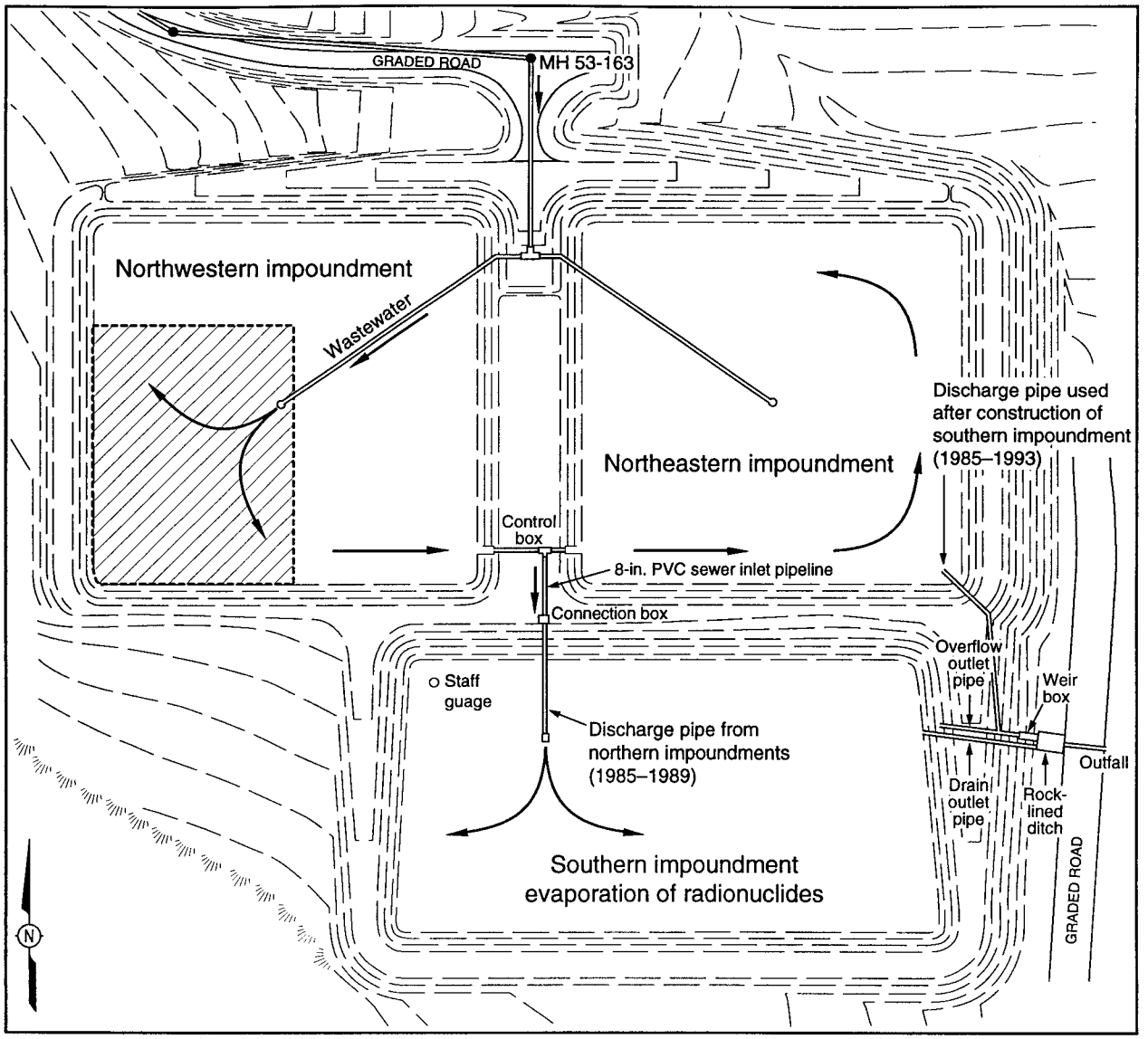
Both the northern surface impoundments frequently reached capacity and discharged to the NPDES outfall. It is believed that discharges actually occurred on a continuous (uninterrupted) basis. Violations of the NPDES permit were frequent for pH, TSS, and BOD parameters. A Federal Facilities Compliance Agreement (FFCA) was established in 1983 that contained a schedule to install sand filters intended to correct the violations; however, the sand filters were never installed. Therefore, two aerators and a third impoundment, PRS 53-002(b), were installed in 1985.

When the northern surface impoundments were close to reaching capacity, wastewater was diverted to the southern impoundment, PRS 53-002(b), to maintain appropriate liquid levels (1985 – 1989). Therefore releases to the NPDES outfall from the northern impoundments was reduced from continuous releases to releases every four to six months. Figure 2.1-7 shows flow patterns within the surface impoundments.

In 1989 the diversions to the southern surface impoundment from the northern surface impoundments were discontinued and the southern impoundment was put into service as a total retention radioactive liquid storage impoundment (LANL 1992, 29413). At various times of the year there is very little effluent directed to the southern impoundments from the upstream TA-53 facilities. Therefore, additional water was required to hold down the Hypalon™ liner within the southern impoundment, and potable water was added. An additional waste stream was discharged to the southern impoundment during January 1997. This waste stream consisted of approximately 18 000 gal. of nonradioactive, nonhazardous cooling tower water from two cooling towers (TA-53-62 and TA-53-64). This waste stream would typically be discharged to an NPDES-permitted outfall if it meets the concentration limits in the NPDES permit. However, the water could not be discharged to the outfall because the arsenic level (40 ppb) exceeded the allowable discharge limit.

From 1989 to 1993 the northern surface impoundments received sanitary wastewater only and discharged the effluent (sanitary only) to the Los Alamos Canyon tributary outfall on a continuous basis. Records of discharge volumes from the period October 1978 through January 1993 are presented in Appendix D. Records of discharge volumes before October 1978 either no longer exist or cannot be located. Simple summation of the discharge records show that a minimum of 60 million gal. of effluent was discharged into the outfall. There are no records of the chemical composition of the discharge other than pH, BOD, and TSS. From 1989 to 1991, the northern surface impoundments also received all septic tank sludge from the Laboratory. The two northern surface impoundments were taken out of service in 1993 when TA-53 was connected to the TA-46 SWSC. The SWSC connection occurs at manhole 53-163, shown in Figure 2.1-7. The area immediately east of the decommissioned discharge pipe into Los Alamos Canyon from PRS 53-002(a) has been stabilized by implementing a best management practice (BMP). Straw bales have been put in place to minimize runoff and erosion of contaminants in the approximately 150 ft length of area before the canyon drops sharply.

An overflow pipe in the southern impoundment was installed to allow discharge in the event the water in the impoundment reached high levels. However, the overflow pipe was locked and tagged out in 1989 and discharges never took place. The pipe was locked because any discharges from the pipe would not be covered by the NPDES permit. Laboratory staff familiar with past operations of the southern impoundment reported that the water level in the southern impoundment had never exceeded or overflowed the impoundment berms (LANL 1992, 29413). As stated above, the southern surface impoundment is still receiving radioactive liquid waste. The operating group is committed to stopping all waste discharge to the southern surface impoundment by late 1998.



See Figure 2.1-3 for discharge area proir to 1985.

Sources: LANL 1968, ENG-C 57815
LANL 1988, ENG-C 44772
LANL 1992, ENG-C 45523

Contour interval 2 ft
Piping
Manhole
Area of highest concentration of contaminants
Direction of wastewater flow
Canyon rim

0 50 100 ft

cARTography by A. Kron 6/16/98

Figure 2.1-7 Flow of wastewater through impoundments, 1985-1993

2.1.3 Waste Characteristics

This section addresses the potential contaminants that may be present at this PRS based on the information contained in Section 2.1.1, Site Description, and Section 2.1.2, Operational History. This information is potentially relevant to waste (only to the extent that 'solid waste' is a term defined only under RCRA) and is subsequently generated at this PRS. This discussion of potential contaminants in no way implies that the materials present at this PRS are 'solid waste' or 'hazardous waste' as those terms are defined under the New Mexico Statutes Annotated (NMSA), the New Mexico Administrative Code (NMAC), RCRA, HSWA, Safe Drinking Water Act (SDWA), or other statutes or regulations.

Based on the PRS description, site operational history, and an evaluation of the 1994/1995 sampling data, the potential contaminants that may be present in future waste streams generated from a potential voluntary corrective action (VCA) or corrective measures implementation (CMI) at PRSs 53-002(a) and (b) and the associated drainages include:

PCBs:	Aroclor-1254 and Aroclor-1260;
Pesticides:	BHC(alpha-), BHC (gamma-), dieldrin, DDT and metabolites, endrin, endosulfin I, heptachlor;
SVOCs:	Bis(2-ethylhexyl)phthalate;
VOCs:	Acetone, methylene chloride, 2-butanone, toluene, trichlorofluromethane;
Metals:	TAL metals plus mercury; and,
Radionuclides:	Tritium, cesium-134, cobalt-57, cobalt-60, manganese-54, neptunium-237, sodium-22, strontium-90, plutonium 238, plutonium 239/240, uranium-234, uranium-235, uranium-238.

2.2 Investigatory Approach

2.2.1 Existing Data

2.2.1.1 Nonsampling

The nonsampling investigations conducted at the surface impoundments and drainage areas are limited to the threatened and endangered species survey, which was described previously in Section 2.1.1, Cultural and Biological Resources; the AP 4.5 assessment for stormwater run-on and runoff, which was also described previously in Section 2.1.1, Erosion and Runoff; the completion of discharge records previously referenced in Section 2.1.2, Operational History; and the ecological site assessment and scoping checklist presented in Appendix A.

2.2.1.2 Sampling

This section describes previous sampling investigations that have been conducted at PRSs 53-002(a) and (b). Because the extent of such investigations varies between the PRSs the information is presented chronologically by PRS below. All data for chemicals detected during sampling in 1988, 1991, and 1992 is presented in Appendix E. Table 2.2-1 provides an overview of what each summary table contains.

This section also contains the information obtained during the 1991 monitoring well installations in support of the Laboratory's groundwater monitoring waiver demonstration. The text follows in the Vadose Zone Characterization subsection, and the tables of analytical results and hydraulic properties testing results are presented in Appendix E. Table 2.2-2 indicates which table contains data for each borehole.

Note that the results of environmental monitoring include some radionuclides that are not reported as COPCs by the Laboratory's ER project. For example, beryllium-7 and rubidium-83 have short half-lives (53 days for beryllium-7 and 83 days for rubidium-83), and they quickly decrease to undetectable concentrations. Thus, beryllium-7, rubidium-83, and other short lived radionuclides are not currently analyzed for or reported by this ER Project Investigation.

Northern Surface Impoundments, PRS 53-002(a)

The sludge and water in the two TA-53 northern surface impoundments were previously analyzed in four separate sampling events: by the DOE Headquarters Environmental Survey in 1988 (DOE, 1989), by the Laboratory's Environmental Compliance Group (ESH-8) in 1991 and 1992, and by the ER Project in 1994/1995. Because the data generated during the first three sampling campaigns were not validated or assessed for usability in accordance with the Laboratory's ER Project protocols prior to writing this RFI WP/SAP, it was used qualitatively to guide the selection of analytical suites for this RFI WP/SAP. Data from the 1994/1995 sampling campaign were used qualitatively to help design this sampling and analysis plan.

Results from1988 Sampling. The DOE Headquarters Environmental Survey sampled sludge from the two surface impoundments during 1988 (DOE 1989,15367). Three samples, each composited from subsamples collected at three locations, were collected from each impoundment. The subsamples consisted of grab samples collected using a pole-mounted beaker. Volatiles analysis was performed on one of the three subsamples rather than on the composite, so that volatiles would not be lost during compositing. Each sample was analyzed for VOCs, SVOCs, metals, and gamma-emitting radionuclides. The results indicate that two volatiles (acetone and toluene) and six semivolatiles (benzoic acid, benzyl alcohol, fluoranthene, 2-methyl phenol, 4-methyl phenol, and pyrene) were detected, although most of these results are suspected of being false positives (DOE 1989, 15367).

Results from the gamma analyses showed the following radionuclides as being detected in all six samples: beryllium-7, sodium-22, manganese-54, cobalt-56, cobalt-57, cobalt-58, cobalt-60, zinc-65, selenium-75, rubidium-83, yttrium-88, and cesium-134. In addition, scandium-46, and zirconium-88 were seen in three samples, silver-110m in two samples, cadmium-109 in one sample, and natural potassium-40 in all six samples. In general, samples from the northwestern impoundment contained higher concentrations than samples from the northeastern impoundment. With the exception of a few radionuclides, the highest concentrations were generally observed in one sample from the northwestern

TABLE 2.2-1
SUMMARY OF HISTORICAL SAMPLING DATA TABLES LOCATED IN APPENDIX E

Table Id	Analyte Suite	Impoundment Location	Media	Years
Table E-1	VOCs	NW & NE	sludge	1988, 1991, 1992
Table E-2	SVOCs	NW & NE	sludge	1988, 1991, 1992
Table E-3	Metals	NW & NE	sludge	1988, 1991, 1992
Table E-4	Metals	NW & NE	water	1991, 1992
Table E-5	PCBs	NW & NE	sludge	1992
Table E-6	Pesticides & Herbicides	NW & NE	sludge	1992
Table E-7	Radionuclides	NW & NE	sludge & water	1988, 1991
Table E-8	VOCs & SVOCs	Southern	sludge	1991, 1992
Table E-9	Metals	Southern	sludge	1991, 1992
Table E-10	Metals	Southern	water	1991, 1992
Table E-11	Pesticides & Herbicides	Southern	sludge & water	1992
Table E-12	Radionuclides	Southern	sludge & water	1991,1992

TABLE 2.2-2
SUMMARY OF HYDRAULIC PROPERTIES AND TRITIUM CONCENTRATIONS OF TUFF SAMPLES FROM BOREHOLES 53-1 THROUGH 53-7 AND BOREHOLE B, LOCATED IN APPENDIX E

Table ID	Borehole
Table E-13	53-1
Table E-14	53-2
Table E-15	53-3
Table E-16	53-4
Table E-17	53-5
Table E-18	53-6
Table E-19	53-7
Table E-20	"B"

impoundment, located near the influent pipe. The results agree with the flow of material into the northwestern impoundments first, followed by flow into the northeastern impoundment. The highest concentrations of radionuclides in the sludge were generally detected in the northwestern impoundment, where the initial settling took place.

Results from 1991 Sampling. The sludge and water in the surface impoundments were sampled by the Laboratory's Environmental Protection Group (ESH-8) in July 1991. Samples of sludge and water were collected from three locations at each impoundment. Water samples consisted of grab samples collected at the mid-depth of the water column. Sludge samples were grab samples collected using a pole-mounted stainless steel beaker. Volitile and semivolatile organic compound (VOC and SVOC) samples were analyzed using methods comparable to EPA SW-846 methods. The samples for VOCs were analyzed using SW-846 Method 8260 (purge and trap gas chromatography/ mass spectrometry [GC/MS]). The SVOCs compounds were analyzed with GC/MS using methods comparable to EPA Method SW-846 8270. The metals on the toxicity characteristic leaching procedures (TCLP) list were analyzed using the following methods; flame Atomic Absorption Spectrometry (AAS) for silver, cold vapor AAS for mercury, and Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) for arsenic, barium, cadmium, chromium, lead, and selenium. All water samples were also analyzed for gross alpha and beta radioactivity. In addition, one water sample from each impoundment was analyzed for tritium and gamma-emitting radionuclides, and one sludge sample from each impoundment was analyzed for gamma-emitting radionuclides.

The VOC analysis of sludge samples showed only toluene to be present above detection limits. Three semivolatile compounds, benzidine, di-n-butylphthalate, and bis-2-ethylhexylphthalate, were detected in sludge samples. No VOCs were detected in any of the water samples. The only SVOC detected was benzoic acid, which was detected in one sample at 15 ug/L.

Results showed the following radionuclides detected above the analytical uncertainty in water in the northwestern impoundment: tritium, beryllium-7, manganese-54, manganese-56, cobalt-57, cobalt-58, cobalt-60, rubidium-83, cesium-134, europium-154, and hafnium-175. In water from the northeastern impoundment the same isotopes were seen, with the exception of manganese-54, manganese-56, and cobalt-57, which were nondetected. In general, higher concentrations were seen in the northwestern impoundment than in the northeastern impoundment, consistent with the primary historical input into the northwestern impoundment.

The sludge results showed beryllium-7, cobalt-57, cobalt-58, cobalt-60, cesium-134, cesium-137, europium-154, hafnium-175, iridium-190, lutetium-173, manganese-54, manganese-56, and sodium-22 present in at least one impoundment above analytical uncertainty. The pattern of concentration differences was generally the reverse of that seen in 1988. Concentrations of radionuclides in the sludge were generally higher in the northeastern impoundment, possibly reflecting the cessation of radioactive water input in 1989, followed by sewage dilution primarily into the northwestern impoundment.

Comparatively, the concentrations of radionuclides in the sludge were generally much higher in the southern impoundment, (see below) probably reflecting the change in influent routing since 1989. At that time, all radionuclide liquid waste was routed to the southern impoundments exclusively.

Results from 1992 Sampling. A third and more comprehensive round of sampling was performed by ESH-8 in April 1992, according to a sampling and analysis plan approved by NMED. Sludge samples were collected from fifteen locations in each impoundment. Sample locations were defined using a uniform grid for the northern surface impoundments. Grab samples of sludge were collected using a pole-mounted stainless steel beaker. All sludge samples were analyzed for VOCs, SVOCs, TCLP metals, and PCBs. VOCs were analyzed using SW-846 Method 8260. SVOCs were analyzed using capillary column GC/MS methods consistent with SW-846 Method 8270. Metals analyses of sludge and water samples consisted of SW-846 Method 6020 for arsenic, barium, cadmium, chromium, lead, silver, and selenium, and cold vapor AAS Method 245.2 for mercury. PCB analysis was performed using gas chromatography electron capture (GCEC) methods consistent with SW-846 Method 8080. A sludge sample from each impoundment was also analyzed for organochlorine pesticides (SW-846 Method 8080), chlorinated herbicides (SW-846 Method 8150), pH, flashpoint, sulfide, and cyanide.

Volatile and semivolatile organic results were similar to those from the July 1991 sampling, although more compounds were detected. The volatiles analysis showed acetone to be present above detection limits in eleven samples, 2-butanone in one sample, carbon disulfide in six samples, chloroform in four samples, 4-isopropyl toluene in one sample, toluene in six samples, and 1,2,4-trimethylbenzene in one sample. Semivolatiles analysis showed benzoic acid to be present above detection limits in eight samples, bis-2-ethylhexylphthalate in twenty-one samples, and di-n-butylphthalate in nine samples.

PCBs were detected in three sludge samples. The detection limit for PCBs in sludge was 0.06 mg/kg. The total levels of PCBs were below 1 mk/kg (0.33 mg/kg in sample 53-NE-Y-S, and 0.27 mg/kg in sample 53-NE-Z-S, and 0.57 mg/kg in sample 53-NE-C1-S). Several pesticides were present above detection limits. No herbicides were present above detection limits.

Water samples were also collected from one location in each impoundment. Samples were collected from the mid-depth of the water column using a discrete interval sampler. Water samples were analyzed for volatile and semivolatile organics, TCLP metals,and pesticides using the same methods as used for sludge samples. In addition, the samples were analyzed for gross alpha-, beta-, and gamma- radioactivity, and tritium. Metal results above detection limits for water samples are presented in Appendix E.

The only VOC detected was acetone, which was detected at 48 µg/L in the sample from the northeastern impoundment. Acetone was not detected in a duplicate sample from this location. No SVOCs or PCBs were detected in water samples.

The only rad sampling reported was two samples collected from the northern impoundments and analyzed for tritium. The results showed tritium detected in the water at 2200 pCi/L in the northwestern impoundment and 5000 pCi/L in the northeastern impoundment.

Results of 1994/1995 Sampling. The Laboratory's ER Project conducted sampling at the northern surface impoundments in 1995 to assess the nature of the contamination, whether contaminants were migrating out of the surface impoundments, and to collect sufficient data to perform a human health screening assessment. Samples of the sludge, bentonite clay liner, the tuff below the bentonite liner, and the tuff below the gunite liner around the periphery were collected from the northern surface impoundments at PRS 53-002(a). These samples were analyzed for the following: TAL metals (EPA Method 6010A), mercury (EPA Method 7471), total cyanide (EPA Method SW846, Chapter 7), reactive sulfides (EPA Method SW846, Chapter 7), SVOCs (EPA Method 8270), VOCs (EPA Method 8260), pesticides and PCBs (EPA Method 8080), herbicides (EPA Method 8152), isotopic uranium and plutonium (Alpha Spectroscopy), strontium-90, tritium, and gamma-emitting isotopes by gamma spectroscopy (HASL-300).

In addition to the field samples, quality assurance/quality control (QA/QC) samples were analyzed by the analytical laboratory to assist in determining the quality and usability of the inorganic, organic, and radionuclide data. The QA/QC samples included laboratory duplicates, surrogates, matrix spikes/matrix spikes duplicates, laboratory and rinsate blanks, and blank spikes/blank spike duplicates.
The number of samples collected from the northern surface impoundments is adequate to characterize the nature of contamination within the surface impoundments and potentially released from the surface impoundments, because of the systematic nature of the sampling effort. The highlights of the results are presented in the text below, and the detailed presentation is provided in Appendix F. The list of COPCs, detected at concentrations greater than 0.1 time screening action level (SAL) for noncarcinogens, or greater than SAL for radionuclides and carcinogenic organics identified for human health in the northern surface impoundments are as follows:

Sludge:	chromium, copper, lead, mercury, thallium, Aroclor-1254, Aroclor-1260, bis(2-ethylhexyl)phthalate, BHC(alpha-), cobalt-60, neptunium-237, sodium-22, and tritium.
Clay liner:	thallium, dieldrin, cesium-134, cobalt-60, and manganese-54.
Tuff:	aluminum, cesium-134, and cobalt-60.

On the basis of the 1994/1995 data alone, these constituents could be carried forward in a baseline human health risk assessment. These constituents will comprise the COPC list for the proposed sampling plan outlined in Section 2.2.3 of this document. The 1994/1995 data will be aggregated with data collected as proposed in this sampling plan for the purpose of a future human health risk assessment.

For purposes of ecological risk screening the COPCs detected at or above background and detected in the sludge, clay liner, and tuff include those mentioned above for human health, as well as the following:

Sludge:	antimony, cadmium, DDT(4,4'-), DDE(4,4'), endrin, endosulfan, selenium, silver, and zinc.
Clay liner:	cadmium, BHC (gamma-), DDT(4,4'-), DDD(4,4'-), endrin, endosulfan, and zinc.
Tuff:	BHC (gamma-), DDT(4,4'-), DDD(4,4'-), dieldrin, and heptachlor.

Of the analytes listed above, aroclors, bis(2-ethylhexyl)phthalate, DDT and metabolites, dieldrin, endosulfan, endrin, heptaclor, BHC(gamma-), aluminum, cadmium, copper, lead, mercury, and selenium are on the current NMED list of potentially persistent bioaccumulators and biomagnifiers and will therefore be added to the COPC list for this proposed sampling plan. The data from the 1994/1995 sampling campaign will be aggregated with data collected as proposed in this sampling plan for an ecological screening assessment and a human health risk assessment. Refer to Appendix F for a summary of analytes detected in the northern surface impoundments.

Southern Surface Impoundment

The sludge and water in the southern impoundment was analyzed previously in two separate sampling events by the Laboratory's Environmental Protection Group (ESH-8). Because the data collected in these sampling campaigns were not validated or evaluated for usability in accordance with ER Project protocols prior to preparing this RFI WP/SAP, the ER Project staff decided to use the data qualitatively to guide the selection of suites of analytes in the proposed sampling campaign. Tabular results of these initial two data sets are presented in Appendix E.

Results from 1991 Sampling. The Laboratory's former Environmental Protection Group (ESH-8) sampled the sludge and water in the impoundment in July 1991. The purpose of this sampling was to characterize the nature of the surface impoundment's contents in support of regulatory decision-making on the authority under which the surface impoundments should be operated and ultimately closed. Samples of sludge and water were collected from three locations within the impoundment. Sludge samples were grab samples collected using a pole-mounted stainless steel beaker. Water samples consisted of grab samples collected at the mid-depth of the water column. The sludge and water samples were analyzed for VOCs, SVOCs, and TCLP metals. The samples for VOCs analysis were analyzed using a method comparable to SW-846 Method 8260 (purge and trap GC/MS). The SVOCs were analyzed with GC/MS using a method comparable to SW-846 Method 8270. The metals on the TCLP list were analyzed using the following methods: flame AAS for silver, cold vapor AAS for mercury, and inductively coupled plasma atomic emission spectroscopy for arsenic, barium, cadmium, chromium, lead, and selenium. In addition, all three water samples were analyzed for gross alpha and beta radioactivity. One water sample was analyzed for tritium and gamma-emitting radionuclides, and one sludge sample was analyzed for gamma-emitting radionuclides.

The volatiles analysis of sludge samples showed only toluene and 4-isopropyltoluene to be present above detection limits. Only one SVOC, di-n-butylphthalate, was detected in sludge samples. No VOCs or SVOCs were detected in any of the water samples.

In the southern impoundment, tritium, beryllium-7, cobalt-58, cobalt-60, cesium-137, manganese-54, manganese-56, rubidium-83, europium-154, hafnium-175, and lutetium-173 were detected above the analytical uncertainty in the water. Concentrations of tritium were much higher in the southern impoundment water than in the two northern impoundments. Concentrations of other radionuclides in the southern impoundment were generally higher than seen in the northeastern impoundment, but lower than seen in the northwestern impoundment. The reason for this distribution is not apparent.

The sludge results showed beryllium-7, cobalt-57, cobalt-58, cobalt-60, cesium-134, cesium-137, europium-154, hafnium-175, iridium-190, lutetium-173, manganese-54, manganese-56, and sodium-22 present above analytical uncertainty. The concentrations of radionuclides in the sludge were generally much higher in the southern impoundment than the northern impoundments, probably reflecting the change in influent routing since 1989. At that time, all radioactive liquid waste was routed to the southern impoundments exclusively.

Results from 1992 Sampling. A second and more comprehensive round of sampling was performed by the former ESH-8 in April 1992 in accordance with a sampling and analysis procedures recommended by NMED. Sludge samples were collected from sixteen locations in the impoundment and analyzed for VOCs, SVOCs, TCLP metals, and PCBs). Sample locations were defined using a uniform grid. Grab samples of sludge were collected using a pole-mounted stainless steel beaker. VOCs were analyzed using SW-846 Method 8260. SVOCs were analyzed using capillary column GC/MS methods consistent with SW-846 Method 8270. Metal analysis consisted of SW-846 Method 6020, ICP/MS for arsenic, barium, cadmium, chromium, lead, silver, and selenium, and cold vapor AAS Method 245.2 for mercury. PCB analysis was performed using gas chromatography electron capture methods consistent with SW-846 Method 8080. One sludge sample was also analyzed for organochlorine pesticides (SW-846 Method 8080), chlorinated herbicides (SW-846 Method 8150), pH (SW-846 Method 9045), flashpoint (modified SW-846 Method 1010, International Technology Laboratory, SOP 4039), total sulfide (EPA Method 376.1), and total cyanide (EPA Method 335.2).

Different VOCs and SVOCs were detected in the April 1992 sludge samples than were detected in the July 1991 sludge samples. The volatile organic analysis showed acetone to be present above detection limits in three samples and 1,1,1-trichloroethane in four samples. Semivolatile organic analysis showed bis-(2-ethylhexyl)phthalate to be present above its detection limit in one sample.
Organic compounds and metals were also detected.

PCBs were not detected in sludge samples. The detection limit for PCBs in sludge was 0.06 mg/kg. No pesticides or herbicides were present at concentrations above detection limits.

One sludge sample was tested for ignitability, corrosivity, and reactivity based on flashpoint, pH, and total sulfide/cyanide analyses. Based on these results, the sludge did not appear to exhibit the ignitability, corrosivity, or reactivity characteristics

One water sample was also collected from one location in the southern impoundment. The sample was collected from the mid-depth of the water column using a discrete interval sampler. The sample was analyzed for VOCs, SVOCs, TCLP metals, PCBs, pesticides, and herbicides using the same methods as used for sludge samples. In addition, three water samples were collected and analyzed for gross alpha/ beta/gamma radioactivity and tritium.

The only VOC detected was acetone (at 29 µg/L). Acetone was also detected in a duplicate sample from this location at 35 µg/L. No SVOCs, PCBs, pesticides, or herbicides were detected in water samples.

Two samples of water showed much higher concentrations of tritium, 2 260 000 pCi/L, than in the northern impoundments, reflecting the exclusive input of radioactive water to the southern impoundments since 1989.

No sludge samples were analyzed for specific radionuclides.

Vadose Zone Characterization

During a 1991 vadose zone study, eight boreholes were drilled adjacent to the three surface impoundments. Four 50-ft boreholes were drilled adjacent to the impoundments to determine if subsurface saturation is present and to determine if the release of contaminants from the impoundments has occurred. The locations of these boreholes are identified as Boreholes 53-1 through 53-4 on Figure 2.2-1. An additional 50-ft borehole, identified as Borehole B, was drilled 450 ft west of the impoundments to determine baseline moisture and tritium levels. The boreholes were completed as neutron-moisture access wells. (LANL 1992, 29413). Grab samples of cuttings were collected every 5 ft from each borehole. The samples were analyzed for tritium and gravimetric moisture content. All borehole results are presented in tabular form in Appendix E.

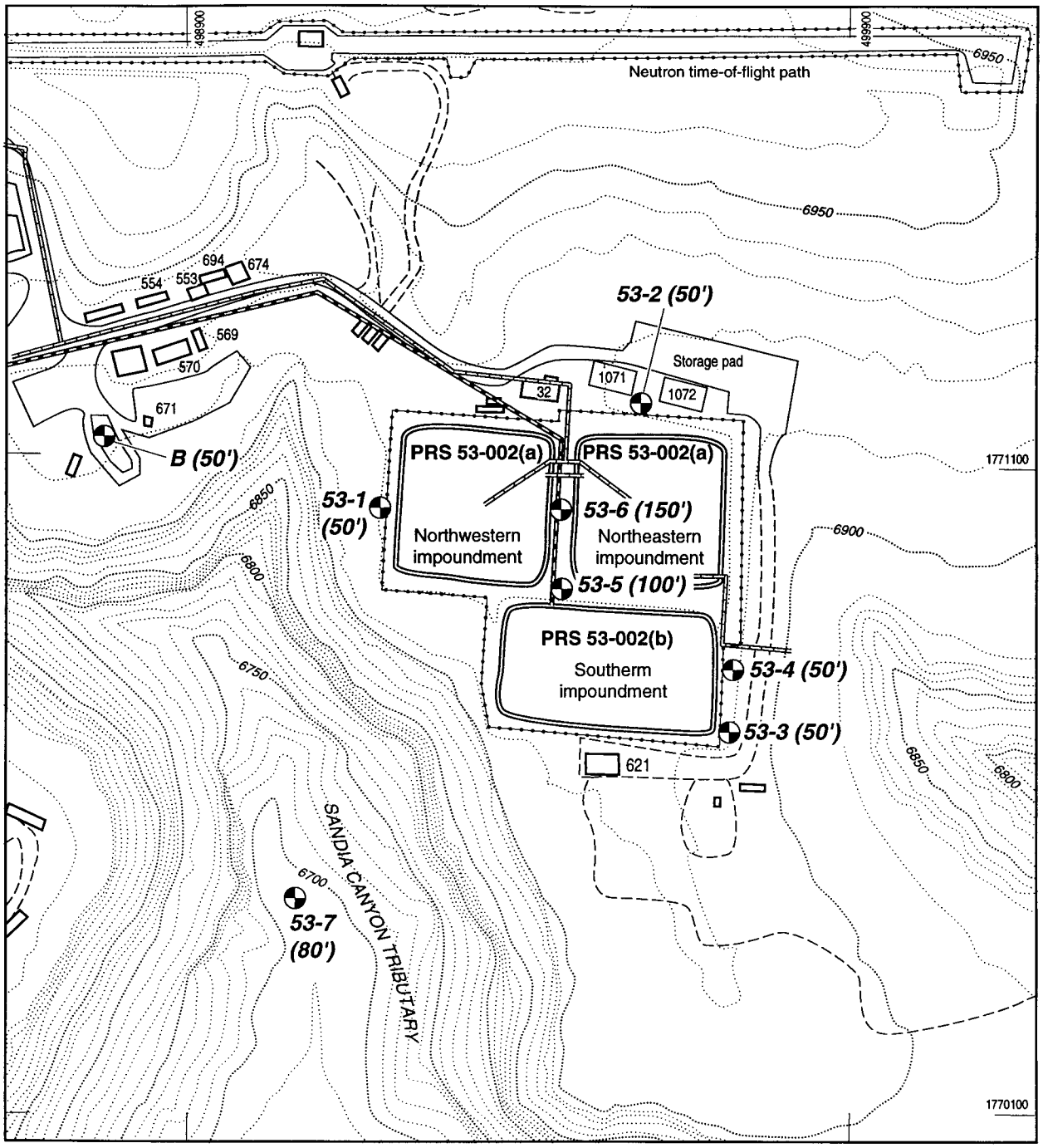
A 100-ft borehole, identified as Borehole 53-5 on Figure 2.2-1, was drilled between the three impoundments to further evaluate leakage from the impoundments. Grab samples of cuttings were collected every 5 ft for the first 50 ft, and every 10 ft thereafter. These samples were also analyzed for tritium and gravimetric moisture content. This borehole was completed with a pore-gas monitoring system (LANL 1992, 29413). See Appendix E for tabular results.

Samples from boreholes 53-6 and 53-7 were used to determine the hydraulic properties of the Bandelier Tuff that immediately underlies the surface impoundments. Cores were collected from the Tshirege Member in Borehole 53-6 and from the Otowi Member in Borehole 53-7 (Figure 2.2-1). The samples were measured for gravimetric and volumetric moisture content, density, and moisture retention characteristics. Porosity and saturated hydraulic conductivity of the samples were also determined (Stephens 1991, 27618).

Borehole 53-6 was placed between the northwestern and northeastern impoundments and was completed at a total depth of 150 ft. Samples were collected at 5-ft intervals for the first 30 ft, and at 10-ft intervals thereafter. The core samples were analyzed for tritium and gravimetric moisture at each sampling depth. Volatile organics and semivolatile organics analyses were performed on the 5-ft through 30-ft samples and on the 50-ft, 80-ft, 100-ft, 110-ft, 140-ft, and 150-ft samples. Total metals analysis was performed on the 20-ft and 100-ft samples. (LANL 1992, 29413).

Borehole 53-7 was drilled near the head of a small canyon directly adjacent to and southwest of the impoundments to identify impacts from the impoundments at greater depths than Boreholes 1 through 6 and B. Samples were collected at 5-ft intervals for the first 35 ft, and at 10-ft intervals thereafter, to a depth of 80 ft. These samples were analyzed for tritium and gravimetric moisture content. Samples collected at 5 ft, 20 ft, and 80 ft, were analyzed for VOCs and SVOCs. This borehole was completed as a neutron-moisture access well. The moisture and tritium data from 53-6 and 53-7 are presented in tabular form in Appendix E.

Saturation was not observed in any of the six boreholes around the surface impoundments. Hydraulic properties of the tuff samples are summarized in tables presented in Appendix E.



0 100 200 300 400 ft

Sources: LANL 1994 RFI Work Plan for OU 1100; FIMAD 1993, G101407 ; LANL 1993, 87Y-217958, size D
Modified by: cARTography by A. Kron 6/16/98

N

Building or structure
Surface impoundment
Fence
Paved road/edge of asphalt
Unimproved road or trail
Sewer line
Radioactive liquid waste line
Borehole location
Contour interval 10 ft

Figure 2.2-1. Approximate locations of boreholes near the TA-53 surface impoundments

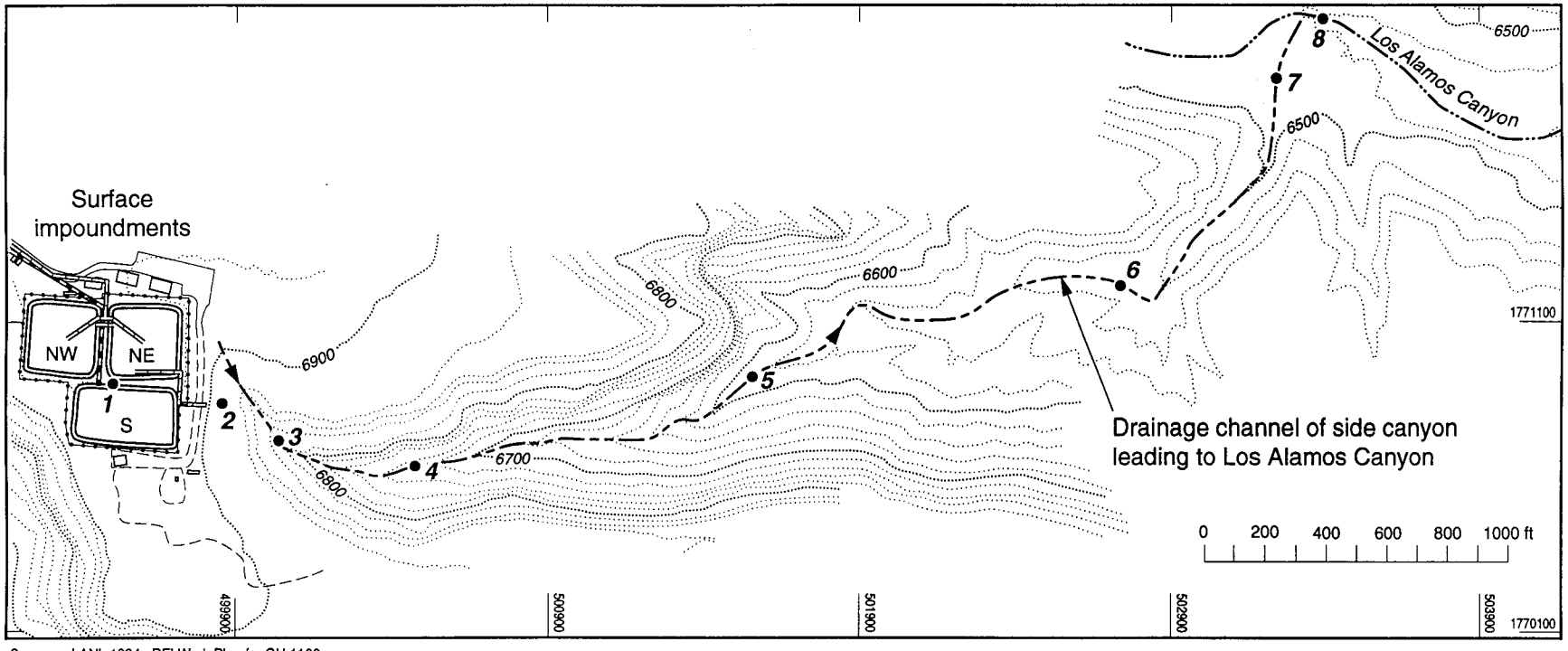
Boreholes drilled adjacent to the impoundments showed only tritium at depth. The highest concentration of tritium was seen in borehole 53-5, located immediately south of the middle of the two northern impoundments, in the area of the former unlined drainage ditch. The highest concentration detected was 100 nCi/L at 100 ft (the bottom of the borehole), which is approximately 100-1000 times greater than baseline borehole "B" at TA-53. The other five boreholes, drilled within about 50 ft of the impoundment dikes, all had tritium concentrations at depth that ranged from less than 0.1 to about 10 nCi/L, considerably less than seen in borehole 53-5. Metals were detected at background concentrations, and VOCs and SVOCs were not detected, therefore the data are not presented in any table. These measurements indicate that tritium is the only contaminant that has migrated into the vadose zone below the surface impoundments; the lateral tritium migration is at most 30 ft from the impoundment, while vertical tritium migration it is at least 100 ft in this location.

Discharge Area

Effluent discharged from the northern surface impoundments was channeled into a side canyon that eventually drains into Los Alamos Canyon. The length of the channel, estimated by measuring the distance from the discharge point to the edge of the mesa on a topographic site map, was approximately 450 ft (LANL 1994, 34756). To ascertain the extent of radionuclide migration from these discharges, the Laboratory conducted environmental monitoring from 1979 to 1985 (ESG 1980, 05961; ESG 1982, 06295; ESG 1983, 06418; ESG 1984, 06523; ESG 1985, 06610). As described in Section 6.2.1.2.3, pages 6-9 through 6-11 of the RFI Work Plan for OU 1100, sediment samples were collected annually at eight locations (LANL 1994, 34756). These locations are illustrated in Figure 2.2-2. Sampling locations 1 and 2 lie in the approximate course of the drainage channel along the mesa, which was largely obliterated when the southern surface impoundment was created. Radionuclides were detected; however, values decreased with distance from the outfall.

Water and sediment samples from the stream channel indicate that radionuclides were carried from the surface impoundments via the effluent discharges. (LANL 1994, 34756) The effluent infiltrated the alluvium quite rapidly, usually within 1200 to 2400 ft from the discharge point, (i.e. well above the confluence with Los Alamos Canyon). The farthest downstream point reached by surface flow was sampling location 5. Radionuclide concentrations, which decreased steadily with distance from the surface impoundments, fell off sharply once the effluent infiltrated the alluvium (only a small degree of migration beyond sampling location 4 was noted).

Biological sampling, carried out during 1981 and 1982 as part of the monitoring program also detected radionuclides, but showed a lower accumulation factor than in other studies. These results contradicted those of other studies that showed high biomagnification. Possible explanations for the difference are the high clay content, the low pH, and the high concentrations of potassium in the soil (ESG 1982, 06295; ESG 1983, 06418). The data presented from these studies were insufficient to determine whether there was an ecological risk.



Sources: LANL 1994, RFI Work Plan for OU 1100;
FIMAD 1993, G101407; LANL 1984, LA-10100-ENV
Modified by: cARTography by A. Kron 6/3/98

Building or structure
Surface impoundment
Fence
Paved road/edge of asphalt
Unimproved road or trail
Sewer line
Radioactive liquid waste line
Ephemeral stream
Sample location
Contour interval 20 ft
N

Figure 2.2-2. Sample locations below impoundment outfall

2.2.2 Conceptual Model

The surface impoundments at TA-53 were designed and constructed to hold liquid waste. This design is important to the conceptual model for the surface impoundments, it also makes the conceptual model for the PRSs' drainages different from the conceptual model for the surface impoundments. Because the surface impoundments were constructed with liners, bentonite clay for PRS 53-002(a) and a rubber-polymer material for PRS 53-002(b), the highest concentration of contaminants are expected to be found in the sludge media above the liners. Contaminants are also expected to decrease with depth below the liners, and become undetectable within a few feet of depth in native tuff. Data gathered from the 1994/1995 sampling at this site have set the expected contaminant concentration trend of limited contaminants below the liner with the exception of tritium, which was found in the deepest sample within borehole 53-5. The spatial evaluation of data (Appendix G) determining where extent has been defined below the northern surface impoundments also confirms the conceptual exposure model pathway hypothesis. Contaminants are expected to be found at higher concentrations immediately under the clay liner in the northeastern surface impoundment because the layer of crushed tuff fill overlying the native tuff is thicker than the layer below the clay liner in the northwestern surface impoundment. This crushed tuff layer is expected to be more permeable than the native tuff.

In the southern impoundment, it is expected that if the Hypalon™ liner leaked at the seams, the liquid would quickly infiltrate the sand layer then move vertically through the crushed tuff to the native tuff. Once the liquid reaches the native tuff it would tend to start moving laterally before permeating the native tuff. The conceptual model for pipes laid within a sand or permeable material cushion layer would be very similar to the movement of contaminants at the southern surface impoundment.

In the surface impoundments, contaminants were subjected to a variety of physical, chemical and biological processes under both aerobic and anaerobic conditions. Biological and chemical degradation would have been most effective for organic compounds and nutrients, and least effective for inorganic or radioactive trace metals, major ions, and tritium. The current location of contaminants in and below the surface impoundments reflects the physical inputs, locations of piping, tendencies for solids to rapidly settle and coagulate out of solution, (trapping many compounds), the biological degradation of organics, and the movement of water and dissolved substances vertically through the clay liner or through the sand underlayment of the Hypalon™ liner, into the tuff. Because of its physical properties, the clay liner would retard water movement, while it would tend to ion-exchange with dissolved ionic species, retarding their movement. Refer to Figure 2.2-3 for the conceptual exposure model for surface impoundment media.

Effluent discharge transported an altered set of contaminants away from the surface impoundments via one known surface discharge that continued to at least 2400 ft from the site into a side canyon of Los Alamos Canyon. While in the discharged effluent, contaminants that were highly soluble (e.g. sodium-22, tritium, or chelated metals) would have been transported the farthest, and contaminants that were insoluble or sparingly soluble (e.g. PCBs, most SVOCs, or certain metals such as chromium III) would have quickly been adsorbed to fine grain sediments and/or organic matter, and deposited in catchment basins relatively close to the source. If discharges to the mesa above the Sandia Canyon tributary occurred, then the conceptual model is identical as for the Los Alamos Canyon tributary. Refer to Figure 2.2-4 for the conceptual exposure model for drainages from PRS 53-002(a).

Media receiving contaminants	Potential treansport mechanisms	Exposure		Human receptors		Ecological receptors	
		Medium	Route	Worker	Recreational	Terrestrial	Aquatic
Water → Sludge	→ Wind erosion	Air	Inhalation	◆	◆	•	•
Water → Clay liner, sand	→ Effluent infiltration	Groundwater	Ingestion	-	-	-	-
			Dermal	-	-	-	-
Water → Tuff	→ Groundwater (Irrigation)	Plants and Animals	Beef cattle	-	-	-	-
			Game	-	-	◆	◆
	→ Wind erosion (Deposition)		Garden/poultry	-	-	-	-
			Wood/fuel	-	-	-	-
	→ Biotic uptake		Wild plants	-	◆	◆	◆

◆ Primary exposure pathway

• Secondary exposure pathway (quantitatively evaluated only if sample data or modeling indicate that significant exposure may occur)

- Pathway not evaluated

Figure 2.2-3. Conceptual exposure model for surface impoundments

Once deposited or infiltrated, vertical migration may also occur, which would be greatest for highly soluble contaminants. Aerobic biodegradation, which is most effective for lightly chlorinated organics and simple compounds, would continue after surface deposition, while anaerobic degradation could occur at depth. Biodegradation of metals or radioactive contaminants should be essentially nonexistent. Radioactive contaminants would decay according to their half-lives, and move as their nonradioactive analogs, while tritium would move in a manner identical to water.

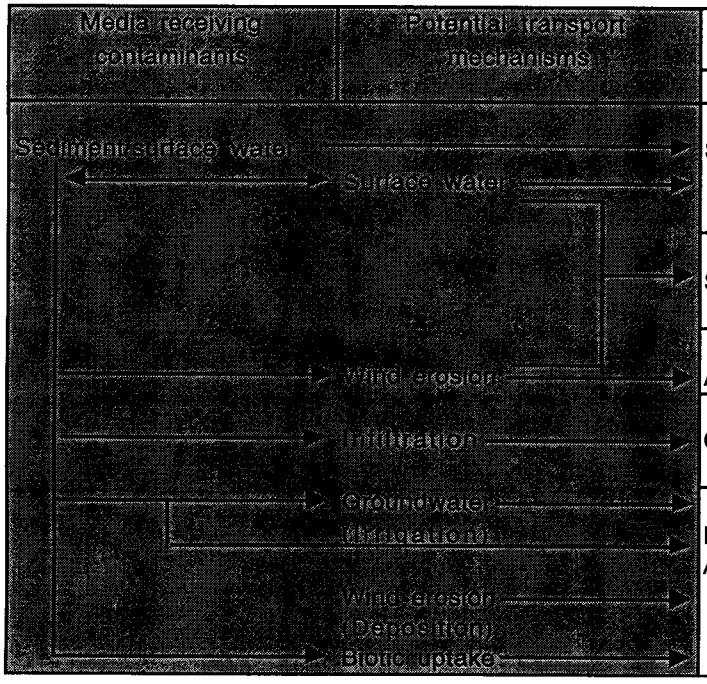
Fluid movement beneath the TA-53 impoundments has not been characterized. The hydrogeologic information collected from boreholes surrounding the impoundments suggests that water movement through the porous tuff matrix could proceed fairly rapidly under saturated or near-saturated conditions. In addition, open fractures within unit 2b may allow very rapid water movement under similar conditions. At other locations within the Laboratory, fractures are frequently filled with caliche and/or clays near the surface but may be open at depths greater than 30 ft. Filled fractures are expected to inhibit moisture movement (LANL 1993, 46402; LANL 1993, 46403).

Moisture data collected from around the impoundments suggest that the tuff is less than saturated. Under these conditions, the conductivity of the porous tuff matrix is extremely low and fluid movement is expected to be slow. The moisture content of the tuff may be near the holding capacity of the formation; therefore, infiltration of any additional fluid may promote more rapid gravity drainage within the tuff matrix. Open fractures may also act to impede fluid movement under unsaturated conditions. In contrast, contaminants can move long distances through pores and fractures of the tuff in the vapor phase when moisture conditions are low and open fractures may provide preferential vapor phase pathways (LANL 1993, 46402; LANL 1993, 46403).

To support the conceptual model for the surface impoundments, data must be collected from the differing engineered media and from crushed and native tuff vertically and laterally from the contaminant source (sludge). Data also need to be collected from the fill material around the influent and effluent piping and from the drainage areas to determine concentration of contaminants versus depth and distance.

2.2.2.1 Nature and Extent of Contamination

Previous sampling efforts have found a variety of contaminants to be present in the sludge, clay liner, and to some extent the underlying tuff. Such contaminants include radionuclides, SVOCs (including PCBs) and heavy metals. In the northeastern impoundment, which received material after passage through the northwestern impoundment, concentrations of contaminants generally decrease from sludge to liner to tuff, with the exception of tritium, which is incorporated into water, and travels at the same rate. The data screening assessment shows the tuff beneath the northeastern impoundment contains many more locations with concentrations greater than SAL or 0.1 SAL than the northwestern impoundment. A spatial assessment of the data reveals the same trend, which is believed to be due to the differing thicknesses of crushed tuff underlying each impoundment.



Exposure		Human receptors		Ecological receptors	
Medium	Route	Worker	Recreational	Terrestrial	Aquatic
Sediment	Ingestion	◆	◆	◆	◆
	Dermal	◆	◆	◆	◆
	External	◆	◆	◆	◆
Surface water	Ingestion	-	◆	◆	◆
	Dermal	-	•	•	◆
Air	Inhalation	◆	◆	•	•
Groundwater	Ingestion	-	◆	-	-
	Dermal	-	•	-	-
Plants and Animals	Beef cattle	-	-	-	-
	Game	-	-	◆	◆
	Garden/poultry	-	-	-	-
	Wood/fuel	-	-	-	-
	Wild plants	-	◆	◆	◆

◆ Primary exposure pathway
• Secondary exposure pathway (quantitatively evaluated only if sample data or modeling indicate that significant exposure may occur)
- Pathway not evaluated

Figure 2.2-4. Conceptual exposure model for drainages from PRS 53-002(a)

A spatial assessment of the 1994/1995 data was performed to look at contaminant trends and determine where data gaps at depth existed below the northern surface impoundments. This assessment is provided in full in Appendix G. The following text is a summary of the assessment.

A subset of analytes was identified as indicator contaminants based on historical disposals into the impoundments and the probability of observing these contaminants in all samples if they were detected. This subset includes arsenic, cadmium, chromium, copper, lead, mercury, selenium, zinc, cobalt-60, plutonium-239, and sodium-22.

Both inorganic and radioactive indicator contaminants follow the pattern described above, such that many more locations with relatively higher concentrations are located beneath the northeastern impoundment compared to concentrations beneath the northwestern impoundment. The relatively high concentrations of contaminants in the northwestern impoundment are generally located in the southern area. Chromium and cobalt-60 are the most-often identified indicator contaminants with relatively high concentrations in the northwestern impoundment, while lead , mercury, and sodium-22 are of higher concentrations in the northeastern impoundment. Contaminants that exceed the Laboratory background are one location in each impoundment for copper, one location in the northwestern surface impoundment for chromium, and one location for lead, mercury, and plutonium-239 in the northeastern surface impoundment.

The general areas where vertical extent has yet to be determined include the bermed areas between and below the surface impoundments, the southern portion of the northwestern impoundment, and much of the area beneath the northeastern impoundment.

The conceptual model was used to guide the sampling design. Consistent with the hypothesized primary release mechanism, the most extensive sampling will be conducted in and beneath the surface impoundments. Samples will be collected outside the surface impoundments to better characterize, the extent of contamination. Groundwater sampling for tritium is not proposed in this RFI WP/SAP. Instead, evaluation of the sampling data from the northern surface impoundments, the southern impoundment, adjacent piping and drainage areas will be assimilated to better design a subsequent sampling subsurface effort for tritium beyond a 12-ft depth.

Samples collected from this RFI WP/SAP will provide data to refine the conceptual model. If data indicate that contamination does not follow the guidelines of the conceptual model, then the model will be changed and will be reflected in future actions at the TA-53 surface impoundments. The revised conceptual model will be used to estimate the human health and ecological risks associated with the site and the potential for future transport of contaminants.

The extent of contaminants outside the lateral boundaries of the three surface impoundments has not been determined. The vertical extent of tritium beneath the surface impoundments also has not been determined.

2.2.2.2 Fate and Transport

Fate and transport discussions are divided into three sections: Vertical Migration, Direct Discharge, and Atmospheric Releases. These sections correspond to the primary pathways identified in the conceptual models.

The site topography would have had a major effect on fate and transport of the contaminants, the steeper portions of the site would allow rapid migration of liquid effluent to areas away from the surface impoundments. Vegetation in the runoff channels would tend to allow sediment to accumulate, thus concentrating contaminants. Near the influent, transfer, and effluent pipes, any leak would allow contamination to infiltrate first the soil surrounding the pipes, followed by infiltration into deeper strata. Anthropogenic activities are not known to have disturbed the contamination subsequent to releases.

The1994/1995 sampling data from the northern surface impoundments indicate the presence of contaminants. The contaminants detected are inorganics, organics, and radionuclides in all three media present within the surface impoundments. With the exception of the detected VOCs, all of the contaminants detected are resistant to biodegradation in varying degrees. Table 2.2-3 lists the organic compounds detected in the 1994/1995 sampling with their biodegradation rates.

Biodegradation of halogenated organics is complicated. In general, it is believed that as the number of chlorine atoms in a molecule increases, it becomes more toxic and more difficult to degrade. However, recent evidence indicates that such behavior is organism- and environment-specific. The more highly chlorinated compounds, such as PCBs, carbon tetrachloride, and tetrachloroethylene, are more readily transformed under anaerobic conditions, while those compounds with fewer chlorines, such as monochlorinated biphenyls and chloroethene (vinyl chloride), are more readily biodegraded aerobically. The biodegradation processes in the surface impoundments consisted of both an aerobic zone and an anaerobic zone. The northern surface impoundments also utilized gas stripping by aerators, which could remove VOCs from the wastewater. The aparent absence of VOCs in sample results reveals that VOCs that may have been present in discharges to the impoundments volatilized, biodegraded, or were otherwise removed from solution and thus were not available for transport. Figure 2.2-5 presents a schematic of the treatment process believed to be present in the TA-53 surface impoundments.

Vertical Migration

One release mechanism at the surface impoundments is hypothesized to be leaching of contaminants from the sludge through the impoundment liners to the surrounding soils and native tuff. The sludge in the surface impoundments is believed to be the major contaminant source based on both the physical properties of the sludge and previous data from sludge sampling at the northern surface impoundments.

The greatest limiting factor in the transport of PCBs from the surface impoundments to the environment is the solubility of PCBs in water. The solubility of PCBs is low and decreases with increasing chlorine content. Values given by Monsanto are 40 ppb for Aroclor 1254 and about 25 ppb for Aroclor 1260 (the chemicals of PCBs). PCBs adsorb relatively quickly onto plastic, silts, and organic material. Thus, organic matter with adsorbed PCBs would be resistant to migration.

TABLE 2.2-3
ORGANIC COMPOUNDS DETECTED IN THE 1994/1995 SAMPLING CAMPAIGN

Organic Chemical	Biodegradation or Disappearance rate[a]	Aqueous Biodegradation Half-Life[b]		Removal/ Secondary treatment
		Aerobic	*Anaerobic*	
Acetone	No data	High – 168 hrs. Low – 24 hrs.	High - 672 hrs. Low – 96 hrs	High – 75% Low – 54%
Methylene chloride	100% in 7 days	High – 672 hrs. Low – 168 hrs.	High – 2688 hrs. Low – 672 hrs.	No data
2-butanone (MEK)	86 – 100% in 7 days	High – 168 hrs. Low – 24 hrs.	High – 672 hrs. Low – 96 hrs.	High 100% Low 86%
bis(2-ethylhexyl) phthalate	0% in 7 days	High – 550 hrs. Los – 120 hrs.	High – 9336 hrs. Low – 980 hrs.	High – 91% Low – 70%
Aroclor-1254	11% in 7 days	No data	No data	No data
Aroclor-1260	0% in 7 days	No data	No data	No data
alpha-hexachloro-cyclohexane	0% in 7 days	High – 3240 hrs. Low – 1920 hrs.	High – 960 hrs. Low – 168 hrs.	No data

(a) Taken from *The Soil Chemistry of Hazardous Materials* (Dragun, 57645)

(b) Taken from *Handbook of Environmental Degradation Rates* (Howard et al., 57902)

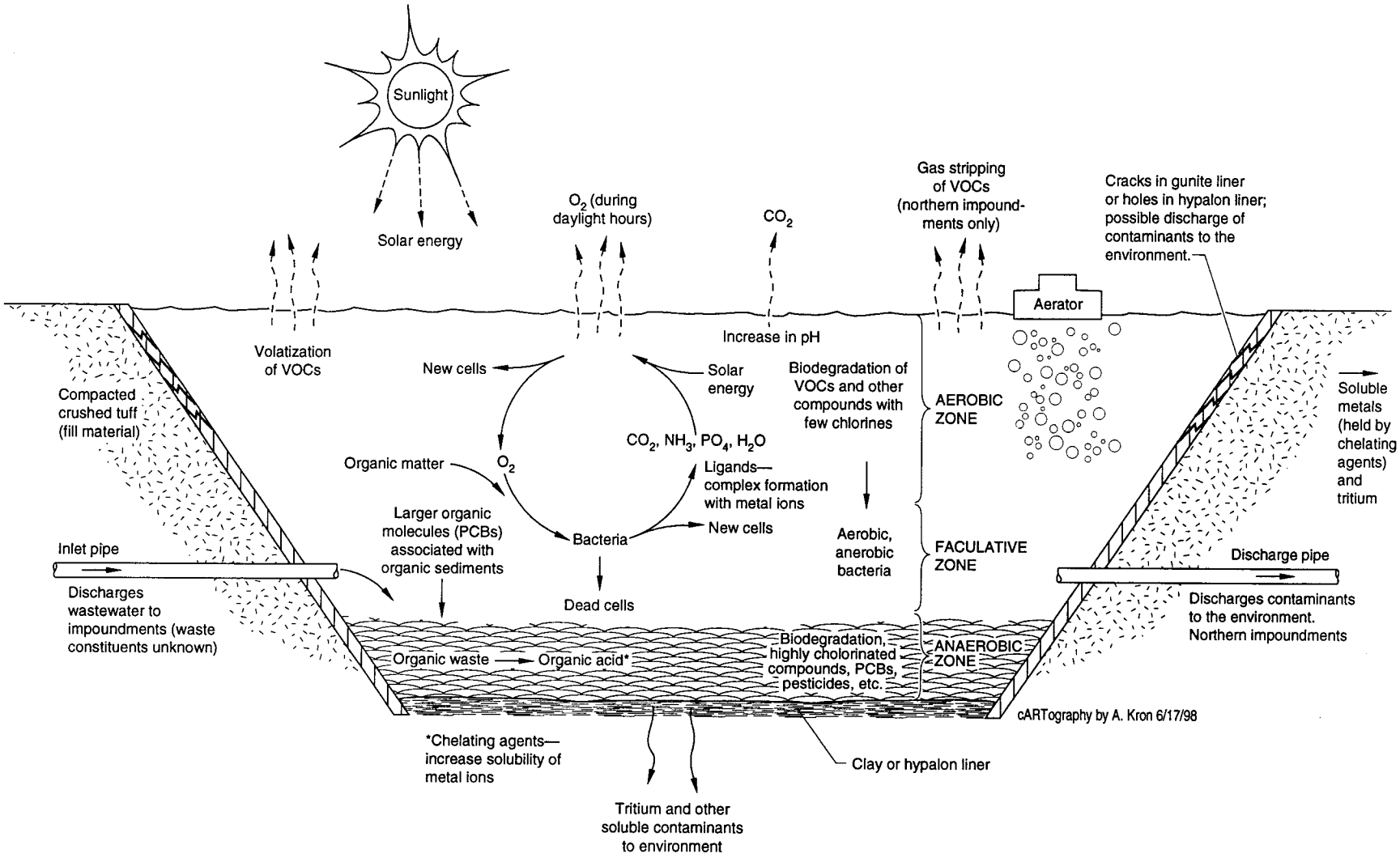


Figure 2.2-5. Schematic of biodegration process at TA-53 surface impounments

Of these major mobilization mechanisms, the primary transport and migration pathway present for material within the surface impoundments is the leaching pathway. Potential migration from the site consists of PCBs adsorbed to organic matter, silts, and clays, and mobilized by water within the surface impoundments. Limited migration of the PCBs is expected in the subsurface because of a marked decrease in permeability of the native tuff, which is directly beneath the surface impoundments, as compared to the soils. Thus, the PCBs tend to remain in the soil/sand and not be available for further transport.

VOCs either biodegraded or stripped out of solutions in the northern surface impoundments. In the southern surface impoundment, VOCs biodegraded and thus were not available for transport.

The greatest limiting factor in the transport of metals from the surface impoundments to the environment is the solubility of metals in water. The biodegradation process believed to be occurring at the surface impoundments will affect the solubility of metals. The metal ions present in the wastewater will come in contact with several ligands, such as NH_3 and PO_4 when introduced to the surface impoundments liquids. The ligands will compete for complex formation with the metal ions present. Thus, the metal ions will combine with the ligands to produce inorganic salts and settle out of solution. The bacteria and algae present in the surface impoundments produce and excrete organic compounds that can chelate metal ions. The solubility of metal ions is greatly increased by the presence of chelating agents. The chelating molecule forms a ring in which the metal ion is held so that it is not free to form insoluble salts. The equilibrium between the inorganic salts and the chelated metal ions is not known. Thus, chelated metal ions (in solution) could migrate with the water from the surface impoundments to adjacent soil through the liner.

Transport of radionuclides will occur in an identical manner as for their nonradioactive analogs. In addition, radioactive decay will decrease the concentrations of radionuclides according to their respective half-lives. Tritium will move as water, either in the liquid or vapor phase. See Appendix E tables for the hydraulic properties and tritium concentrations of tuff samples in vadose zone boreholes.

Because groundwater is approximately 750 to 1000 ft below the PRSs, it is difficult to assess whether contaminants could be carried to depth. Tritium was detected at a concentration of 100 nCi/L at 100 ft, which is approximately 100-1000 times greater than a background borehole located approximately 450 ft upgradient of the impoundments. Measurements of other contaminants (metals, VOCs, SVOCs) indicate that tritium is the only contaminant that has migrated into the vadose zone below the surface impoundments.

Direct Discharge

An additional release mechanism was historically via the release of liquid effluent to the NPDES outfall that ultimately drains to the Los Alamos Canyon tributary and may have drained into a Sandia Canyon tributary as well.

Fate and transport of contaminants discharged via the NPDES outfall varies both with the chemical nature of the contaminant and the operational history of the surface impoundments. The flow of wastewater throughout the surface impoundments was as follows: the northwestern impoundment received the waste

first and was the initial treatment pond; the wastewater was then transferred to the northeastern impoundment via a piping system; when the two northern surface impoundments were filled to capacity, excess wastewater was diverted from the northern surface impoundments via a piping system to the southern impoundment. Alternatively, effluent from the northeastern impoundment was discharged to an NPDES-permitted outfall. Highly soluble contaminants (e.g. sodium-22, tritium, or chelated metals) would have been transported the farthest from this outfall, while contaminants that were sparingly soluble (e.g. PCBs, most SVOCs, or certain metals such as chromium VI) would have quickly been adsorbed to fine grain sediments and/or organic matter, and deposited in catchment basins relatively close to the source (compared to the soluble contaminants). Once deposited or infiltrated, vertical migration would also occur, which would be greatest for soluble contaminants. Aerobic biodegradation, which is most effective for lightly chlorinated organics and simple compounds, would continue after deposition. Biodegradation of metals or radioactive contaminants should be nonexistent. Radioactive contaminants would decay according to their half lives. Relatively longer-lived contaminants such as cobalt-60 (half life 5.3 years) and tritium (half life 12.3 years) will persist in the environment longer than relatively short-lived contaminants, such as sodium-22 (half life 2.6 years). Radioactive contaminants will behave as their nonradioactive analogs with respect to transport.

Any contamination present today should be most concentrated in the area of the sources, and should tend to decrease at different rates away from the sources, both horizontally and vertically, depending on physical, chemical, and biological parameters.

Atmospheric Release

A final migration pathway is via the atmosphere. Neither PCBs nor metals readily volatilize under normal ambient conditions. Generally, PCBs and metals occur as particulates in the atmosphere. At the surface impoundments, this pathway may consist of PCBs and metals adsorbed to organic matter and dried silts and clays suspended by wind and transported from the site. Adsorbed particles in dried sludge in the northern surface impoundments, that are in areas where the geotextile cover has degraded, are susceptible to transport via atmospheric dispersion, and pose a potential inhalation hazard if the concentrations were higher than was detected. A calculation of the current contaminant levels at PRS 53-002(a) was completed to determine that there are no human health risks associated with inhalation of the sludge particulate. Therefore no additional surface samples will be collected upwind (northeast) of the boundaries of either PRS 53-002(a) or 53-008 (which was sampled in 1995).

2.2.2.3 Data Gaps

There are several data gaps in the environmental data that exist for this system. The vertical and lateral extent of contamination has not been adequately characterized under and around the surface impoundments, or in the drainage areas. In the area to the southwest of the southern impoundment, from which stormwater drains into Sandia Canyon, no previous sampling has taken place. The influent and effluent pipes associated with all three surface impoundments have not been sampled. The drainage area at the NPDES outfall, which ultimately drains to a Los Alamos Canyon, has not been sampled for

contaminants other than radionuclides. Therefore vertical and lateral extent of contamination is unknown for the impoundments and drainage areas.

There are also some gaps in the source term data that exist for this system. The PCB data collected during the 1994/1995 sampling campaign at the northern surface impoundments is of questionable quality; therefore, PCBs must be resampled and reanalyzed. It is unknown what percentage of chromium VI, if any, makes up the total chromium concentrations. There is limited characterization data on the southern impoundment, and so additional samples must be collected for this purpose.

As stated previously, samples for tritium (or any other COPC) at depths greater than 12 ft will occur subsequent to this investigation based on resulting data.

2.2.3 Proposed Sampling Activities

Sampling of the northeastern, northwestern, and southern surface impoundments (PRSs 53-002[a] and [b]), and their adjacent piping and drainages will be performed to determine whether there have been any releases from these areas that have resulted in contamination that poses a potential human health or ecological risk. Several types of media within the site will be sampled during this effort: (1) sludge within all three surface impoundments, (2) the clay liner in the northern surface impoundments, (3) the sand layer underneath the Hypalon™ liner in the southern surface impoundment, (4) tuff underlying the three surface impoundments, (5) the soil and tuff surrounding the surface impoundments, and (6) the soil and tuff in the associated drainage areas. Sludge samples will be collected to determine the nature of contaminants within the three surface impoundments. Samples will be collected from the clay liner and the sand layer to help support the conceptual model. Finally, samples will be collected in the tuff underlying all three surface impoundments and in the drainage pathways leading from the northern surface impoundments so that extent of contamination (to a depth of 12 ft) can be better characterized.

The 12-ft sampling depth was chosen primarily for practical reasons, and secondarily for scientific reasons. First, locating a drill rig within the impoundments would be difficult for several reasons. The sides of the impoundments make directly driving into them impossible. A ramp would have to be built to accomplish this; however, adding material into the impoundments would potentially increase the volume of waste. In addition, driving the rig in the impoundments would disrupt the existing clay liner in the northern impoundments. Angle drilling is not a cost effective option due to the size of the impoundments. Thus, drilling is deemed to be difficult, and hand and/or power augering was chosen as the most practical method for obtaining depth distribution information at reasonable cost. Should the auger holes not reveal a decreasing trend, then deeper drilling will be necessary, but only at locations deemed necessary by data resulting from implementation of this RFI WP/SAP.

For scientific reasons, extensive drilling may not be necessary. First, with few exceptions, most contaminants of concern at the impoundments are not highly mobile, or are not present at depth, limiting the need for deep drilling. Semivolatile compounds, pesticides and PCBs are highly immobile, not very soluble, and would not have migrated vertically through the vadose zone. Volatiles are more mobile, but have been demonstrated to volatilize during aeration and biodegradation processes that occurred in the impoundments. Metals and radionuclide mobility vary with the individual contaminant, but in general, the

clay liner has a very high ion exchange capacity, and would greatly retard the movement of these species as well.

Tritium migration has no retardation, and would move with the water at the same rate. Alkali earth cations, notably sodium-22, and anions would also move with little retardation, and would be expected to be found at greater depths under the impoundments, relative to the highly retarded species.

A follow-up sampling plan to determine extent for COPCs found below the 12-ft depth will be designed using data obtained through implementation of this RFI WP/SAP.

The COPC list for both the northern and southern surface impoundments was derived from assessing data previously collected at these sites. The COPC list is less extensive for the northern surface impoundments than the southern surface impoundments because more data exist for the northern surface impoundments.

The COPC list from the northern surface impoundments derived from the data screening assessment is presented in Appendix F, and the COPC list derived from determining where extent had not been defined in the tuff below the clay liner of the northern surface impoundments is presented in Appendix G. Combining the two data sets provides a complete COPC list that can be used at both surface impoundments and surrounding drainages and piping areas, because contaminants detected in the northern surface impoundments would represent the broadest spectrum of constituents. A few radionuclides that were detected in the northern surface impoundments but not carried forward to the COPC list were added for the southern surface impoundment investigation to determine the concentrations of these contaminants (strontium-90, isotopic uranium, and isotopic plutonium).

Because existing data show organochlorine pesticides and chlorinated herbicide constituents were only detected at concentrations indicative of appropriate usage, analyses are being performed on only a subset of samples collected. The subsequent data obtained from the analyses will help support this conclusion.

Even though there are specific analytes within an analytical suite that constitute the COPC list (i.e., copper, lead), when the chemical analyses are performed at the offsite laboratory it will be performed for the entire standard suite of constituents such as metals, VOCs, SVOCs, PCBs, and so forth. It is not usually cost effective to ask for specific analytes within an analytical suite, and the additional information from analytes that did not become part of the COPC list should compare with previous concentrations. The exception to this statement is the analyses for radionuclides. Radionuclide analyses will be performed specifically to detect isotopes identified as COPCs. The only analysis in which additional information will be obtained is the gamma spectroscopy analysis, which will be requested to detect sodium-22, neptunium-237, cobalt-60, cesium-134, and manganese-54.

The full suites of analyses that will be requested to help determine extent of possible contamination for the northern surface impoundments are PCBs, SVOCs, and TAL metals including mercury. Chromium VI analyses will also be requested for 10% of the total number of samples collected. A full suite organochlorine pesticide and chlorinated herbicide analyses will also be performed for 10% of the samples collected. Radionuclide analyses will be performed for tritium, plutonium-238, and gamma-emitting isotopes.

The full suites of analyses that will be requested for this proposed sampling campaign for the southern surface impoundment are PCBs, SVOCs, TAL metals including mercury, and VOCs. Chromium VI analyses will also be requested for 10% of the total number of samples collected. A full suite organochlorine pesticide and chlorinated herbicide analyses will also be performed for 10% of the

samples collected. Radionuclide analyses will be performed for tritium, isotopic plutonium, isotopic uranium, strontium-90, and gamma-emitting isotopes.

Sampling for Tritium. The extent of tritium contamination is not expected to be completely defined in this investigation. Because tritium is an isotope of hydrogen and readily incorporates into water, it will migrate as water either in the liquid or vapor phases. It is the most mobile constituent of the COPCs at this site. If results from this phase of sampling indicate that tritium contamination is not bounded (i.e., decreasing trends with distance from the source areas are not apparent) then samples collected from greater depths than outlined in this RFI WP/SAP, may be necessary and an addenda to this RFI WP/SAP will be prepared.

VOC Sampling Procedures in Solid Media. All VOC samples called out in the following text for solid media will be collected using the thin wall tube sampler which will contain two 6-in.-long brass sleeves. After the sample hole has been hand-augered to the appropriate depth, a drive hammer will be attached to the thin wall tube sampler containing the brass sleeves and driven an additional 12-in. depth to fill the sleeves with solid media. Once the sample is extracted from the hole, plastic caps will be placed on each end of each brass sleeve and teflon tape will be secured around the cap lip to prevent any volatilization. If the sample cannot be collected, either because the depth of the sample is too great for the manual collection processes or because the tuff is impenetrable, no sample will be collected for VOCs in this manner. After VOC data are available to assess the COPCs at the sample location, if concentrations of VOCs are found not to be bounded by samples collected at shallower depths at the same location, an addendum to this RFI WP/SAP will be prepared to address the data gap.

All sampling suites and the number of samples to be collected during this investigation are summarized in Table 2.2-4. All procedures to be used for sample collection are listed in Section 3.3.

2.2.3.1 Contaminant Source

Water, liquid sludge, and dried sludge samples will be collected to determine concentrations in these media. This information will be used to verify the conceptual exposure model and guide future sampling efforts for waste characterization.

Sampling Design for Northern and Southern Surface Impoundment Sludge

This section describes the strategy for the sampling and analysis activities to be implemented for the northern and southern surface impoundments sludge media.

Resampling for PCBs in Northern Surface Impoundment. Because of poor recovery of PCBs from PE samples analyzed with the 1995 samples, it is necessary to resample the sludge, clay liner, and underlying tuff for PCBs at PRS 53-002(a) to complete the 1995 data set. The same grid spacing and sample locations sampled in 1995 will be used to re-collect the PCB data (Figure 2.2-6). In addition, 10% of the samples will be randomly selected from both the sludge and underlying tuff for chromium VI analyses. These data, which are important for risk assessment purposes, do not presently exist. From these results, the amount of chromium VI within the total chromium concentrations for the remainder of the data will be inferred.

Sampling Design for Southern Surface Impoundment Sludge Samples. This section describes the strategy for the sampling and analysis activities to be implemented for the southern surface impoundment. These activities are to be conducted in a multifaceted approach because of the potential for airborne contaminant dispersion. If the sludge is allowed to dry out, the weight of the dried sludge may

TABLE 2.2-4
SUMMARY OF SAMPLING SUITES AND NUMBER OF SAMPLES TO BE COLLECTED

	Samples	Field Screening		Laboratory Analyses												
	Type	Gross Gamma	Volatile Organics	TAL Metals (SW-846, 6010B, 7000 series for As, Se, PB, Tl, Hg as required)	Chromium VI (SW-846, 3060A (Alkaline Digest, 7199 (IC))	Volatile Organics plus TICs (SW-846, 8260B)	Semivolatile Organics plus TICs (SW-846, 8270C)	PCBs by GC (SW-846, 8082, Aroclors option)	Chlorinated Herbicides (SW-846, 8151A GC/deriv.)	Total Cyanide (SW-846, 9010B or 9012A)	Reactive Cyanide and Sulfide (SW-846, Section 7.3.3.2 and 7.3.4.2)	Gamma Spectroscopy	Isotopic Uranium	Isotopic Plutonium	Strontium-90	Tritium
NW Impoundment																
Sludge	Surface	X			2			17								
Clay Liner	Subsurface	X						17								
Tuff 12" - 24"	Subsurface	X			2			17								
Tuff 48" - 60"	Subsurface	X	X	4	1	4	4	4				4		4		4
Tuff 132" - 144"	Subsurface	X	X	4	1	4	4	4				4		4		4
Total Samples: NW Impoundment				**8**	**6**	**8**	**8**	**59**				**8**		**8**		**8**
In Between NW & NE Impoundments																
Tuff 12" - 24"	Subsurface	X	X	3		3	3	3				3		3		3
Tuff 48" - 60"	Subsurface	X	X	3		3	3	3				3		3		3
Tuff 132" - 144"	Subsurface	X	X	3		3	3	3				3		3		3
Total Samples: Between Impoundments				**9**		**9**	**9**	**9**				**9**		**9**		**9**
NE Impoundment																
Sludge	Surface	X			2			17								
Clay Liner	Subsurface	X						17								
Tuff 12" - 24"	Subsurface	X			2			17								
Tuff 48" - 60"	Subsurface	X	X	13	2	13	13	13				13		13		13
Tuff 132" - 144"	Subsurface	X	X	13	2	13	13	13				13		13		13
Total Samples: NE Impoundment				**26**	**8**	**26**	**26**	**77**				**26**		**26**		**26**

TABLE 2.2-4
SUMMARY OF SAMPLING SUITES AND NUMBER OF SAMPLES TO BE COLLECTED

	Samples	Field Screening		Laboratory Analyses													
	Type	Gross Gamma	Volatile Organics	TAL Metals (SW-846, 6010B, 7000 series for As, Se, PB, Tl, Hg as required)	Chromium VI (SW-846, 3060A (Alkaline Digest, 7199 (IC))	Volatile Organics plus TICs (SW-846, 8260B)	Semivolatile Organics plus TICs (SW-846, 8270C)	PCBs by GC (SW-846, 8082, Aroclors option)	Organochlorine pesticides by GC (SW-846, 8081A)	Chlorinated Herbicides (SW-846, 8151A GC/deriv.)	Total Cyanide (SW-846, 9010B or 9012A)	Reactive Cyanide and Sulfide (SW-846, Section 7.3.3.2 and 7.3.4.2)	Gamma Spectroscopy	Isotopic Uranium	Isotopic Plutonium	Strontium-90	Tritium
Southern Impoundment																	
Liquid Sampling																	
Liquid Sludge	Surface	X	X	14	2	14	14	14	1	1	14	14	14	14	14	14	14
Water	Water	X	X	3		3	3	3	1	1	3	3	3	3	3	3	3
Solid Media Sampling*																	
Sand Layer	Subsurface	X	X	14		14	14	14	1	1			14	14	14	14	14
Tuff 12" - 24"	Subsurface	X	X	14	2	14	14	14	1	1			14	14	14	14	14
Tuff 48" - 60"	Subsurface	X	X	14	2	14	14	14	1	1			14	14	14	14	14
Tuff 132" - 144"	Subsurface	X	X	14	2	14	14	14	1	1			14	14	14	14	14
Berm Tuff 12"-24"	Subsurface	X	X	8		8	8	8	1	1			8	8	8	8	8
Berm Tuff (equivalent with liner)	Subsurface	X	X	8		8	8	8	1	1			8	8	8	8	8
Total Samples: Southern Impoundment				**89**	**8**	**89**	**89**	**89**	**8**	**8**	**17**	**17**	**89**	**89**	**89**	**89**	**89**

*This is the maximum number of samples that will be taken from this area.

TABLE 2.2-4
SUMMARY OF SAMPLING SUITES AND NUMBER OF SAMPLES TO BE COLLECTED

	Samples	Field Screening		Laboratory Analyses													
	Type	Gross Gamma	Volatile Organics	TAL Metals (SW-846, 6010B, 7000 series for As, Se, PB, Tl, Hg as required)	Chromium VI (SW-846, 3060A (Alkaline Digest, 7199 (IC))	Volatile Organics plus TICs (SW-846, 8260B)	Semivolatile Organics plus TICs (SW-846, 8270C)	PCBs by GC (SW-846, 8082, Aroclors option)	Organochlorine pesticides by GC (SW-846, 8081A)	Chlorinated Herbicides (SW-846, 8151A GC/deriv.)	Total Cyanide (SW-846, 9010B or 9012A)	Reactive Cyanide and Sulfide (SW-846, Section 7.3.3.2 and 7.3.4.2)	Gamma Spectroscopy	Isotopic Uranium	Isotopic Plutonium	Strontium-90	Tritium
Extent Around Impoundments																	
Soil/Tuff 12"-24"	subsurface	X	X	12		12	12	12	1	1			12	12	12	12	12
Soil/Tuff 48"-60"	subsurface	X	X	12		12	12	13	1	1			12	12	12	12	12
Soil/Tuff (Equivalent with Liner)	subsurface	X	X	12		12	12	14	1	1			12	12	12	12	12
Total Samples: Exent Around Impound.				**36**	**0**	**36**	**36**	**36**	**3**	**3**	**0**	**0**	**36**	**36**	**36**	**36**	**36**
Sandia Canyon Tributary*																	
Sediment (Mesa Top) 0"-6"	surface	X		10	1		10	10	1	1			10	10	10	10	10
Sediment (Mesa Top) Soil/tuff interface	subsurface	X	X	10	1	10	10	10	1	1			10	10	10	10	10
Sediment (Bench) 0"-6"	surface	X		2	1		2	2	1	1			2	2	2	2	2
Sediment (Bench) Soil/tuff interface	subsurface	X	X	2	1	2	2	2	1	1			2	2	2	2	2
Total Samples: Sandia Canyon Tri.				**24**	**4**	**12**	**24**	**24**	**4**	**4**	**0**	**0**	**24**	**24**	**24**	**24**	**24**
Influent Pipes and Discharge Lines																	
Sand Layer (Pipe bedding material)	subsurface	X	X	15	1	15	15	15	1	1			15	15	15	15	15
Tuff 9' depth (if applicable)	subsurface	X	X	15	1	15	15	15	1	1			15	15	15	15	15
Tuff 12' depth (if applicable)	subsurface	X	X	15	1	15	15	15	1	1			15	15	15	15	15
Total Samples: Inf. Pipes and Dis. Lines				**45**	**3**	**45**	**45**	**45**	**3**	**3**			**45**	**45**	**45**	**45**	**45**

*This is the maximum number of samples that will be taken from this area.

TABLE 2.2-4
SUMMARY OF SAMPLING SUITES AND NUMBER OF SAMPLES TO BE COLLECTED

	Samples	Field Screening		Laboratory Analyses													
	Type	Gross Gamma	Volatile Organics	TAL Metals (SW-846, 6010B, 7000 series for As, Se, PB, Tl, Hg as required)	Chromium VI (SW-846, 3060A (Alkaline Digest, 7199 (IC))	Volatile Organics plus TICs (SW-846, 8260B)	Semivolatile Organics plus TICs (SW-846, 8270C)	PCBs by GC (SW-846, 8082, Aroclors option)	Organochlorine pesticides by GC (SW-846, 8081A)	Chlorinated Herbicides (SW-846, 8151A GC/deriv.)	Total Cyanide (SW-846, 9010B or 9012A)	Reactive Cyanide and Sulfide (SW-846, Section 7.3.3.2 and 7.3.4.2)	Gamma Spectroscopy	Isotopic Uranium	Isotopic Plutonium	Strontium-90	Tritium
Outfall Drainage Area																	
Area A																	
Soil (below cobble stones)	subsurface	X	X	3	1	3	3	3	1	1			3	3	3	3	3
Area B																	
Soil 0"-6"	surface	X		10			10	10	1	1			10	10	10	10	10
Soil/tuff interface	subsurface	X	X	10	1	10	10	10	1	1			10	10	10	10	10
6" below native tuff		X	X	10	1	10	10	10	1	1			10	10	10	10	10
Area C																	
Soil 0"-6"	surface	X		10			10	10	1	1			10	10	10	10	10
Soil/tuff interface	subsurface	X	X	10	1	10	10	10	1	1			10	10	10	10	10
6" below native tuff		X	X	10	1	10	10	10	1	1			10	10	10	10	10
Area D																	
Soil 0"-6"	surface	X		3			3	3	1	1			3	3	3	3	3
Soil/tuff interface	subsurface	X	X	3	1	3	3	3	1	1			3	3	3	3	3
6" below native tuff		X	X	3	1	3	3	3	1	1			3	3	3	3	3
Area E																	
Soil 0"-6"	surface	X		3			3	3	1	1			3	3	3	3	3
Soil/tuff interface	subsurface	X	X	3	1	3	3	3	1	1			3	3	3	3	3
6" below native tuff		X	X	3	1	3	3	3	1	1			3	3	3	3	3
Total Samples: Outfall Drainage Area				**81**	**9**	**55**	**81**	**81**	**13**	**13**	**0**	**0**	**81**	**81**	**81**	**81**	**81**

QA/QC Samples: One QA/QC sample will be collected for every 20 solid media samples collected.

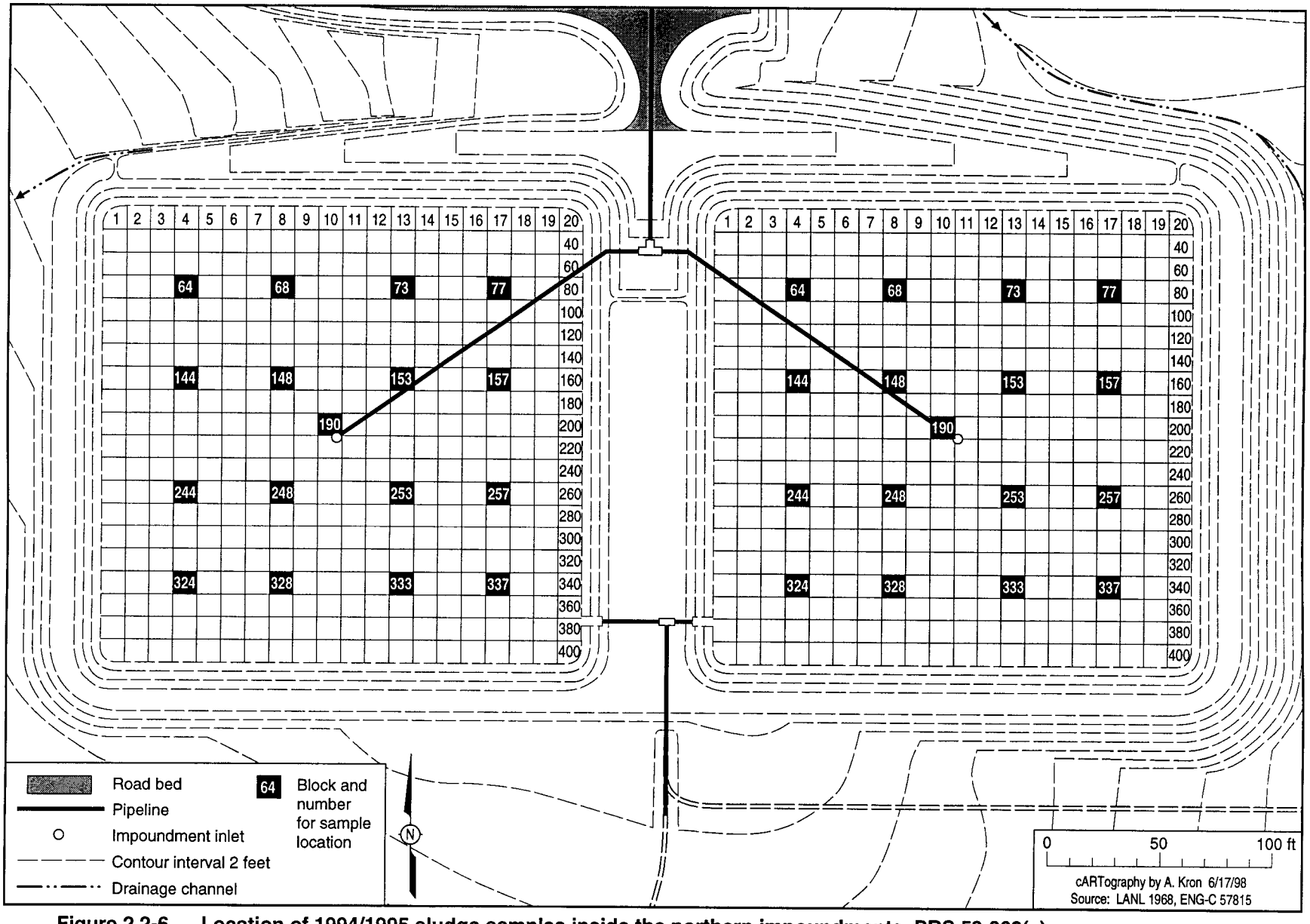


Figure 2.2-6. Location of 1994/1995 sludge samples inside the northern impoundments, PRS 53-002(a)

not be sufficient to hold the Hypalon™ liner in place. The Hypalon™ liner could become inverted by the vacuum created when wind blows across the top of the more-than-one-acre surface area of the southern impoundment and disperse the dried sludge. However, sampling beneath the liner should not be conducted while the impoundment is wet because of the potential for migration of contaminated water to uncontaminated subsurface media.

Initially, the water and sludge in the impoundment will be sampled to characterize both media. This action will take place after the impoundment has been decommissioned (December 1998). The contaminant concentrations of the unfiltered water samples will be added to the concentrations of the laboratory dried sludge after the percent moisture difference between the two is taken into account. This will determine a projected total contaminant concentration for the dried sludge once the water has evaporated. After the total contaminant concentrations have been identified, the disposition of the media (once dried) can be determined (i.e., store sludge in containers either within the PRS boundary or at TA-54 until characterization of the underlying media has been completed, or dispose of the media if a decision on disposition can be determined). The disposal option may require an interim measures plan. Therefore, it is anticipated that the containerized dried sludge will only be shifted to differing locations within the impoundment to accomodate sample collection through the Hypalon™ liner.

The Hypalon™ liner will either be cut up or rolled up (whichever prevents it from becoming airborne) and left within the PRS boundary until a decision on future disposition can be determined. The sand underlying the Hypalon™ liner will then be sampled, as well as the pulverized and/or solid tuff beneath the liner. Sampling of the material below the Hypalon™ liner will be performed to determine whether there have been any releases from the southern surface impoundment that have resulted in contamination above risk-based levels for human health or that may have an adverse ecological impact.

Sludge samples within the southern surface impoundment will be collected using a similar grid system to that recommended by the NMED in its March 19, 1992 letter responding to the proposed RCRA closure sampling plan for this PRS (NMED 1992, 28774). As depicted in Figure 2.2-7, the impoundment will be subdivided into a grid of approximately 10-ft by 10-ft blocks, totaling 420 blocks. The blocks will be uniquely numbered and fourteen blocks will be selected as sample locations biased by professional judgement to provide uniform coverage. In addition, sample locations will be biased to focus on liner seams and/or areas of the liner that have visual evidence of physical damage. At present about 4 ft of the liner is visible above the water level.

During the liquid sludge characterization sampling, three grab samples of water will be collected from the impoundment. The water samples will be analyzed for the same full suite of analyses as the liquid sludge samples. Fourteen grab samples of liquid sludge will be collected from the grid locations depicted in Figure 2.2-8. The laboratory will be instructed to dry the sample and analyze it as a solid. All liquid samples (water and sludge) will be analyzed for TAL metals, mercury, chromium VI (for 10% of the sludge samples), total amenable cyanide (for sludge only), VOCs, SVOCs, PCBs, organochlorine pesticides (for 10% of the samples), and chlorinated herbicides (for 10% of the samples), reactive cyanide and sulfide, gamma-emitting isotopes, isotopic uranium, isotopic plutonium, strontium-90, and tritium. It should be noted that sludge is expected to have relatively high concentrations of sulfide because of anaerobic biological activity.

Sludge samples will be collected within each of the selected blocks, as near to the center of the block as can be achieved. The approximate depth of the sludge will be recorded at each sampling location. If the amount of sludge at a selected block is insufficient for the collection of an adequate sample volume, the absence of sufficient volume will be recorded in the field logbook, and an immediately adjacent block will be sampled. If a sample cannot be obtained from one of the eight adjacent blocks, then the sample will be collected at the nearest appropriate location. The alternate sample location will also be noted in the field log book.

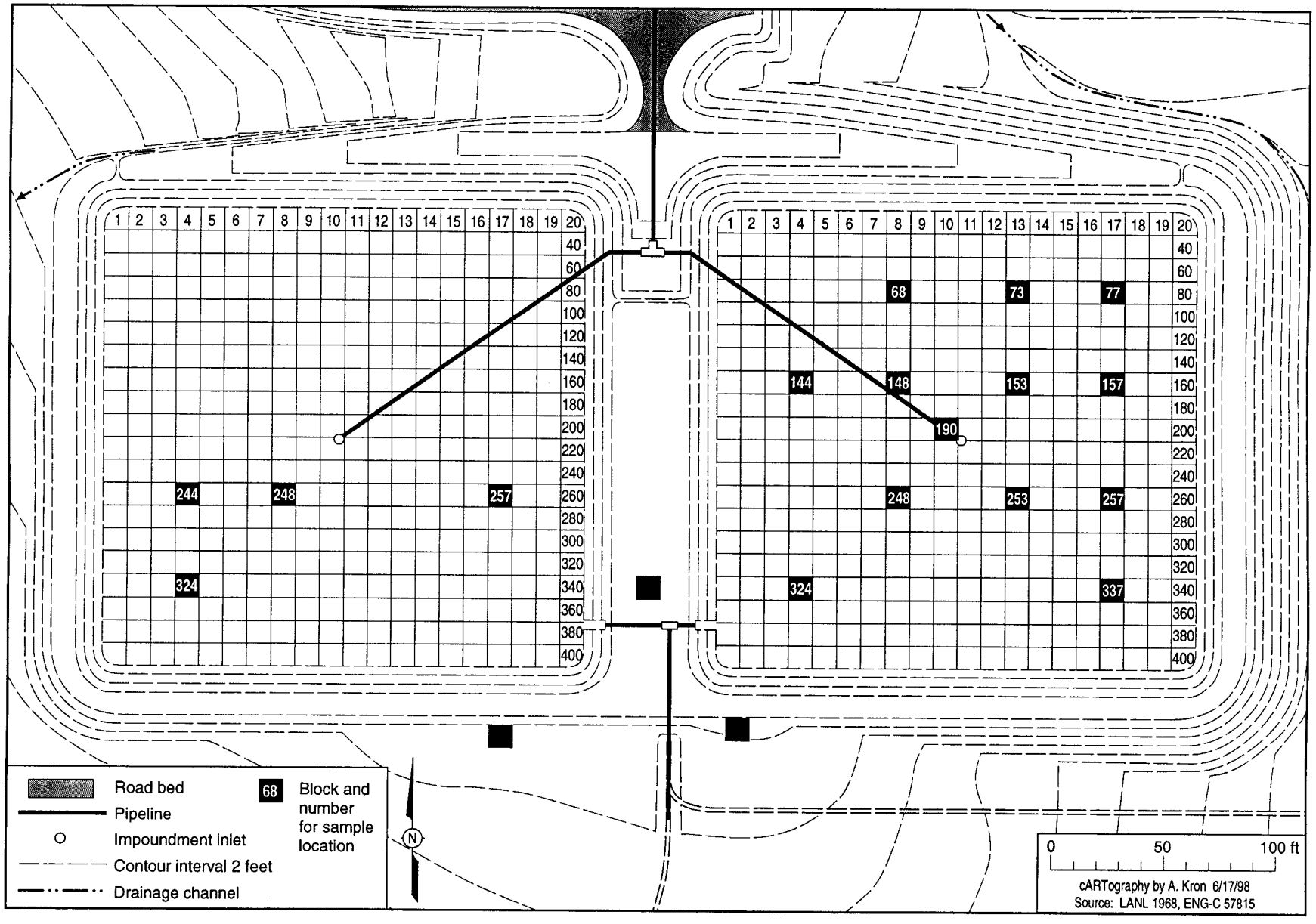


Figure 2.2-7. Location of proposed tuff samples inside the northern surface impoundments, PRS 53-002(a)

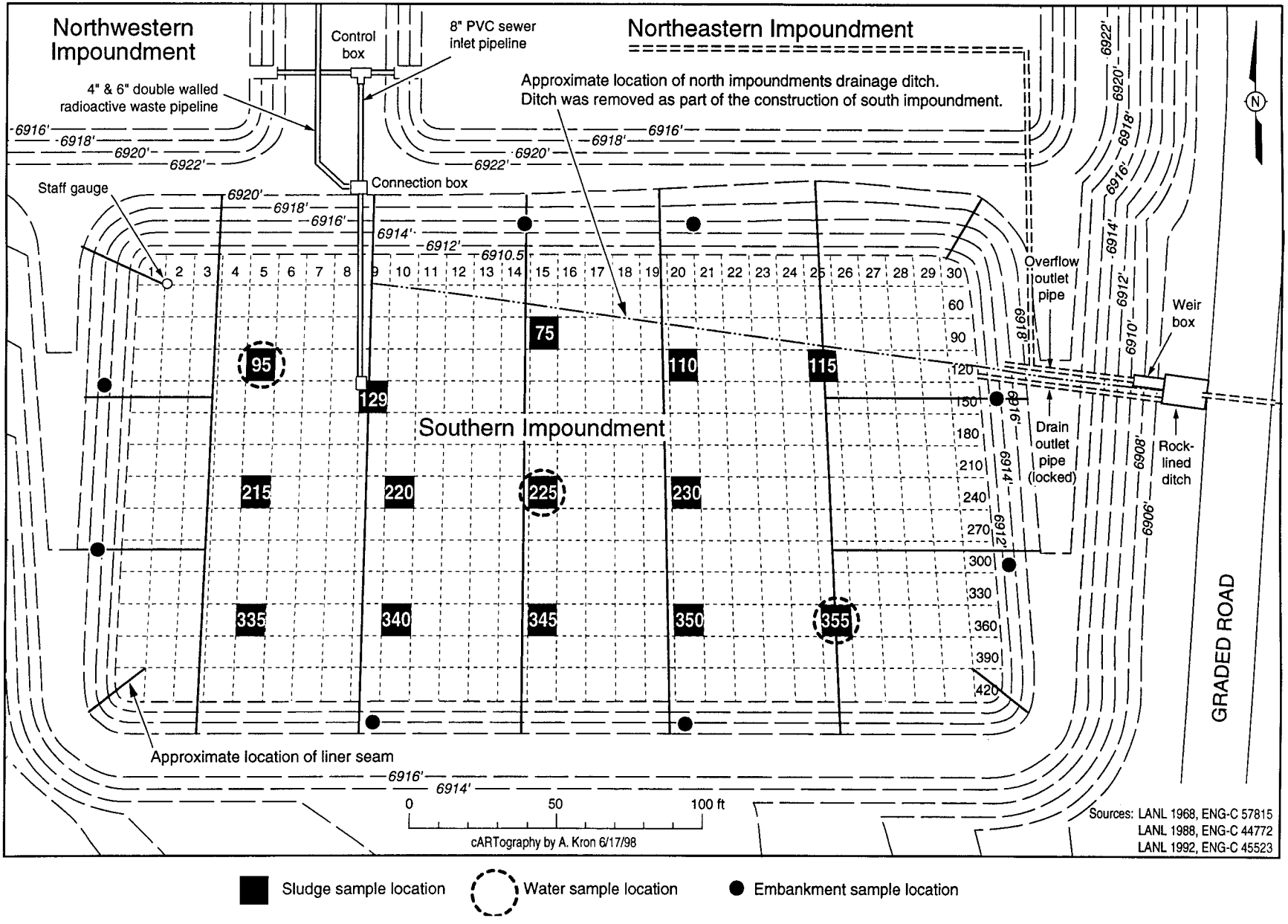


Figure 2.2-8. Proposed sludge, water, and liner seam sampling locations for the southern surface impoundment, PRS 53-002(b)

2.2.3.2 Media Characterization

Sampling Design for Northern and Southern Surface Impoundment Media Characterization

Solid media characterization below the clay liner and tuff will be performed to determine the presence or absence of contaminants in soil at the sites described in these sections, and to bound the extent of contamination. Within the surface impoundments and immediately outside the surface impoundments, samples will be collected from the proposed locations following radiological screening for health and safety considerations.

The outfall sampling will proceed differently. After geomorphic surveys are conducted to identify drainage paths and sediment catchment areas with young (post-Laboratory) sediment, radiation surveys will be performed on grids as described below. Sampling locations will be chosen based upon the radiological survey results, or will be judgmentally chosen. A land survey will be conducted using established survey monuments and coordinates published in the Laboratory Survey Monument Network Manual (LANL 1994, 55599).

Sampling to Determine Vertical Extent of Contamination Within the Northern Surface Impoundments. After the 1994/1995 grid and sampling locations were reviewed against the data presented in Section 2.2.2.1, Nature and Extent of Contamination. Based on professional judgment, a few samples were added to the original sample design to account for areas not adequately covered. Based on a qualitative evaluation of the spatial distribution of indicator contaminants, twenty locations were identified as locations where deeper interval tuff samples should be collected (See Appendix G assessment). Four locations in the southern half of the northwestern impoundment, and thirteen locations in the northeastern impoundment will be sampled at two additional depth intervals. Three additional sample locations were identified between the surface impoundments to bound cobalt-60. Samples will be collected from the twenty locations at the 60- to 72-in. depth and the 132- to 146-in. depth (Figure 2.2-7). Samples will be analyzed for the following analytical suites to determine extent: TAL metals, PCBs, SVOCs, gamma-emitting isotopes, isotopic plutonium, and tritium.

Solid Media Sampling in the Southern Surface Impoundment. Samples of the sand layer and tuff will be collected below the Hypalon™ liner from the same fourteen locations as the sludge. These samples will be collected to determine whether constituents have migrated from the impoundment into the underlying tuff. These samples must be collected after all water has evaporated in order to prevent migration of contaminants through the liner. However, the sludge must be physically removed from the impoundment, or repackaged within the impoundment, to allow progression of this phase of the WP/ SAP's implementation.

A maximum of fifty-six samples will be collected. These samples will be collected from the following media and depths: 1) the sand layer (directly underlying the Hypalon™ liner), and 2) tuff at three depth intervals (the 12- to 24-in. depth, the 48- to 60-in. depth, and the 132- to 144-in. depth. The tuff samples will be collected at all depth intervals and screened with an appropriate radiological screening method to detect elevated radioactivity and select samples accordingly for full suite analyses ("elevated" is defined as two times the background based on background in the field at the time of sampling). This screening tool can be used effectively because co-location of radionuclides and other contaminants was observed in the northern surface impoundments. Process knowledge and previous sampling predict the presence of cobalt-60 (which emits extremely energetic gamma photons) at this site.

Each location will have a minimum of two depth intervals sampled from the tuff. If all tuff depth intervals at a particular location are determined to have radionuclide values above background, all depths will be sampled and analyzed for the full suite of COPCs. If only the first tuff depth interval is elevated then all of the second depth interval will be sampled to ascertain extent and 20% of the third depth interval will be sampled to verify the screening. If the second depth interval is elevated then the third depth interval will be collected for the full suite of COPCs to confirm extent. Because media other than sludge is not expected to have high concentrations of sulfide, reactive cyanide and sulfide will not be analyzed for in tuff samples. All solid media samples (sand and tuff) from the southern surface impoundment will be analyzed for TAL metals, mercury, chromium VI (for 10% of the samples), VOCs (only below a 6-in. depth unless the Hypalon™ liner is left in place up to the time of sample collection), SVOCs, organochlorine pesticides and chlorinated herbicides (for 10% of the samples), PCBs, gamma-emitting isotopes, isotopic uranium, isotopic plutonium, strontium-90, and tritium.

Berm Sampling of Southern Impoundment. The berm surrounding the southern surface impoundment will be sampled at eight locations for two depth intervals (12 to 24 in. below ground surface [bgs] and at a depth equivalent to the bottom of the sand layer underlying the Hypalon™ liner). These samples will be collected to determine if the soil/tuff of the northern surface impoundment outfall area was incorporated into the berm during the construction of the southern impoundment. The eight locations (two from each berm wall) are depicted on Figure 2.2-8. The tuff will be analyzed for TAL metals, mercury, chromium VI (for 10% of the samples), VOCs, SVOCs, organochlorine pesticides and chlorinated herbicides (for 10% of the samples), PCBs, gamma-emitting isotopes, isotopic uranium, isotopic plutonium, strontium-90, and tritium.

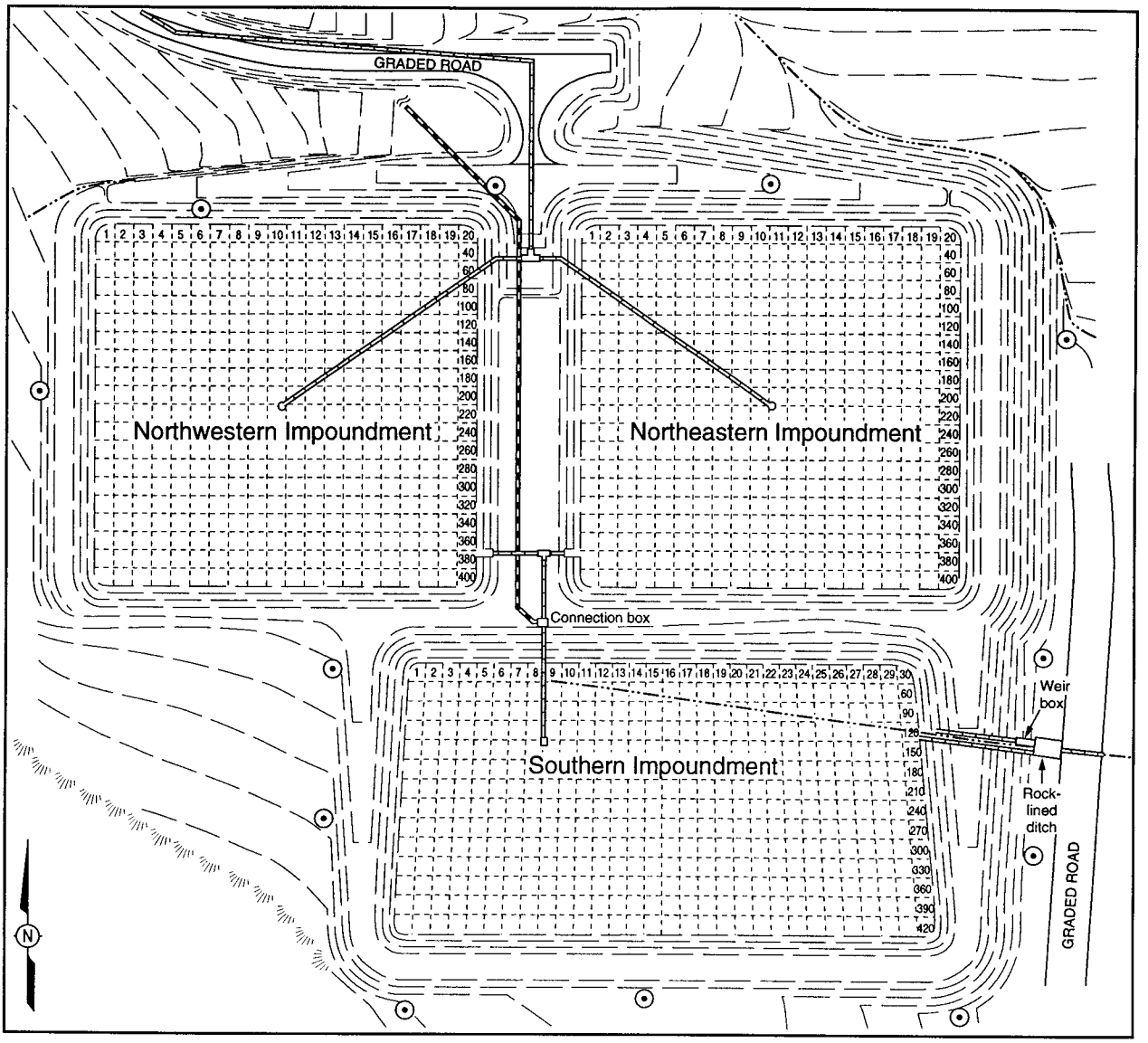
Sampling Design for Lateral Extent of Contamination Around the Northern and Southern Surface Impoundments

This section describes the strategy for the sampling and analysis activities to be implemented to determine lateral extent around the outside of the northwestern, northeastern, and southern surface impoundment berms. Sampling will be performed to determine whether there have been any releases from the surface impoundments that have migrated laterally.

Fixed laboratory samples have not yet been collected outside the bermed areas of the surface impoundments, making a statistically based design for this area inappropriate. Therefore, the number and locations of samples outside the bermed areas are based on professional judgment.

Soil/tuff samples will be collected at the locations shown in Figure 2.2-9. At the chosen location, samples will be collected at three depth intervals (12 to 24 in., 48 to 60 in., and 132 to 144 in.) below the bottom of the adjacent impoundment's liner. A total of thirty-six samples of tuff will be collected at the twelve locations.

All soil/tuff samples will be analyzed for TAL metals, mercury, chromium VI (for 10% of the samples), VOCs, SVOCs, organochlorine pesticides and chlorinated herbicides (for 10% of the samples), PCBs, gamma-emitting isotopes, isotopic uranium, isotopic plutonium, strontium-90, and tritium.



Sources: LANL 1968, ENG-C 57815
LANL 1988, ENG-C 44772
LANL 1992, ENG-C 45523

⊙ Proposed borehole location

0 50 100 ft

cARTography by A. Kron 6/17/98

Figure 2.2-9. Locations of proposed boreholes around perimeter of impoundments

Sampling Design for Sandia Canyon Tributary Area

This section describes the strategy for sampling and analysis activities to be implemented for solid media leading to the Sandia Canyon tributary.

Because there is no existing evidence of any outfalls on this mesa top, a radiation survey followed by judgmentally determined sample locations will constitute the sampling plan. Activation products, usually short-lived, emit extremely energetic gamma photons and beta particles; for this reason, the radiation survey will principally use sodium iodide detectors.

A 15-ft by 15-ft grid will be established along the northwest, west, and southwest boundary of the three surface impoundments (the northeast, east, and southeast boundary was screened for radioactivity and sampled during the 1995 sampling campaign for PRS 53-008). All grid intersections will be surveyed for radiation using field instrumentation. Radiological field survey readings will be documented. Ten samples will be collected at random from numbered grid nodes using a table of random numbers. The ten sample locations will be selected based on radioactivity levels of high, medium, and low; with four locations determined to be high, three locations determined to be medium, and three locations determined to be low (Figure 2.2-10). This strategy is being used to provide correlations between the radiological screening and the laboratory determination of contaminants. A low radioactivity reading will be equivalent to two times background radioactivity. A medium radioactivity reading will be equivalent to three times background. A high radioactivity reading will be greater than three times background levels. A minimum of two depths (0 to 6 in. and soil-tuff interface) will be sampled at each location if elevated radiological readings are detected and if enough soil is present. If elevated radiological readings are not observed at levels greater than two times background, no samples will be collected from this area.

On the bench below the mesa top, a similar strategy will be followed, except the grid size will be reduced to 5 ft by 5 ft, and only two fixed laboratory samples will be collected if there is elevated radioactivity detected. This area is being surveyed for radioactivity in case an outfall pipe extended in the direction of this side canyon. A recent field trip indicated little new (within the last twenty to fifty years) accumulation of sediment as evidenced by tree roots visible at the surface, no sediment accumulation around tree roots, and crusts forming on the soil. There also was no evidence of runoff sheet flow. Thus, there is no existing evidence of any outfalls in this area.

Collected samples will be analyzed for TAL metals, mercury, chromium VI (for 10% of the samples), VOCs (below 6 in.), SVOCs, organochlorine pesticides and chlorinated herbicides (for 10% of the samples), PCBs, gamma-emitting isotopes, isotopic uranium, isotopic plutonium, strontium-90, and tritium.

Sampling Design for Influent Pipes and Discharge Lines

This section describes the strategy for sampling and analysis activities to be implemented for the influent lines to all three impoundments and decommissioned discharge line from the northern surface impoundments.

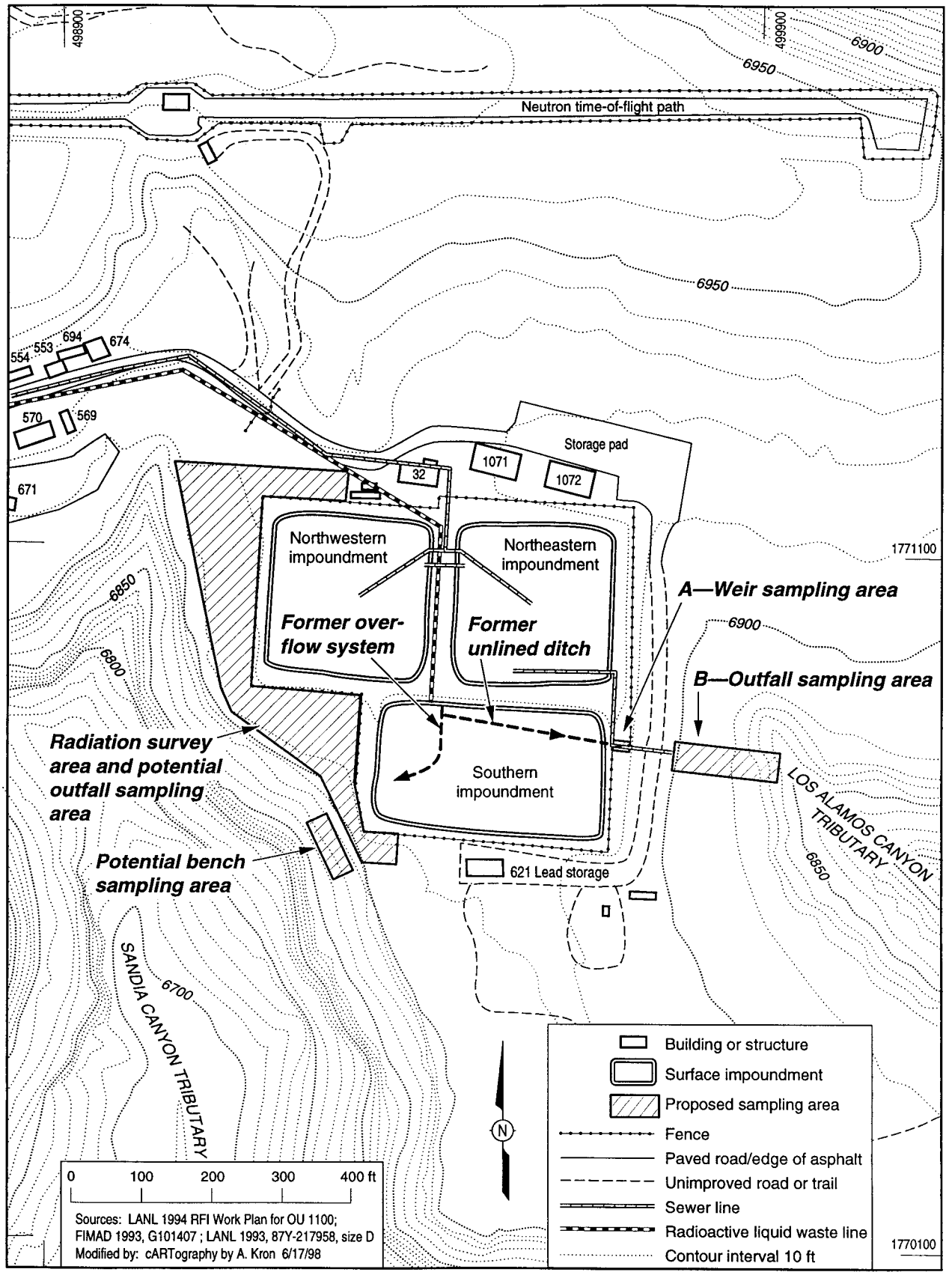


Figure 2.2-10. Proposed sampling location adjacent to the impoundments

Soil samples will be collected starting at the administrative boundary of the influent lines, manhole 53-163 and the northern fence line to the southern impoundment between the sewer line and radioactive liquid waste line, as shown in Figure 2.2-11. The line will be sampled at ten locations, at intervals not to exceed 20 ft. Samples will be collected in the sand bedding layer adjacent to and beneath the pipe. One of the ten sample locations will be placed at the distribution box and one of the ten sample locations will be placed at the manhole. The pipe depth varies from 5 to 6 ft below grade, with the bedding material extending 4 in. below and 12 in. above the pipe. Samples will be screened for radioactivity in the field. Locations with samples showing elevated radioactivity at the 6 ft sand bedding layer will also be sampled at 9 ft and 12 ft to determine extent.

A similar strategy will be followed at the decommissioned discharge line. The line will be sampled at five locations, at intervals not to exceed 20 ft. Samples will be collected in the sand bedding layer adjacent to and beneath the pipe. The pipe depth varies from 5 to 6 ft below grade, with the bedding material extending 4 in. below and 12 in. above the pipe. Samples will be screened for radioactivity in the field. Locations with samples showing elevated radioactivity at the 6 ft sand bedding layer will also be sampled at 9 ft and 12 ft to determine extent.

All pipe bedding material and tuff samples will be analyzed for TAL metals, mercury, chromium VI (for 10% of the samples), VOCs (below 6 in.), SVOCs, organochlorine pesticides and chlorinated herbicides (for 10% of the samples), PCBs, gamma-emitting isotopes, isotopic uranium, isotopic plutonium, strontium-90, and tritium.

Sampling Design for the Northern Surface Impoundment's Decommissioned Outfall Drainage Area

This section describes the strategy for sampling and analysis activities to be implemented for the solid media below the decommissioned outfall from the northern surface impoundments and the affected drainage area within the Los Alamos Canyon tributary.

As shown on Figures 2.2-10 and 2.2-12, the sampling for this area is divided into five distinct areas, labeled A through E. Area A is the cobble area immediately where the discharge line exits from the beneath the northwestern surface impoundment. The cobbles will be moved and enough material for three samples will be collected. These samples will characterize this first discharge area.

Area B is the area across the dirt road, which is approximately 150 ft long by 20 ft wide and constitutes the area which would have received the first transported discharges before the canyon drop off. The area is a posted radiation control area and is surrounded by straw bales. A 10-ft by 10-ft grid will be placed on the outfall area, and a radiation survey will be conducted to help bias sampling locations. If elevated surface radiation is encountered, a minimum of ten locations will be selected, spanning the range of high, medium, and low radiological screening results to test whether co-location of contaminants and radioactivity is occurring. Samples will be collected for laboratory analyses at these locations, at a minimum of three depths (0 to 6 in., the soil/tuff interface, and 0 to 6 in. of native tuff). This area encompases former sampling locations 3 and 4, see Figure 2.2-2.

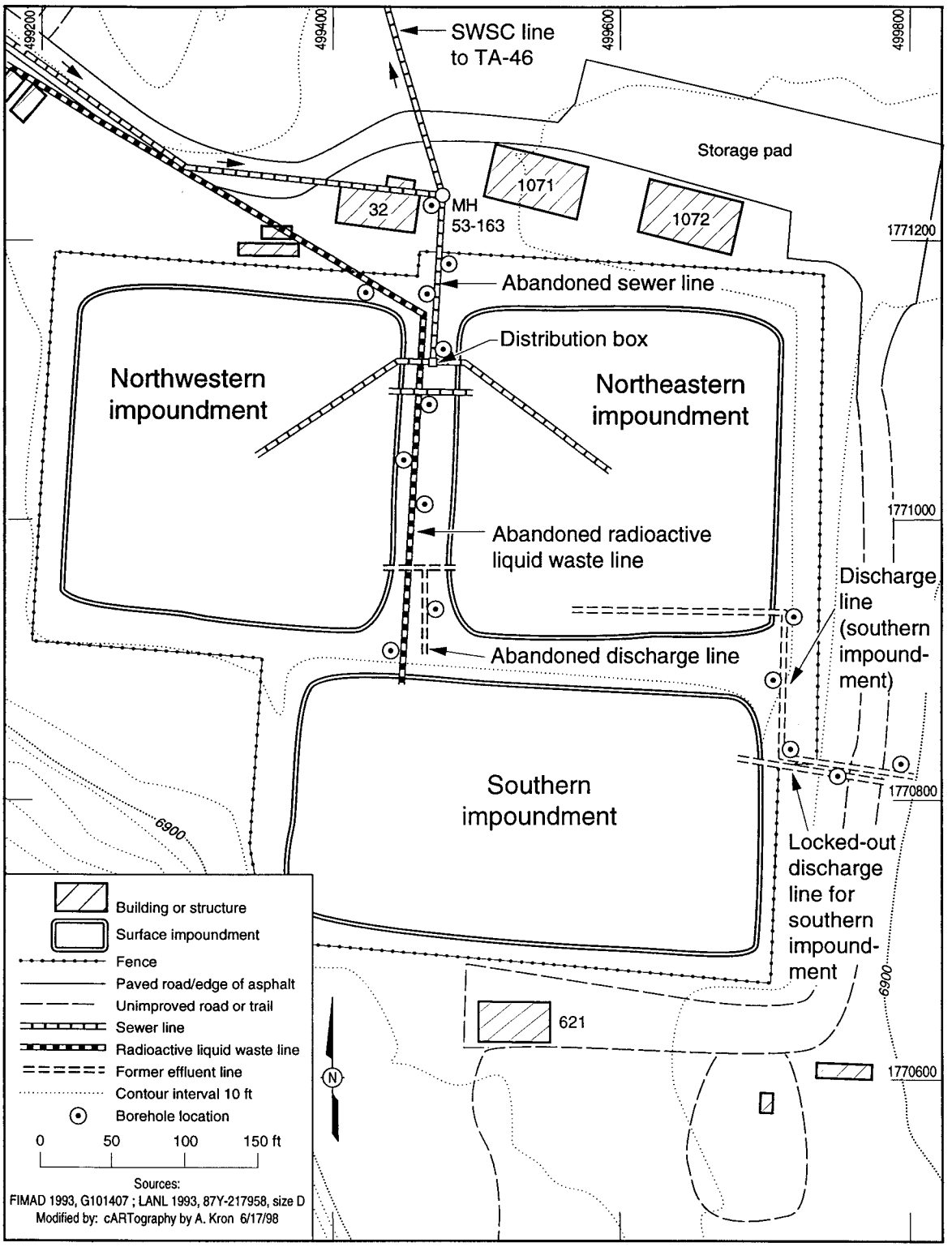
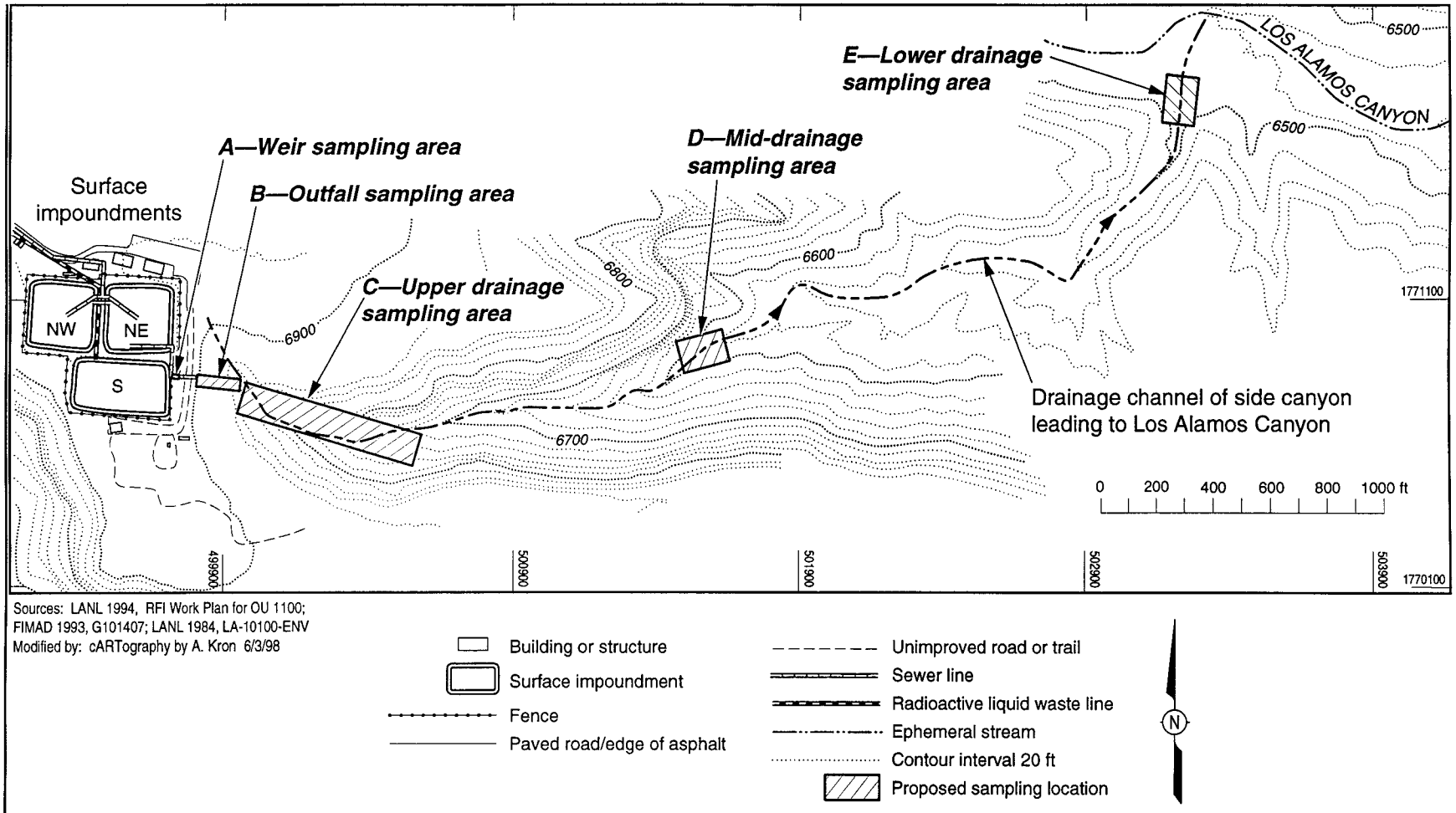


Figure 2.2-11. Sample locations of inactive piping for TA-53 surface impoundments



Sources: LANL 1994, RFI Work Plan for OU 1100;
FIMAD 1993, G101407; LANL 1984, LA-10100-ENV
Modified by: cARTography by A. Kron 6/3/98

Building or structure
Surface impoundment
Fence
Paved road/edge of asphalt
Unimproved road or trail
Sewer line
Radioactive liquid waste line
Ephemeral stream
Contour interval 20 ft
Proposed sampling location
N

Figure 2.2-12. Proposed sampling area in drainage below impoundment outfall

Area C is the area below area B and is about 600 ft long. A grid will be placed over this area, and the area will be surveyed and sampled as above at ten locations. If the radioactivity screening does not indicate elevated readings, then a geomorphologist will judgmentally determine sample locations, with emphasis on locations in drainages where young sediment would accumulate. Samples will be collected for laboratory analyses at these locations, at a minimum of three depths (0 to 6 in., the soil/tuff interface, and 0-6 in. of native tuff).

Area D will coincide with former sample location 5, and area E with location 7 from the previous ESG sampling. From both of these areas, three locations will be chosen from each sediment catchment area in the main channel. Samples will be collected at three depths, the surface (0 to 6 in.), the sediment/tuff interface, and the first interval of native tuff. Note that if the soil or sediment/tuff interface is deeper than 12 ft at any given sample location, the final depth interval collected will be the 12 ft interval. If analysis of the 11.5 ft to 12 ft sample indicates contaminants are present above background, and does not clearly show a decreasing trend or is not above SALs, an addendum to this RFI WP /SAP may be prepared.

Former sampling location 6 will not be sampled because previous results did not show radionuclides below sample location 4. If area D is contaminated, additional sampling at former area 6 may be proposed (see Figure 2.2-2 for former sample locations 1 through 8).

All sediment samples will be analyzed for TAL metals, mercury, chromium VI (for 10% of the samples), VOCs (only below 6-in. depth), SVOCs, organochlorine pesticides and chlorinated herbicides (for 10% of the samples), PCBs, gamma-emitting isotopes, isotopic uranium, isotopic plutonium, strontium-90, and tritium.

If contaminants are detected in the most downgradient sample of the Los Alamos Canyon tributary sampling area, or at the lower bench of the Sandia Canyon tributary sampling area, the data will be turned over to the Canyons Focus Area of the ER Project so that they may use it to determine how to proceed downstream of the site.

3.0 DATA COLLECTION DESIGN AND PROCEDURES

3.1 Data Quality Objectives

The results from this RFI WP/SAP will be used to evaluate the design assumptions relating to the conceptual site model, quantify uncertainties associated with the nature and extent of contamination, and quantify uncertainties associated with the human health and ecological risk assessment.

The decision flow diagram (Figure 3.1-1) demonstrates how the two-step characterization will be used to evaluate data and prepare a baseline human health risk assessment and an ecological screening assessment. A key component of the data assessment strategy is the use of a screening assessment to evaluate data in an ecological and human health risk context. The first step in the screening assessment is an evaluation of the key assumptions used to develop the sampling approach, including the conceptual site model. Further assessments will be based on (1) realistic estimates of the contaminant source term and (2) conservative assumptions to estimate contaminant concentration in unsampled media (e.g., biota, groundwater, and air). The source term will be calculated based on the human health receptor activity being modeled or the source of contaminants to ecological receptors.

To ensure that COPCs are detected at levels of concern, analytical detection limits must be less than current LANL background values for inorganics and radionuclides. Precision and accuracy of measurements will be assessed using appropriate field and laboratory QA/QC and performance evaluation (PE) samples as described in detail in Section 3.2, Quality Assurance/Quality Control.

Data generated by the analytical laboratories will undergo verification and baseline validation procedures described in Sections D1 and D2 of the ER Project QAPP (LANL 1996, 57368). The bias and precision of fixed-site laboratory analyses for inorganic and organic chemicals will be assessed using the standard QA/QC procedures described in the EPA SW-846 methods. For radiological measurements, QA/QC procedures similar to the EPA SW-846 procedures will be employed. The ER Project analytical services statement of work (LANL 1995, 49738) contains the LANL-specific acceptance criteria for these QA/QC procedures.

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, 57368). The assessment team will evaluate the sufficiency of the data set for decision-making purposes using their best professional judgment. The assessment team shall consist, at a minimum, of a geologist, a human health risk assessor, an ecological risk assessor, a statistician, and a chemist (at a minimum). The data quality assessment process outlined in Figure D-3 of the ER Project QAPP (LANL 1996, 57368) will be followed.

Both human health and ecological risk assessments will be conducted in accordance with the HRMB Risk-Based Decision Tree (NMED 1998, 57761) and appropriate EPA guidelines.

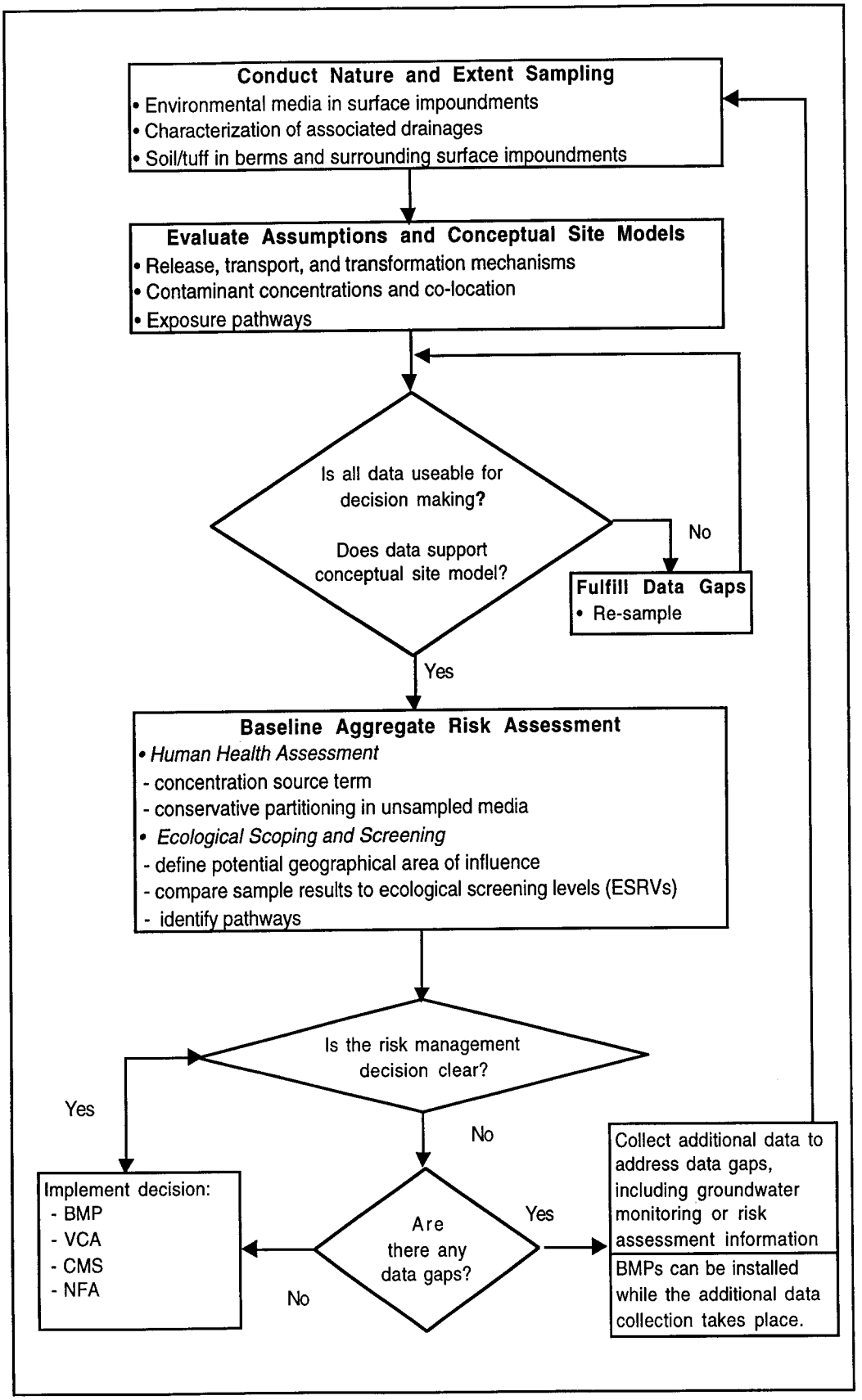


Figure 3.1-1 Decision logic diagram for RFI WorkPlan/SAP for TA-53, PRSs 53-002(a) and (b)

To determine whether a contaminant release has occurred, inorganic chemicals and radionuclides will be compared with background values (BVs) or fallout concentrations. For organic chemicals, determining whether a release has occurred requires identifying which organic chemicals are detected. For human health screening, carcinogens and radionuclides will be compared with their respective SALs and noncarcinogens will be compared with one tenth of their respective SALs. For ecological screening, inorganics and radionuclides at or above BVs (or fallout concentrations) and detected organic chemicals will be compared with the appropriate ecological screening reference values (ESRVs).

It is probable that the extent of contamination will not be sufficiently determined for tritium during this sampling investigation. A follow-up sampling campaign will be developed as an addendum to this RFI WP/SAP to determine extent beyond 12 ft for any COPCs for which the extent was not bounded during this investigation.

3.2 Quality Assurance/Quality Control

Collected QA/QC samples will assess the quality of sampling and measurement techniques and help with the following objectives:

1. To provide information on false negatives needed to estimate negative bias;
2. To estimate sample collection and total measurement variance; and
3. To evaluate whether the data are complete, representative and comparable.

Field QA/QC activities will include collecting QA/QC samples in addition to the field documentation requirements discussed in Section 3.3, Field Activities. QA/QC samples include field duplicate samples, equipment rinsate blanks, and PE samples. Table 3.2-1 summarizes QA/QC samples discussed in this RFI WP/SAP.

Field duplicate samples of water, sludge, and pulverized or solid tuff will be collected at a frequency of one duplicate sample per twenty environmental samples for each sample matrix. The field duplicate samples will be collected at the same locations as the corresponding environmental samples and will undergo the same analyses. The results of analysis of duplicate samples will be used to indicate the variability of the sampled matrix.

Rinsate blank samples are used to assess contamination within the sample itself from improperly cleaned sample equipment. Rinsate blank samples will be collected during decontamination of sampling equipment. Rinsate blank samples will be collected from the final deionized water rinse and at a frequency of one per day for the first two days of the sampling campaign. These samples will be assigned a unique sample identification number for tracking purposes, but will not be identified as blanks to the analytical laboratory. Rinsate blanks will undergo analyses of PCBs/pesticides, gamma-emmitting isotopes by gamma spectroscopy, and TAL metals, which will indicate if there has been cross contamination.

TABLE 3.2-1
SUMMARY OF QA/QC SAMPLES

QC Sample Type	Sample Matrix	Applicable Analysis	Frequency	Purpose	Acceptance Criteria	Corrective Action
Field Duplicate	Tuff, Sludge	Tuff/Sludge: VOCs, SVOCs, Pesticides/PCBs, Herbicides, TAL Metals, Radionuclides Water: Radionuclides	One per 20 tuff/sludge samples	Monitor sample variability	See note (a)	Advisory -- no action required
Rinsate Blanks (use only deionized water)	Water	Pesticides/PCBs, TAL metals, Radionuclides, VOCs SVOCs	One per day for the first 2 days of sampling campaign.	Monitor effectiveness of decontamination and cross-contamination of samples	See notes (b) and (c)	Advisory -- no action required
PE Samples	Soil	PCBs	5 Samples with a range of concentrations, if available	Monitor accuracy of laboratory	Correct Aroclor identification, consistent precision	Use matrix cleanup methods, reanalyze

(a) For water samples, the goal for relative percent difference is 25%. For sludge and tuff samples, the goal for relative percent difference is 50%. These goals are based on the expected variability of the matrices to be sampled. Failure to meet these goals will not require corrective action, but may require evaluation of the cause of variability.

(b) For VOCs and SVOCs analysis, if blank shows detectable levels of any common laboratory contaminant, sample must exhibit that contaminant at a level equal to or greater than 10 times the quantitation limit to be considered detectable. For all other contaminants, sample must exhibit that contaminant at a level equal to or greater than 5 times the quantitation limit to be considered detectable.

(c)For pesticides and herbicides, if blank shows detectable level of any contaminant, sample must exhibit that contaminant at a level equal to or greater than 5 times the quantitation limit to be considered detectable.

Because there are a variety of matrices at this site (sludge, soil, and crushed tuff) and soil is assumed to be the most representative, a maximum of five PCB PE soil samples will be submitted to the analytical laboratory. Each sample will be submitted with a unique request number. The results will be used to verify identification of aroclors and evaluate potential laboratory-introduced biases in order to differentiate matrix interferences in the sludge samples.

Instrument calibration and maintenance are field activities subject to QA/QC procedures. All field equipment will be calibrated as specified in the Site-Specific Health and Safety Plan (SSHASP). This equipment will be calibrated and maintained using the manufacturer's instructions and appropriate SOPs.

Field personnel will monitor for organic vapors in the surface impoundment area and may prescribe additional personal protective devices based on these measurements. Monitoring shall be conducted for nonspecific organic vapors using either a photo-ionization detector or a flame ionization detector. Before field activities, the organic vapor analyzer will be calibrated by a trained technician using a calibration gas to check instrument response and ensure proper operation. Each day before monitoring, the organic vapor analyzer shall be zeroed, set in an area free from organic vapors, response-checked using a commercially available calibration gas, and then taken to the surface impoundment site for monitoring.

Field documentation is an integral part of QA/QC procedures. Field documentation requirements and procedures are discussed in detail in Section 3.3 of this RFI WP/SAP.

In addition to the field QA/QC samples, the analytical laboratories will provide standard QA/QC measurements including method and calibration blanks, surrogates, spikes, and internal standards as specified by the statement of work with the analytical laboratory. Analytical data packages will contain all reported results, including all QA/QC information. The PCB data will also be compared to standard detection limits to determine if the data are usable and whether there are any issues associated with the sample matrix and analysis.

3.3 FIELD ACTIVITIES / FIELD SURVEYING

Radiological Survey
The northern surface impoundments' overflow piping discharged through a ditch and a side canyon into Los Alamos Canyon. This canyon reach and the area to the southwest of the northern surface impoundments will be surveyed for gamma-emitting radionuclides using sodium iodide detectors in accordance with LAN-ER-SOP-6.23, "Measurement of Gamma-Ray Fields Using a Sodium Iodide Detector" and LANL-ER-SOP-10.10, "Radiation Scoping Surveys." This survey will identify locations with elevated gamma activity from which soil samples will be taken for fixed laboratory radionuclide analysis.

Geodetic Survey
Licensed surveyors will identify state planar coordinates for sample collection locations. All survey data will be submitted to the LANL ER Project's Facility for Information Management, Analysis, and Display (FIMAD). Surveys will be conducted in accordance with LANL-ER-SOP-03.01, "Land Surveying Procedures" (LANL 1991, 21556).

FIELD SCREENING

Background Measurements
The background for each instrument, including its detector, detector holder (if being used) and Marinelli beaker filled with background soil, will be detected in a relatively low background area in the field. Refer to LANL-ER-SOP-10.07, "Field Monitoring for Surface and Volume Radioactivity Levels."

The decision amount (DA) and minimum detectable activity (MDA) for the instruments with blanks will be calculated, as detailed in LANL-ER-SOP-10.07. All calculations will be recorded on Attachment C of LANL-ER-SOP-10.07, "Determination of DA and MDA."

The estimation of sample radioactivity parameters for all samples, except those contaminated with tritium or plutonium will be calculated as detailed in LANL-ER-SOP-10.07.

STANDARD OPERATING PROCEDURES FOR SAMPLE COLLECTION AT PRSs 53-002(a) AND (b)

Sample collection procedures for northern surface impoundments
All solid media samples will be collected in accordance with LANL-ER-SOP-06.09, "Spade and Scoop Method for Collection of Soil Samples," and LANL-ER-SOP-06.10, "Hand Auger and Thin-Wall Tube Sampler" (LANL, ER IDS # 21556). The tools used to collect the samples will depend on the cohesion of the materials and the collection depth.

Sample collection procedures for southern surface impoundment
The liquid samples will be collected in accordance with the LANL-ER-SOP, "Pole Mounted Beaker Sampling for Liquids" that is currently being documented.

All solid media samples will be collected in accordance with LANL-ER-SOP-06.09, "Spade and Scoop Method for Collection of Soil Samples," and LANL-ER-SOP-06.10, "Hand Auger and Thin-Wall Tube Sampler" (LANL 1991, 21556). The tools used to collect the samples will depend upon the cohesion of the materials and the collection depth.

Sample collection procedures for lateral extent around the three surface impoundments
All tuff samples will be collected in accordance with LANL-ER-SOP-06.10, "Hand Auger and Thin-Wall Tube Sampler" (LANL 1991, 21556).

Sample collection procedures for Sandia Canyon tributary area
All solid media samples will be collected in accordance with LANL-ER-SOP-06.09, "Spade and Scoop Method for Collection of Soil Samples," and LANL-ER-SOP-06.10, "Hand Auger and Thin-Wall Tube Sampler" (LANL 1991, 21556). The tools used to collect the samples will depend on the cohesion of the materials and the collection depth.

Sample collection procedures for influent pipes and discharge lines
All solid media samples will be collected in accordance with LANL-ER-SOP-06.10, "Hand Auger and Thin-Wall Tube Sampler" (LANL 1991, 21556).

Sample collection procedures from the decommissioned outfall drainage area
Sediment samples will be collected in accordance with LANL-ER-SOP-06.09, "Spade and Scoop Method for Collection of Soil Samples," and/or LANL-ER-SOP-06.10, "Hand Auger and Thin-Wall Tube Sampler" (LANL 1991, 21556). The tools used to collect the samples will depend on the cohesion of the materials and the collection depth.

Sample Collection Methods
All samples will be collected in accordance with the applicable ER Project SOPs (LANL 1991, 21556) for collecting, preserving, identifying, storing, transporting, and documenting environmental samples, as described in the ER Project QAPP (LANL 1996, 57368). All samples will be identified in accordance with LANL-ER-SOP-01.04, "Sample Control and Field Documentation." Chain-of-custody requirements described in LANL-ER-SOP-01.04 will be implemented. The Field Support Facility (FSF) will be consulted regarding the appropriate sample containers and preservation. Samples will be packaged and shipped in accordance with LANL-ER-SOP-01.03, "Handling, Packaging and Shipping of Samples." All samples will be shipped from the FSF to fixed laboratories for analysis.

Sampling equipment will be decontaminated 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."

Data Management

The data management scheme described in Sections A10 and B10 of the ER Project QAPP (LANL 1996, 57368) will be followed. Manually recorded data will be reviewed by the field team as required by LANL-ER-SOP-1.01 "General Instructions for Field Investigations"; LANL-ER-SOP-01.04; and LANL-ER-SOP-03.12, "Field and Laboratory Notebook Documentation for Environmental Restoration Earth Science Studies." Field records will document sample collection and tracking, health and safety briefings and checks of monitoring equipment performance, and nonsampling activities such as site inspections and walkovers, which are documented as engineering surveys on daily activity logs. All original documents will be transferred to the ER Project Records Processing Facility (RPF) in accordance with administrative procedure LANL-ER-AP-02.1, "Procedure for LANL ER Records Management" (LANL 1995, 49708).

Data generated by the analytical laboratories will be submitted to the FSF in accordance with 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 FSF is responsible for data verification, validation, and transmittal to FIMAD.

Analytical Methods

Samples will be submitted to the FSF for shipment to a fixed laboratory approved by the Laboratory ER Project, and analyses will be conducted in accordance with EPA SW-846 protocols (EPA 1986, 57589). Radiochemical analyses will be performed using Laboratory-approved methods according to the ER Project analytical services statement of work (LANL 1995, 49738). The detailed analyte lists, estimated quantitation limits (EQLs), required QC procedures, and acceptance criteria are found in the ER Project analytical services statement of work (LANL 1995, 49738). Analytical methods to be used are detailed in Table 3.3-2.

Special instruction for analytical services are listed as follows:

- Antimony detection limit: Detection limit of 0.5 mg/kg required for antimony in the TAL metals suite.
- Hexavalent chromium determination: Alkaline digestion (SW-846 Method 3060A) followed by ion chromatography (SW-846 Method 7199) is required for chromium determination.
- PCBs and chlorinated pesticides: Separate analyses are required (SW-846 8081A for chlorinated pesticides and 8082 for PCBs). Use appropriate sample preparation methods specified in the methods to minimize interferences.

TABLE 3.3-2. SUMMARY OF ANALYSES BY MATRIX

ANALYSES	MEDIA					
	Impoundment Water	Impoundment Sludge	Clay Liner	Sand Layer	Crushed and Native Tuff	Canyon Sediment
TAL metals (SW-846, 6010B, 7000 series for As, Se, Pb, Tl, Hg as required)	X	X		X	X	X
Total cyanide (SW-846, 9010B or 9012A)	X	X				
Chromium VI (SW-846, 3060A, alkaline digest, 7199 [IC])		X			X	X
Volatile organics plus TICs[a] (SW-846, 8260B)	X	X		X	X (>6 in. depth)	X (>6 in. depth)
Semivolatile organics plus TICs (SW-846, 8270C)	X	X		X	X	X
Organochlorine pesticides by GC (SW-846, 8081A)	X	X		X	X	X
PCBs by GC[b] (SW-846, 8082)	X	X	X	X	X	X
Chlorinated herbicides (SW-846, 8151A)	X	X		X	X	X
Reactive cyanide and sulfide (SW-846, Section 7.3.3.2 and 7.3.4.2)	X	X				
Gamma spectroscopy	X	X		X	X	X
Isotopic uranium	X	X		X	X	X
Isotopic plutonium	X	X		X	X	X
Strontium-90	X	X		X	X	X
Tritium	X	X		X	X	X

(a) TICs Tentatively Identified Compounds

(b) GC Gas Chromatography

- Strontium-90 determination: Strontium-90 specific analysis is required. Do not use Strontium-89/Strontium-90 method.

- Water Samples: Do not filter water samples before sample preparation or analysis. Report analytical results on volume basis.

- Sludge Samples: Dry sludge samples before sample preparation or analysis. Report analytical results on a solids basis.

4.0 PROJECT MANAGEMENT

4.1 Project Scheduling and Reporting Requirements

Project scheduling and reporting will be directed by the Remedial Actions Industrial Sites Team of the ER Project at the Laboratory. An actual schedule for this investigation has not been established. These activities are currently included in the ER Project baseline currently available to NMED, however, schedules are developed based on joint DOE, Laboratory, and NMED site prioritization.

Activities that will be included in the schedule for the investigation of PRSs 53-002(a) and (b) include:

- Receive RFI WP/SAP approval from NMED
- Develop SSHASP, SPPC plan, IDW plan
- Coordinate field work with operating group
- Prepare other field support documents (i.e., ESH ID sequence)
- Conduct field readiness review
- Perform visual site survey
- Conduct radiological and geodetic surveys
- Implement BMPs for proposed sampling (if necessary)
- Collect samples
- Send samples offsite for analyses
- Monitor waste storage area
- Perform data tracking
- Perform data validation
- Prepare waste disposal documentation (if applicable)
- Dispose of investigation derived waste (if applicable)
- Restore site
- Perform data assessments
- Write report

4.2 Health and Safety Plan

A site-specific Health and Safety Plan will be developed prior (approximately 2 months) to engaging in field activities, in accordance with the Environmental Restoration Project SSHASP, LANL EM/ER:95-PCT-012, April 13, 1005 (LANL, 56448). All field work associated plans must be as current as possible. Therefore, it is important that they are prepared as a part of field work preparation activities.

4.3 Investigation-Derived Waste Plan

Investigation-derived waste, if any, will be handled in accordance with LANL-ER-SOP-1.06 (LANL, 57367). The plan will be prepared just prior to engaging in field activities to ensure it is as current as possible.

4.4 Community Relations Plan

Community Relations are governed by the Public Involvement Plan in Chapter 7 of the1996 IWP (LANL 1996 57368).

REFERENCES

The following list includes all of the documents cited in the body and appendixes of this RFI WP/SAP. The parenthetical information following each reference provides the author, publication date, and ER ID number, and, if applicable, the LANL ER Project Reference Library reference set number and tab number for each document. This information is also included in the citations in the text. This information can be used to locate the documents on this list as follows.

The ER ID number is assigned by the Laboratory's ER Project to track material associated with LANL PRSs. This number can be used to locate the actual document at the ER Project's Records Processing Facility. All cited documents are assigned ER ID numbers.

The reference set number and tab number are assigned to locate material in the LANL ER Project Reference Library, which is housed at NMED HRMB, DOE, and the ER Project Office. This library is a living document that was developed to insure that the AA has all of the necessary material to review the decisions and actions proposed in documents submitted by the Laboratory's ER Project. Documents previously submitted to the AA and documents that are specific to this RFI report are not included in theReference Library, and their citations do not include reference set and tab numbers.

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The surface impoundments at technical area (TA) 53, potential release sites (PRSs) 53-002(a) and (b), and adjacent PRS 53-008, the "Boneyard", have had an ecological scoping evaluation according to the ecological screening process (ER Project 1998, 57916). A scoping evaluation of the PRSs and the surrounding area was conducted in conjunction with a site visit in February 1998. This evaluation, which is the first step in the ecological screening process, is equivalent to the problem formulation step described in EPA's *Framework for Ecological Risk Assessment* (EPA 1992, 48847) and *Ecological Risk Assessment for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA 1997, 48846). The objectives of the scoping evaluation are to identify sites that require a screening evaluation, assess the need for an aggregate assessment, identify COPCs, determine data adequacy for screening assessment, develop the ecological exposure site conceptual model (EESCM), and evaluate bioaccumulation concerns. As part of the scoping evaluation, an ecological scoping checklist was completed for this site and is provided in this Appendix. Neither an ecological screening evaluation nor a baseline ecological risk assessment has been conducted for this site. Additional sampling is necessary to characterize the nature and extent of the contamination originating from the surface impoundments. The samples proposed in this SAP along with the data already collected will support an ecological screening evaluation of the geographical area inclusive of the surface impoundments and the drainage areas.

The ecological scoping indicated that the northeastern, northwestern, and southern surface impoundments are contiguous with and inseparable from each other as well as PRS 53-008. As a result, PRSs 53-002(a), 53-002(b), and 53-008 should be aggregated in order to properly evaluate the potential ecological risk associated with this area. The latter PRSs have not been adequately characterized for conducting an ecological screening assessment or baseline ecological risk evaluation. In addition, operations from the northern surface impoundments may have resulted in the release of contamination to the hanging canyons on the southwest and on the east of PRS 53-002(a) that join with Sandia Canyon and Los Alamos Canyon, respectively. Additional sampling is necessary for PRS 53-002(a), in order to address the extent of contamination, both vertically (into tuff media) and horizontally along the hanging canyon off the eastern edge of the mesa to Los Alamos Canyon in the sediments/soil and surface water (if available). In addition, the area on the mesa south of the northwest surface impoundment and east of the southern surface impoundment must be sampled in order to determine whether a release has occurred to the hanging canyon off the southwestern edge of the mesa to Sandia Canyon. Further sampling should be biased in order to capture the maxima for all of the chemicals of potential concern (COPCs) identified and suspected of being present from the surface impoundments and surrounding areas. In addition, the sampling of the drainage areas in the adjacent canyons should be sufficient to determine extent of contamination and supply information on the fate and rate of transport of materials off-site. This information will support an ecological screening evaluation for the area.

The number of samples to be collected from the northern surface impoundments will be adequate to characterize the nature of contamination within the surface impoundments and potentially released from the surface impoundments. The list of COPCs in the northern surface impoundments include, inorganics, organics (pesticides, semivolatile organic compounds [SVOC], and polychlorinated biphenyls [PCBs]), and radionuclides. The inorganic COPCs greater than background are aluminum, antimony, cadmium, chromium, copper, lead, mercury, silver, selenium, thallium, and zinc. The detected organic COPCs are aroclor-1254, aroclor-1260, bis(2-ethylhexyl)phthalate, BHC(alpha-), BHC(gamma-), dieldrin, DDT, DDE, DDD, endrin, endosulfan, and heptachlor. The radionuclide COPCs detected at greater than fallout/

background are cesium-134, cobalt-57, cobalt-60, manganese-54, neptunium-237, sodium-22, and tritium. Among these COPCs, aroclor-1254, aroclor-1260, bis(2-ethylhexyl)phthalate, DDT and metabolites, dieldrin, endosulfan, endrin, heptachlor, BHC(gamma-), aluminum, cadmium, copper, lead, mercury, and selenium are on the current New Mexico Environment Department (NMED) list of potentially persistent bioaccumulators and biomagnifiers.

The major physical disturbance to the area is the physical placement of the surface impoundments (PRSs 53-002[a] and 53-002[b]) on the mesa top. The embankments of the surface impoundments, which are comprised of crushed tuff, have eroded and the crushed tuff has formed a thick layer on the ground on the west side of the surface impoundments. This layer of crushed tuff clearly limits vegetative growth from the surface impoundments to the edge of the mesa. The development of a lightly pigmented crushed tuff layer on the mesa top may have increased the reflective properties of the surrounding area, which can profoundly affect vegetative development.

The potential major pathways of contaminant uptake by ecological receptors include all surface soil pathways as well as all surface water and sediment pathways to terrestrial receptors (see the ecological scoping checklist). Pathways to aquatic receptors are unlikely because of the intermittent presence of surface water. However, the presence and importance of the aquatic receptors and pathways will be investigated as part of the continuing site assessment. Representative species include a generic plant, earthworm, vagrant shrew, desert cottontail, deer mouse, American robin, American kestrel, and gray fox. The area does not appear to have suitable habitat for threatened and endangered species, e.g., the Mexican spotted owl and peregrine falcon. A present invasion of the surface impoundments by plants includes several weedy angiosperm species as well as mosses and possibly other plant types. This, in conjunction with stormwater trapped within the surface impoundments, attracts various small mammals and birds for watering and feeding purposes, as well as providing suitable invertebrates. There is evidence of fossorial mammals using the embankments and traversing the surface impoundments. Observations of birds around the surface impoundment area support this contention. The direct effects on populations and individuals that may be in contact with the contaminants from the surface impoundments cannot be determined without further site-specific evaluation.

Based on the information provided from the ecological scoping checklist and the list of COPCs, including the presence of potentially persistent bioaccumulators, PRS 53-002(a) is a potential source of ecological concern. The sampling investigations proposed for this PRS, as well as the associated PRSs and adjacent canyon drainages, are necessary in order to properly characterize this area for ecological risk. Although the ecological risk to the surrounding area cannot be evaluated separately for the northern surface impoundments, the elimination and/or management of these potentially major sources of contamination would prevent the dispersal of contaminants, reduce the physical disturbance of the surrounding area (e.g., erosion), and markedly reduce the level of potential risk to ecological receptors.

Ecological Scoping Checklist
Objectives and Preparation Instructions

Objectives of checklist:

Confirm that ecological receptors can be affected by release

Determine if PRSs should be combined for screening

Evaluate data adequacy - primarily related to nature, rate and extent of contamination

Prepare for HQ/HI analysis (determine which screen is appropriate: terrestrial, aquatic screen, both?)

Provide information for prioritization / uncertainty analysis, e.g. what are the dominant/important transport pathways, exposure routes, and receptors

Scoping checklist instructions:

1. Obtain the following information to prepare for the scoping meeting
   - Most current biological information for the PRS, which is typically the Biological and Floodplain Assessment for applicable OU and/or TA
   - Surface runoff and erosion information from AP 4.5 Parts A,B
   - RFI Work Plan or Report, as applicable, that provide: contamination source, sample locations, analytical suites, results
   - FIMAD - Arcinfo maps that show the following features: neighboring PRSs, sample locations, vegetation types, watershed name, wetlands

2. Focus area manager for PRS or PRS aggregate will arrange a meeting prior to the site visit

3. Complete Section A of the checklist during the scoping meeting

4. Arrange site visit at an appropriate time of year (ideally spring or summer) to properly evaluate biological resources at the site (if the site visit is planned for another time of year make note of any uncertainties introduced in the initial biological assessment by such timing). The following resources are typically needed for the site visit:
   - Maps showing sample locations and results should be taken on site visit
   - Camera to record site conditions
   - If significant biological or contaminant transport features are noted, the following items will be useful:
     - ⇒ Distance measuring device, either a measuring tape or rangefinder
     - ⇒ GPS or markers to specify locations for surveying

5. Complete Section B of the checklist during the site visit

6. Complete Section C of the checklist after the site visit (should be completed within 1-2 days of site visit)

Ecological Scoping Checklist: Part A
Scoping Meeting Documentation

Note: This scoping was handled very early in the process of developing scoping procedures. Consequently, no scoping meeting was held. Part A of this checklist is provided from information gathered during the field survey of the site and from post-survey inquiry.

Site ID:	**PRS 53-002(a,b) and PRS 53-008**	
Eco Questions	**Observations**	
Nature of PRS releases (indicate all that apply)	Solid Liquid Gaseous Other, explain	X X
List of Primary Impacted Media (indicate all that apply)	Surface soil Surface water/sediment Subsurface Groundwater Other, explain	X X X (possibly) X (possibly) Possible air transport pathways of contaminant dispersal.
FIMAD vegetation class (indicate all that apply)	Water Bare Ground Spruce/fir/aspen/mixed conifer Ponderosa pine Piñon juniper/juniper woodland Grassland/shrubland Developed	FIMAD vegetation class for the PRS 53-002(a) is **developed** with the immediate area surrounding the site listed as piñon juniper/juniper woodland.
Is T&E Habitat Present? list species if applicable	This area does not appear to be suitable habitat for T&E species. This is yet to be confirmed by ESH-20.	
Provide list and description of Neighboring/ Contiguous/ Upgradient PRSs (consider need to aggregate PRS for screening)	PRS 53-002(b) is an active surface impoundment that lies immediately south of PRS 53-002(a). Both PRSs are surrounded by a "bone yard" that is also listed as a PRS 53-008. All of these PRSs are absolutely contiguous and inseparable for ecological screening. PRS 53-002(a) is reported to have had similar activity to PRS 53-002(b), which is currently in use. A historically active drainage from PRS 53-002(a) crosses the surface of the bone yard from the south-east side of PRS 53-002(a). There is a culvert that crosses under a road through the bone yard at the point of this historical drainage and spills into a depression/ditch that exits into a small hanging canyon on the east side of the area approximately 50 to 100 yards from the point of exiting PRS 53-002(a). It is clear that some or most of the drainage of run-off from the bone yard (mostly sheet flow that gathers on the road), north of the historical drainage of PRS 53-002(a), enters the surface depression created by the historical drainage from PRS 53-002(a) and spills into the easterly hanging canyon. There is a drain from the corner of PRS 53-002(b) into a hanging canyon on the western side of the PRSs. It is unclear whether this is an active outfall.	
AP 4.5 Part B Information Run-off score (out of 46) Terminal point of surface water transport	Not available at the time of scoping. It is likely that the scores for run-off potential at this site are high. The terminal points of surface transport are the hanging canyons on both the west and east sides of the surface impoundments.	
Other Scoping Meeting Notes	None	

Ecological Scoping Checklist: Part B
Site Visit Documentation

Site ID	PRS 53-002(a,b) and 53-008
Date of Site Visit	Feb. 26, 1998.
Site Visit Conducted by	Mark M. Hooten, Patricia Newell, Rich Mirenda.

Receptor Information:

Estimate cover	% vegetated % wetland % structures/asphalt, etc.	< 1%-2% (Invasion by some weeds). 0% 100% Clay liner, crushed tuff embankments, solid precipitates from historical use, some remnants of a nylon tarpaulin.
Field notes on the FIMAD vegetation class	Listing is concurred by the site visit. It is unclear that this area is managed in a way to prevent the invasion of native plant (and animal) species into the surface impoundments and the site. Therefore, the site is cursorily piñon juniper/juniper woodland.	
Field notes on T&E Habitat, if applicable	N/A.	
Are ecological receptors present at the PRS? (yes/no/uncertain) Provide explanation	Yes. Plant invasion of the site is currently active. There has been invasion by many weedy angiosperm species as well as mosses and possibly other plant types. There is evidence of fossorial mammals utilizing the embankments. The surface impoundments capture some moisture and would therefore be attractive to some mammals and birds for watering purposes.	

Contaminant Transport Information:

Surface water transport Field notes on the terminal point of surface water transport (if applicable)	The surface impoundments were maintained historically with an active drain that exited into a small hanging canyon on the east side of the PRSs (see above description under Neighboring/Contiguous/Upgradient PRSs). This drain, and possibly the drain on the west side of PRS 53-002(b) (see also above description) were active in carrying effluents from the surface impoundments into the surrounding canyons. Currently, any residues from these activities may be transported further into these canyons by surface water run-off from storm events.
Are there any off-site transport pathways? (yes/no/uncertain). Provide explanation	Yes. There is currently the potential for off-site transport of contaminants by water (see above, Surface water transport) and air. The surface impoundments are not adequately covered or protected from wind, therefore airborne transport of sediments is likely.

Ecological Scoping Checklist: Part B
Site Visit Documentation Continued

Ecological Effects Information:

Physical Disturbance (provide list of major types of disturbances)	The major physical disturbance to the area is the physical placement of the surface impoundments on the section of mesa-top. However, there has been a large amount of erosion to the embankments of the surface impoundments, which are comprised of crushed tuff. The crushed tuff has formed a thick layer on the ground of the west side of the surface impoundments and clearly limits vegetative growth from the surface impoundments to the edge of the mesa. The development of a lightly pigmented crushed tuff layer to the mesa top may be increasing the albedo of the surrounding area which can have profound effects on vegetative development.
Are there obvious ecological effects? (yes/no/uncertain). Provide explanation	Yes. The area has pathways to receptors and there are receptors present. It is unclear, without further site-specific evaluation, as to the direct effects on populations and individuals that are in contact with contaminants from the site. Additionally, it is unclear from the site visit that the site is being actively managed in a manner that prevents the dispersal of contaminants and physical disturbances into the surrounding area. The presence of the surface impoundments and the surrounding bone yard has had profound impact on the area's vegetative assemblage and continues to have such an impact due to the erosional processes active on the surface impoundment embankments.

No Receptor/ No Pathways:

If there are no receptors and no offsite transport pathways the remainder of the checklist should not be completed. Stop here and provide any additional explanation/justification for proposing an ecological No Further Action recommendation (if needed). N/A

Data Adequacy:

Do existing data provide information on the nature, rate and extent of contamination? (yes/no/uncertain) Provide explanation. (consider if the maximum value was captured by existing sample data).	No. The sludge, liner, and tuff below the surface impoundments have been analyzed for metals, radionuclides, semivolatiles, volatiles, pesticides, and PCBs. The results of this sampling have indicated that PCBs, some pesticides, several radionuclides (tritium, cobalt-60, and sodium-22), and a few metals are present in the sludge and to a lesser degree the liner and tuff. Data quality issues require that the surface impoundments be resampled for PCBs and pesticides to determine the nature of the contamination. In addition, drilling deeper into the tuff below the surface impoundments is necessary to determine vertical extent. The sampling conducted for metals and radiological contaminants inside the surface impoundments is sufficient to characterize the sludge, liner, and tuff. However, the area outside of the surface impoundments as well as the south (active) surface impoundment have not been adequately characterized and require additional sampling. Therefore, the data are not adequate for conducting an ecological screening assessment for the whole area without a high degree of uncertainty of the values obtained. Hazard quotient and hazard index calculations for this site would be incomplete, especially given that adequate sampling outside of the surface impoundments has not occurred. The data are incomplete for characterizing the nature of site contamination and are nonexistent for characterizing lateral extent of contamination, especially with respect to down-gradient surface water run-off and surface sediments transported by wind.

Ecological Scoping Checklist: Part B
Site Visit Documentation Continued

Do existing data for the PRS address potential pathways of off-site contamination? (yes/no/uncertain) Provide explanation (consider if other sites could be impacting this PRS)	No. The data are incomplete for characterizing the nature of site contamination and are nonexistent for characterizing lateral extent of contamination, especially for receptors down gradient of surface water run-off and surface sediments transported by wind. The data are incomplete for characterizing pathways of contaminants to ecological receptors.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.

It must be emphasized that the PRS 53-002 (a) and (b) surface impoundments and PRS 53-008 are inseparable as ecologically definitive units. The contiguity of the PRSs and the current activity of PRS 53-002(b) and 53-008 is contrary to consideration of PRS 53-002(a) in isolation when considering the biotic nature and ecological processes at work in the area. Additionally, these PRSs lie at the periphery of a mesa where it is unclear that the area is not reclaimable by natural biotic processes. Biotic processes in place are indicative of an area that is not being managed for the exclusion of vegetative succession and natural reclamation of the site.

ECOLOGICAL SCOPING CHECKLIST: PART C

Ecological Pathways Conceptual Exposure Model

Provide answers to Questions A to Q and use this information to complete the Ecological Pathways Conceptual Exposure Model

Question A: Could soil contaminants reach receptors via vapors?

- Volatility of the hazardous substance (volatile chemicals generally have Henry's Law constant $>10^{-5}$ atm-me/mol and molecular weight <200 g/mol).

Answer (yes/no/uncertain): Uncertain.

Provide explanation: The lateral and deep vertical extent of volatile and semivolatile compounds has not been characterized.

Question B: Could the soil contaminants identified above reach receptors through fugitive dust carried in air?

- Soil contamination would have to be on the actual surface of the soil to become available for dust.
- In the case of dust exposures to burrowing animals, the contamination would have to occur in the depth interval where these burrows occur.

Answer (yes/no/uncertain): Yes.

Provide explanation: Contaminants present at the site are vulnerable to airborne transport due to the exposed nature of the site to wind. Fossorial animals are present and active at the site.

Question C: Can contaminated soil be transported to aquatic ecological communities (use AP 4.5 run-off score and terminal point of surface water runoff to help answer this question)?

- If the AP 4.5 run-off score* equal to zero, this suggests that erosion at PRS is not a transport pathway. (* note that the runoff score is not the entire erosion potential score, rather it is a subtotal of this score with a maximum value of 46 points)
- If erosion is a transport pathway, evaluate the terminal point to see if aquatic receptors could be affected.

Answer (yes/no/uncertain) Yes.

Provide explanation: There is clear evidence of surface transport of waterborne contaminants to the westerly and easterly hanging canyons (see Part B). Surface measures of gamma emissions (per Tyson Lansford) indicate that historical flow of effluents reached the easterly hanging canyon.

Question D: Is contaminated groundwater potentially available to biological receptors through seeps or springs?

- Known or suspected presence of contaminants in groundwater.
- The potential for contaminants to migrate via groundwater and discharge into habitats and/or surface waters.
- Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1 m depth).
- Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.

Answer (yes/no/uncertain): Uncertain.

Provide explanation: The hydrology of the area is not characterized.

Question E: Is infiltration/percolation from contaminated subsurface material a viable transport pathway?

- Suspected ability of contaminants to migrate to groundwater.
- The potential for contaminants to migrate via groundwater and discharge into habitats and/or surface waters.
- Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1 m depth).
- Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.
- Also consider the importance of mass wasting as a potential release mechanism for subsurface material.

Answer (yes/no/uncertain): Uncertain.

Provide explanation: This seems like an unlikely pathway, however, without sufficient knowledge of the extent of subsurface contamination, the integrity of the surface impoundments' lay lining, and the understanding of subsurface hydrology in the area, this pathway cannot be evaluated adequately. The southwestern-most corner of PRS 53-002(b) is very near (within 5 ft of) the westerly hanging canyon and would appear to have the greatest potential for mass wasting events.

Question F: Could airborne contaminants interact with plants or animals through respiration of vapors?

- Contaminants must be present as volatiles in the air.
- Consider the importance of inhalation of vapors for burrowing animals.
- Foliar uptake of organic vapors is typically not a significant pathway.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 1.

Provide explanation: Process knowledge does not indicate that volatile compounds were ever released at the site. However, analytical data indicates that acetone, 2-butanone, and methylene chloride were detected in the sludge and acetone was detected in the liner and tuff. These volatile compounds are common laboratory contaminants and may be present as a result of laboratory contamination. In addition, if volatile compounds were released into the surface impoundments, it is unlikely that volatile constituents would remain at the site since the site has been inactive and exposed to the open air for some time (several years).

Question G: Could airborne contaminants interact with plants or animals through deposition of particulates or with animals through inhalation of fugitive dust?

- Contaminants must be present as particulates in the air or as dust for this pathway to be viable.
- Exposure via inhalation of fugitive dust is particularly applicable to ground-dwelling species that would be exposed to dust disturbed by their foraging or burrowing activities or by wind movement.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 2

Provide explanation: See Part B of the scoping checklist for explanation.

Question H: Could contaminants interact with plants through root uptake or rain splash from surface soils?

- Contaminants in bulk soil may partition into soil solution, making them available to roots.
- Exposure of terrestrial plants to contaminants present in particulates deposited on leaf and stem surfaces by rain striking contaminated soils (i.e., rain splash).

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3

Provide explanation: There are currently plants growing inside of the surface impoundments. Additionally, there is a likely pathway of contaminant transport outside of the surface impoundments from historical effluent releases (see Part B, above).

Question I: Could contaminants interact with receptors through food web transport from surface soils?

- The chemicals may bioaccumulate in animals (see list of potentially persistent bioaccumulators and biomagnifiers, presented in Table 1).
- Animals may ingest contaminated prey.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3

Provide explanation: PCBs, potentially persistent bioaccumulators and/or biomagnifiers, have been detected in the sludge; they are readily available in the food chain from this site.

Question J: Could contaminants interact with receptors via incidental ingestion of surface soils?

- Incidental ingestion of contaminated soil could occur while animals grub for food resident in the soil, feed on plant matter covered with contaminated soil or while grooming themselves clean of soil.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3

Provide explanation: Ingestion of soils would be likely per the dietary regimen of any given receptor.

Question K: Could contaminants interact with receptors through dermal contact with surface soils?

- Significant exposure via dermal contact would generally be limited to organic contaminants which are lipophilic and can cross epidermal barriers.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3

Provide explanation: For fossorial invertebrates and vertebrates, this is a viable pathway.

Question L: Could contaminants interact with plants or animals through external irradiation?

- External irradiation effects are most relevant for gamma emitting radionuclides.
- Burial of contamination severely attenuates radiological exposure.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3

Provide explanation: There is surface contamination from Cobalt 60.

Question M: Could contaminants interact with plants through direct uptake from water and sediment or sediment rain splash?

- Contaminants may be taken up by terrestrial plants whose roots are in contact with surface waters.
- Terrestrial plants may be exposed to particulates deposited on leaf and stem surfaces by rain striking contaminated sediments (i.e., rain splash). in an area that is only periodically inundated with water.
- Contaminants in sediment may partition into soil solution, making them available to roots.
- Aquatic plants are in direct contact with water.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3 terrestrial, 1 aquatic.

Provide explanation: There are currently plants rooted in the PRS 53-002(a) surface impoundments which gather seasonally available water. Pathways off-site (see Part B) have terrestrial plants directly in their course. Aquatic receptors may lie in downstream reaches of Los Alamos Canyon.

Question N: Could contaminants interact with receptors through food web transport from water and sediment?

- The chemicals may bioaccumulate in animals (see list of potentially persistent bioaccumulators and biomagnifiers, presented in Table 1.)
- Animals may ingest contaminated prey.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3 terrestrial, 1 aquatic.

Provide explanation: PCBs, potentially persistent bioaccumulators and/or biomagnifiers, have been detected in the sludge; they are readily available in the food chain from this site. Aquatic receptors may lie in downstream reaches of Los Alamos Canyon.

Question O: Could contaminants interact with receptors via incidental ingestion of water and sediment?

- If sediments are present in an area that is only periodically inundated with water, terrestrial receptors may incidentally ingest sediments.
- Terrestrial receptors may ingest waterborne contaminants if contaminated surface waters are used as a drinking water source.
- Aquatic receptors may regularly or incidentally ingest sediment while foraging.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3 terrestrial, 1 aquatic.

Provide explanation: It is likely that mammals and birds visit this site specifically for the purpose of accessing water for grooming and consumption. Aquatic receptors may lie in downstream reaches of Los Alamos Canyon.

Question P: Could contaminants interact with receptors through dermal contact with water and sediment?

- If sediments are present in an area that is only periodically inundated with water, terrestrial species may be dermally exposed during dry periods.
- Terrestrial organisms may be dermally exposed to water-borne contaminants as a result of wading or swimming in contaminated waters.
- Aquatic receptors may be directly exposed to sediments or may be exposed through osmotic exchange, respiration, or ventilation of sediment pore waters.
- Aquatic receptors may be exposed through osmotic exchange, respiration, or ventilation of surface waters.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3 terrestrial, 1 aquatic.

Provide explanation: It is likely that mammals and birds visit this site specifically for the purpose of accessing water for grooming. The surface impoundments are likely accessible to fossorial invertebrates. Aquatic receptors may lie in downstream reaches of Los Alamos Canyon.

Question Q: Could contaminants interact with plants or animals through external irradiation?

- External irradiation effects are most relevant for gamma emitting radionuclides.
- Burial of contamination severely attenuates radiological exposure.
- The water column acts to absorb radiation, thus external irradiation is typically more important for sediment dwelling organisms.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3 terrestrial, 1 aquatic.

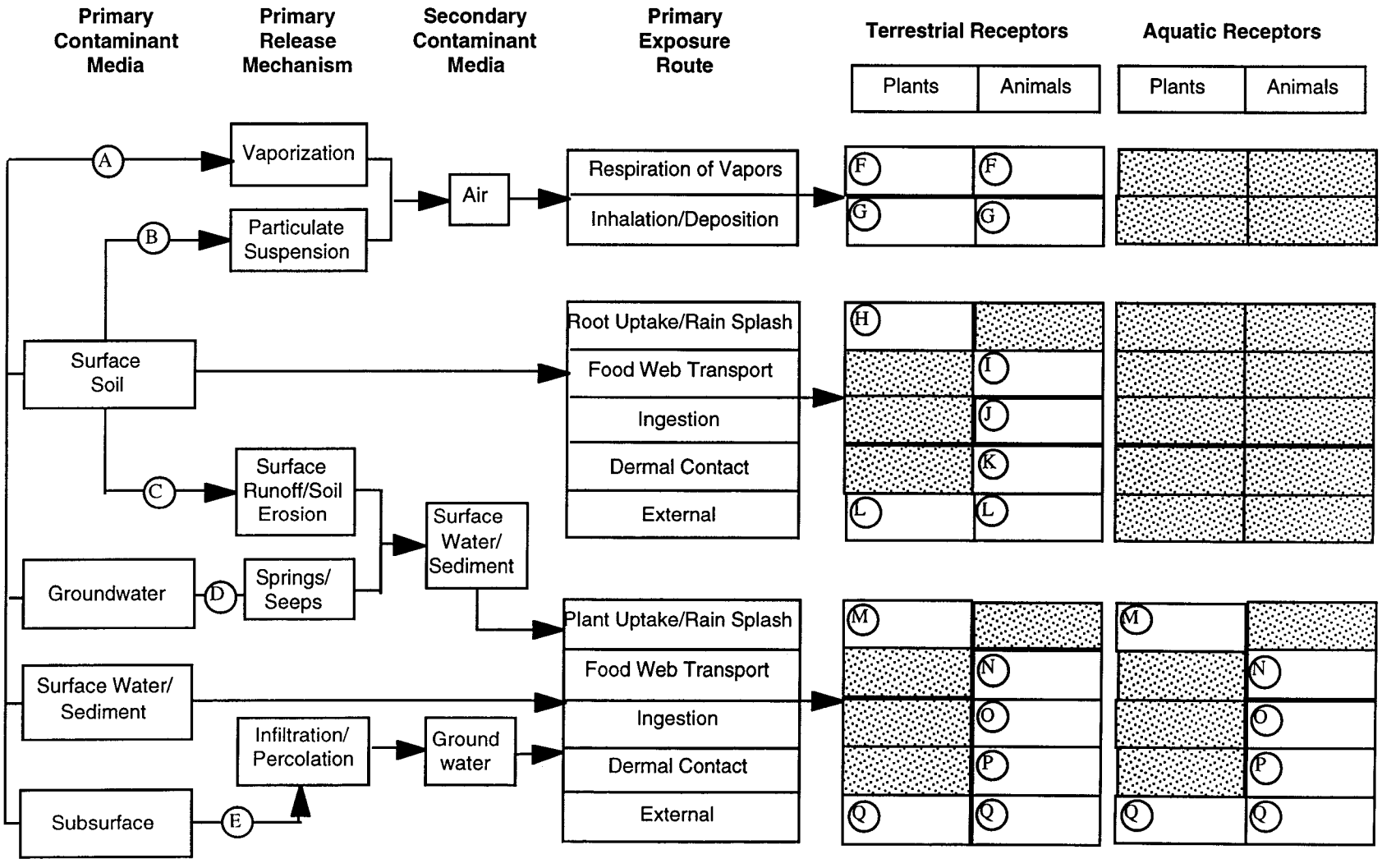
Provide explanation: There is surface contamination from Cobalt 60. Aquatic receptors may lie in downstream reaches of Los Alamos Canyon.

Table A-1
List of Bioaccumulating Chemicals

Volatile Organics	**PCBs/Pesticides**
Bis(2-ethylhexyl)phthalate	All Aroclors
Butyl benzyl phthalate	beta-BHC
Dichlorobenzene[1,4-]	BHC-mixed isomers
Di-n-butyl phthalate	Chlordane
Di-n-octyl phthalate	Chlorecone (Kepone)
Trichlorobenzene[1,2,4-]	DDT and metabolites
Xylene (mixed isomers)	Dieldrin
	Endosulfan
Semivolatile Organics	Endrin
Acenaphthene	Heptaclor
Anthracene	Lindane
Benzo(a)anthracene	Methoxyclor
Benzo(a)pyrene	Toxaphene
Benzo(b)fluoranthene	
Benzo(g,h,i)perylene	**Inorganics**
Benzo(k)fluoranthene	Aluminum
Chrysene	Cadmium
Dibenzo(a,h)anthracene	Copper
Fluoranthene	Lead
Fluorene	Mercury
Indeno(1,2,3-cd)pyrene	Nickel
Phenanthrene	Selenium
Pyrene	
Pentachloronitrobenzene	**Radionuclides**
Pentachlorophenol	Americium-241
	Cesium-137
Dioxins/Furans	Radium-226,-228
Dibenzofuran	Strontium-90
2,3,7,8-tetrachloro-dibenzo(p)dioxin	Thorium-228,-230,-232
2,3,7,8-tetrachloro-dibenzo(p)furan	Uranium-234,-235,-238

Ecological Scoping Checklist: Ecological Pathways Conceptual Exposure Model

KEY
0 - No Pathway
1 - Unlikely Pathway
2 - Minor Pathway
3 - Major Pathway



Signatures and Certifications:

Checklist completed by (provide name, organization and phone number)

Name (printed):	Mark M. Hooten
Name (signature):	Mark M. Hooten
Organization:	Neptune and Co., Inc.
Phone number:	505-662-2121
Date completed:	Feb. 27, 1998; Revised to current format May 10, 1998.

Verification by a member of ER Project Ecological Risk Task Team (provide name, organization and phone number)

Name (printed):	**Richard Mirenda**
Name (signature):	Richard Mirenda
Organization:	**Program Management Company**
Phone number:	**(505) 662-1329**

Los Alamos National Laboratory

Environment, Safety and Health Division
ESH-18 Water Quality and Hydrology Group

AP 4.5 Surface Water Assessment Erosion Matrix for PRS 53-002(a)

CRITERIA EVALUATED	Value	Erosion/Sediment Transport Potential Low 0.1	Medium 0.5	High 1.0	Calculated Score
Site Setting (43)					
On mesa top	1	Defined based on topographic setting			1.0
Within bench of canyon	4				
Within the canyon floodplain but not watercourse	13				
Within bottom of canyon channel in watercourse	17				
Estimated % ground and canopy cover	13	>75%	25-75%	<25%	6.5
Slope	13	0-10%	10-30%	>30%	1.3
Surface Water Factors-Run-off (46)					
Visible evidence of runoff discharging? (Yes/No)	5	If no, score of 0 for runoff section. If yes, score 5 and proceed with section.			5.0
Where does runoff terminate?	19	Other	Bench Setting	Drainage/Wetland	19.0
Has runoff caused visible erosion? (Yes/No)	22	Sheet	Rill	Gully	11.0
		If no, score as 0. If yes, calculate as appropriate.			
Surface Water Factors-Run-on (11)					
Structures adversely affecting run-on (Yes/No)	7*	If yes, score as 7. If no, score as 0.			0.0
Current operations adversely impacting (Yes/No)	4	If yes, score as 4. If no, score as 0.			4.0
Natural drainages onto site (Yes/No)	7*	If yes, score as 7. If no, score as 0.			0.0
**Select either structures or natural drainages.*					
MAX. POSSIBLE EROSION MATRIX SCORE:	**100**			**Total Score**	47.8**

** Indicates BMPs in place. Erosion potential without BMPs may be greater.

Los Alamos National Laboratory
SURFACE WATER
SITE ASSESSMENT

SITE INFORMATION

1a) PRS Number 53-002(a) **1b) Structure Number** [ ] **1c) FMU Number** 61

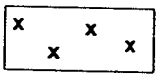
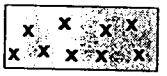
2. Date/Time (M/D/Y H:M am/pm) 10/29/97 1:40:00 PM

SITE SETTING (check all that apply)

3. ◉ **On mesa top (a).** ○ **In the canyon floor, but not in an established channel (c).**
○ **Within a bench of a canyon (b).** ○ **Within established channel in the canyon floor (d).**

Explanation: Located between Sandia and Los Alamos canyons. NPDES outfall from lagoons at TA-53. Outfall at east end of lagoons.

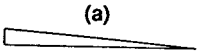
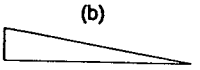
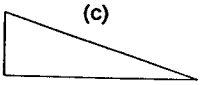
4. Estimated ground and/or canopy cover at site: (deciduous leaves, pine needles, rocks, vegetation, trees, structures, asphalt, etc.)

(illustration) (a)  (b)  (c)

Estimated % of ground/canopy cover: ○ 0% to 25% ◉ 25% to 75% ○ 75% to 100%

Explanation: Riprap extends from base of the outfall to a culvert under the roadway. Sparse ground cover extends from the culvert, across the mesa top, to the canyon edge.

5. Steepest slope at the area impacted:

(a)  (b)  (c) 

◉ Less than 10% ○ 10% to 30% ○ 30% and greater

Explanation:

RUNOFF FACTORS

Y / N

☑ ☐ **6. Is there visible evidence of runoff discharging from site? If yes, answer a) - c) below:**

☐ ☑ 6a) Is runoff channelized? If yes, describe: ○ Man-made channel. ○ Natural channel.

Explanation: Lagoons are dry and the outfall is not active. However, there is evidence of discharge (erosion) from the culvert under the roadway. This area is within the PRS boundary.

RUNOFF FACTORS, CONT'D

6b) Where does evidence of runoff terminate?

- (●) **Drainage or wetland (name)** Los Alamos Canyon
- ( ) **Within bench of canyon setting (name)**
- ( ) **Other (i.e., retention pond, meadow, mesa top)**

Explanation:

Y / N

☑ ☐ 6c) **Has runoff caused visible erosion at the site? If yes, explain below:** ( ) Sheet (●) Rill ( ) Gully

Explanation: Adjacent to the NPDES outfall, a culvert is placed under the roadway. This culvert conveys storm water as well as discharges from the outfall. Minor rill erosion is present at the culvert outlet.

RUN-ON FACTORS

Please rate the potential for storm water to run on to this site: (Check EITHER #7 or #9)

☐ ☑ **7.** Are structures (i.e., buildings, roof drains, parking lots, storm drains) creating run-on to the site?

Explanation:

☑ ☐ **8.** Are current operations (i.e., fire hydrants, NPDES outfalls) adversely impacting run-on to the site?

Explanation: Site is not active but is still classified as active NPDES outfall EPASSS095.

☐ ☑ **9.** Are natural drainage patterns directing stormwater onto site?

Explanation:

ASSESSMENT FINDING:

☐ ☑ **10. Based on the above criteria and the assessment of this site, does soil erosion potential exist? (REFER TO EROSION POTENTIAL MATRIX.)**

T. Lemke

11. Signature of Water Quality/Hydrology Representative

SJ Initials of independent reviewer.

Check here when information is entered in database: ☑

This page is for ESH-18 notes, recommendations, and photos.

	Y	N	
12. a)	○	◉	Is there visible trash/debris on the site?
b)	○	◉	Is there visible trash/debris in a watercourse?

Description of existing BMPs:

Riprap extends from the NPDES outfall to the inlet of the culvert under the adjacent roadway.

◉ ○ Are BMPs being properly maintained? If no, describe in "Other Internal Notes."

◉ ○ Are BMPs effectively keeping sediment in place and reducing erosion potential?

OTHER INTERNAL NOTES:

Outfall is no longer active. Area is relatively flat so only a minimal amount of storm water would flow across the site. Outfall is a concrete flume with a metal wire.

Los Alamos National Laboratory

Environment, Safety and Health Division
ESH-18 Water Quality and Hydrology Group

AP 4.5 Surface Water Assessment Erosion Matrix for PRS 53-002(b)

CRITERIA EVALUATED	Value	Erosion/Sediment Transport Potential Low 0.1	Medium 0.5	High 1.0	Calculated Score
Site Setting (43)					
On mesa top	1	Defined based on topographic setting			1.0
Within bench of canyon	4				
Within the canyon floodplain but not watercourse	13				
Within bottom of canyon channel in watercourse	17				
Estimated % ground and canopy cover	13	>75%	25-75%	<25%	1.3
Slope	13	0-10%	10-30%	>30%	1.3
Surface Water Factors-Run-off (46)					
Visible evidence of runoff discharging? (Yes/No)	5	If no, score of 0 for runoff section. If yes, score 5 and proceed with section.			0.0
Where does runoff terminate?	19	Other	Bench Setting	Drainage/Wetland	0.0
Has runoff caused visible erosion? (Yes/No)	22	Sheet	Rill	Gully	0.0
		If no, score as 0. If yes, calculate as appropriate.			
Surface Water Factors-Run-on (11)					
Structures adversely affecting run-on (Yes/No)	7*	If yes, score as 7. If no, score as 0.			0.0
Current operations adversely impacting (Yes/No)	4	If yes, score as 4. If no, score as 0.			0.0
Natural drainages onto site (Yes/No)	7*	If yes, score as 7. If no, score as 0.			0.0
**Select either structures or natural drainages.*					
MAX. POSSIBLE EROSION MATRIX SCORE:	**100**			**Total Score**	3.6

Los Alamos National Laboratory
SURFACE WATER
SITE ASSESSMENT

SITE INFORMATION

1a) PRS Number 53-002(b) **1b) Structure Number** [ ] **1c) FMU Number** 61

2. Date/Time (M/D/Y H:M am/pm) 10/29/97 2:10:00 PM

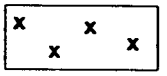
SITE SETTING (check all that apply)

3. ◉ **On mesa top (a).** ○ **In the canyon floor, but not in an established channel (c).**

○ **Within a bench of a canyon (b).** ○ **Within established channel in the canyon floor (d).**

Explanation: Active lagoon located on mesa top between Sandia and Los Alamos canyons. Located south of lagoons classified as PRS 53-002(a).

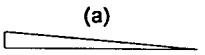
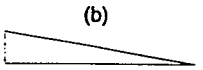
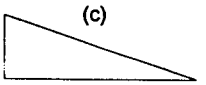
4. Estimated ground and/or canopy cover at site: (deciduous leaves, pine needles, rocks, vegetation, trees, structures, asphalt, etc.)

(illustration) (a)  (b) (c)

Estimated % of ground/canopy cover: ○ 0% to 25% ○ 25% to 75% ◉ 75% to 100%

Explanation: Sides and bottom of lagoon are covered with an impermeable membrane.

5. Steepest slope at the area impacted:

(a)  (b)  (c) 

◉ Less than 10% ○ 10% to 30% ○ 30% and greater

Explanation:

RUNOFF FACTORS

Y / N

☐ ☑ **6. Is there visible evidence of runoff discharging from site? If yes, answer a) - c) below:**

☐ ☑ 6a) Is runoff channelized? If yes, describe: ○ Man-made channel. ○ Natural channel.

Explanation: Lagoon is situated below grade. An overflow outlet that discharges to the same outfall as 53-002(a) is located within the lagoon.

RUNOFF FACTORS, CONT'D

6b) Where does evidence of runoff terminate?

- ○ **Drainage or wetland (name)** [ ]
- ○ **Within bench of canyon setting (name)** [ ]
- ○ **Other (i.e., retention pond, meadow, mesa top)** [ ]

Explanation:

Y / N

☐ ☑ 6c) Has runoff caused visible erosion at the site? If yes, explain below: ○ Sheet ○ Rill ○ Gully

Explanation:

RUN-ON FACTORS

Please rate the potential for storm water to run on to this site: (Check EITHER #7 or #9)

☐ ☑ **7.** Are structures (i.e., buildings, roof drains, parking lots, storm drains) creating run-on to the site?

Explanation:

☐ ☑ **8.** Are current operations (i.e., fire hydrants, NPDES outfalls) adversely impacting run-on to the site?

Explanation:

☐ ☑ **9.** Are natural drainage patterns directing stormwater onto site?

Explanation:

ASSESSMENT FINDING:

☐ ☑ **10. Based on the above criteria and the assessment of this site, does soil erosion potential exist? (REFER TO EROSION POTENTIAL MATRIX.)**

T. Lemke

11. Signature of Water Quality/Hydrology Representative

SV Initials of independent reviewer.

Check here when information is entered in database: ☑

53-002(b)... page 4 of 4

This page is for ESH-18 notes, recommendations, and photos.

	Y / N	
12. a)	○ ⦿	Is there visible trash/debris on the site?
b)	○ ⦿	Is there visible trash/debris in a watercourse?

Description of existing BMPs:

○ ○	Are BMPs being properly maintained? If no, describe in "Other Internal Notes."
○ ○	Are BMPs effectively keeping sediment in place and reducing erosion potential?

OTHER INTERNAL NOTES:

Contents of lagoon are contained. The current liquid level in the lagoon is much lower than the overflow outlet.

The surface impoundments at technical area (TA) 53, potential release sites (PRSs) 53-002(a) and (b), and adjacent PRS 53-008, the "Boneyard", have had an ecological scoping evaluation according to the ecological screening process (ER Project 1998, 57916). A scoping evaluation of the PRSs and the surrounding area was conducted in conjunction with a site visit in February 1998. This evaluation, which is the first step in the ecological screening process, is equivalent to the problem formulation step described in EPA's *Framework for Ecological Risk Assessment* (EPA 1992, 48847) and *Ecological Risk Assessment for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA 1997, 48846). The objectives of the scoping evaluation are to identify sites that require a screening evaluation, assess the need for an aggregate assessment, identify COPCs, determine data adequacy for screening assessment, develop the ecological exposure site conceptual model (EESCM), and evaluate bioaccumulation concerns. As part of the scoping evaluation, an ecological scoping checklist was completed for this site and is provided in this Appendix. Neither an ecological screening evaluation nor a baseline ecological risk assessment has been conducted for this site. Additional sampling is necessary to characterize the nature and extent of the contamination originating from the surface impoundments. The samples proposed in this SAP along with the data already collected will support an ecological screening evaluation of the geographical area inclusive of the surface impoundments and the drainage areas.

The ecological scoping indicated that the northeastern, northwestern, and southern surface impoundments are contiguous with and inseparable from each other as well as PRS 53-008. As a result, PRSs 53-002(a), 53-002(b), and 53-008 should be aggregated in order to properly evaluate the potential ecological risk associated with this area. The latter PRSs have not been adequately characterized for conducting an ecological screening assessment or baseline ecological risk evaluation. In addition, operations from the northern surface impoundments may have resulted in the release of contamination to the hanging canyons on the southwest and on the east of PRS 53-002(a) that join with Sandia Canyon and Los Alamos Canyon, respectively. Additional sampling is necessary for PRS 53-002(a), in order to address the extent of contamination, both vertically (into tuff media) and horizontally along the hanging canyon off the eastern edge of the mesa to Los Alamos Canyon in the sediments/soil and surface water (if available). In addition, the area on the mesa south of the northwest surface impoundment and east of the southern surface impoundment must be sampled in order to determine whether a release has occurred to the hanging canyon off the southwestern edge of the mesa to Sandia Canyon. Further sampling should be biased in order to capture the maxima for all of the chemicals of potential concern (COPCs) identified and suspected of being present from the surface impoundments and surrounding areas. In addition, the sampling of the drainage areas in the adjacent canyons should be sufficient to determine extent of contamination and supply information on the fate and rate of transport of materials off-site. This information will support an ecological screening evaluation for the area.

The number of samples to be collected from the northern surface impoundments will be adequate to characterize the nature of contamination within the surface impoundments and potentially released from the surface impoundments. The list of COPCs in the northern surface impoundments include, inorganics, organics (pesticides, semivolatile organic compounds [SVOC], and polychlorinated biphenyls [PCBs]), and radionuclides. The inorganic COPCs greater than background are aluminum, antimony, cadmium, chromium, copper, lead, mercury, silver, selenium, thallium, and zinc. The detected organic COPCs are aroclor-1254, aroclor-1260, bis(2-ethylhexyl)phthalate, BHC(alpha-), BHC(gamma-), dieldrin, DDT, DDE, DDD, endrin, endosulfan, and heptachlor. The radionuclide COPCs detected at greater than fallout/

background are cesium-134, cobalt-57, cobalt-60, manganese-54, neptunium-237, sodium-22, and tritium. Among these COPCs, aroclor-1254, aroclor-1260, bis(2-ethylhexyl)phthalate, DDT and metabolites, dieldrin, endosulfan, endrin, heptachlor, BHC(gamma-), aluminum, cadmium, copper, lead, mercury, and selenium are on the current New Mexico Environment Department (NMED) list of potentially persistent bioaccumulators and biomagnifiers.

The major physical disturbance to the area is the physical placement of the surface impoundments (PRSs 53-002[a] and 53-002[b]) on the mesa top. The embankments of the surface impoundments, which are comprised of crushed tuff, have eroded and the crushed tuff has formed a thick layer on the ground on the west side of the surface impoundments. This layer of crushed tuff clearly limits vegetative growth from the surface impoundments to the edge of the mesa. The development of a lightly pigmented crushed tuff layer on the mesa top may have increased the reflective properties of the surrounding area, which can profoundly affect vegetative development.

The potential major pathways of contaminant uptake by ecological receptors include all surface soil pathways as well as all surface water and sediment pathways to terrestrial receptors (see the ecological scoping checklist). Pathways to aquatic receptors are unlikely because of the intermittent presence of surface water. However, the presence and importance of the aquatic receptors and pathways will be investigated as part of the continuing site assessment. Representative species include a generic plant, earthworm, vagrant shrew, desert cottontail, deer mouse, American robin, American kestrel, and gray fox. The area does not appear to have suitable habitat for threatened and endangered species, e.g., the Mexican spotted owl and peregrine falcon. A present invasion of the surface impoundments by plants includes several weedy angiosperm species as well as mosses and possibly other plant types. This, in conjunction with stormwater trapped within the surface impoundments, attracts various small mammals and birds for watering and feeding purposes, as well as providing suitable invertebrates. There is evidence of fossorial mammals using the embankments and traversing the surface impoundments. Observations of birds around the surface impoundment area support this contention. The direct effects on populations and individuals that may be in contact with the contaminants from the surface impoundments cannot be determined without further site-specific evaluation.

Based on the information provided from the ecological scoping checklist and the list of COPCs, including the presence of potentially persistent bioaccumulators, PRS 53-002(a) is a potential source of ecological concern. The sampling investigations proposed for this PRS, as well as the associated PRSs and adjacent canyon drainages, are necessary in order to properly characterize this area for ecological risk. Although the ecological risk to the surrounding area cannot be evaluated separately for the northern surface impoundments, the elimination and/or management of these potentially major sources of contamination would prevent the dispersal of contaminants, reduce the physical disturbance of the surrounding area (e.g., erosion), and markedly reduce the level of potential risk to ecological receptors.

Ecological Scoping Checklist
Objectives and Preparation Instructions

Objectives of checklist:

Confirm that ecological receptors can be affected by release

Determine if PRSs should be combined for screening

Evaluate data adequacy - primarily related to nature, rate and extent of contamination

Prepare for HQ/HI analysis (determine which screen is appropriate: terrestrial, aquatic screen, both?)

Provide information for prioritization / uncertainty analysis, e.g. what are the dominant/important transport pathways, exposure routes, and receptors

Scoping checklist instructions:

1. Obtain the following information to prepare for the scoping meeting
   - Most current biological information for the PRS, which is typically the Biological and Floodplain Assessment for applicable OU and/or TA
   - Surface runoff and erosion information from AP 4.5 Parts A,B
   - RFI Work Plan or Report, as applicable, that provide: contamination source, sample locations, analytical suites, results
   - FIMAD - Arcinfo maps that show the following features: neighboring PRSs, sample locations, vegetation types, watershed name, wetlands

2. Focus area manager for PRS or PRS aggregate will arrange a meeting prior to the site visit

3. Complete Section A of the checklist during the scoping meeting

4. Arrange site visit at an appropriate time of year (ideally spring or summer) to properly evaluate biological resources at the site (if the site visit is planned for another time of year make note of any uncertainties introduced in the initial biological assessment by such timing). The following resources are typically needed for the site visit:
   - Maps showing sample locations and results should be taken on site visit
   - Camera to record site conditions
   - If significant biological or contaminant transport features are noted, the following items will be useful:
     - ⇒ Distance measuring device, either a measuring tape or rangefinder
     - ⇒ GPS or markers to specify locations for surveying

5. Complete Section B of the checklist during the site visit

6. Complete Section C of the checklist after the site visit (should be completed within 1-2 days of site visit)

Ecological Scoping Checklist: Part A
Scoping Meeting Documentation

Note: This scoping was handled very early in the process of developing scoping procedures. Consequently, no scoping meeting was held. Part A of this checklist is provided from information gathered during the field survey of the site and from post-survey inquiry.

Site ID:	**PRS 53-002(a,b) and PRS 53-008**	
Eco Questions	**Observations**	
Nature of PRS releases (indicate all that apply)	Solid Liquid Gaseous Other, explain	X X
List of Primary Impacted Media (indicate all that apply)	Surface soil Surface water/sediment Subsurface Groundwater Other, explain	X X X (possibly) X (possibly) Possible air transport pathways of contaminant dispersal.
FIMAD vegetation class (indicate all that apply)	Water Bare Ground Spruce/fir/aspen/mixed conifer Ponderosa pine Piñon juniper/juniper woodland Grassland/shrubland Developed	FIMAD vegetation class for the PRS 53-002(a) is **developed** with the immediate area surrounding the site listed as piñon juniper/juniper woodland.
Is T&E Habitat Present? list species if applicable	This area does not appear to be suitable habitat for T&E species. This is yet to be confirmed by ESH-20.	
Provide list and description of Neighboring/ Contiguous/ Upgradient PRSs (consider need to aggregate PRS for screening)	PRS 53-002(b) is an active surface impoundment that lies immediately south of PRS 53-002(a). Both PRSs are surrounded by a "bone yard" that is also listed as a PRS 53-008. All of these PRSs are absolutely contiguous and inseparable for ecological screening. PRS 53-002(a) is reported to have had similar activity to PRS 53-002(b), which is currently in use. A historically active drainage from PRS 53-002(a) crosses the surface of the bone yard from the south-east side of PRS 53-002(a). There is a culvert that crosses under a road through the bone yard at the point of this historical drainage and spills into a depression/ditch that exits into a small hanging canyon on the east side of the area approximately 50 to 100 yards from the point of exiting PRS 53-002(a). It is clear that some or most of the drainage of run-off from the bone yard (mostly sheet flow that gathers on the road), north of the historical drainage of PRS 53-002(a), enters the surface depression created by the historical drainage from PRS 53-002(a) and spills into the easterly hanging canyon. There is a drain from the corner of PRS 53-002(b) into a hanging canyon on the western side of the PRSs. It is unclear whether this is an active outfall.	
AP 4.5 Part B Information Run-off score (out of 46) Terminal point of surface water transport	Not available at the time of scoping. It is likely that the scores for run-off potential at this site are high. The terminal points of surface transport are the hanging canyons on both the west and east sides of the surface impoundments.	
Other Scoping Meeting Notes	None	

Ecological Scoping Checklist: Part B
Site Visit Documentation

Site ID	PRS 53-002(a,b) and 53-008
Date of Site Visit	Feb. 26, 1998.
Site Visit Conducted by	Mark M. Hooten, Patricia Newell, Rich Mirenda.

Receptor Information:

Estimate cover	% vegetated % wetland % structures/asphalt, etc.	< 1%-2% (Invasion by some weeds). 0% 100% Clay liner, crushed tuff embankments, solid precipitates from historical use, some remnants of a nylon tarpaulin.
Field notes on the FIMAD vegetation class	Listing is concurred by the site visit. It is unclear that this area is managed in a way to prevent the invasion of native plant (and animal) species into the surface impoundments and the site. Therefore, the site is cursorily piñon juniper/juniper woodland.	
Field notes on T&E Habitat, if applicable	N/A.	
Are ecological receptors present at the PRS? (yes/no/uncertain) Provide explanation	Yes. Plant invasion of the site is currently active. There has been invasion by many weedy angiosperm species as well as mosses and possibly other plant types. There is evidence of fossorial mammals utilizing the embankments. The surface impoundments capture some moisture and would therefore be attractive to some mammals and birds for watering purposes.	

Contaminant Transport Information:

Surface water transport Field notes on the terminal point of surface water transport (if applicable)	The surface impoundments were maintained historically with an active drain that exited into a small hanging canyon on the east side of the PRSs (see above description under Neighboring/Contiguous/Upgradient PRSs). This drain, and possibly the drain on the west side of PRS 53-002(b) (see also above description) were active in carrying effluents from the surface impoundments into the surrounding canyons. Currently, any residues from these activities may be transported further into these canyons by surface water run-off from storm events.
Are there any off-site transport pathways? (yes/no/uncertain). Provide explanation	Yes. There is currently the potential for off-site transport of contaminants by water (see above, Surface water transport) and air. The surface impoundments are not adequately covered or protected from wind, therefore airborne transport of sediments is likely.

Ecological Scoping Checklist: Part B
Site Visit Documentation Continued

Ecological Effects Information:

Physical Disturbance (provide list of major types of disturbances)	The major physical disturbance to the area is the physical placement of the surface impoundments on the section of mesa-top. However, there has been a large amount of erosion to the embankments of the surface impoundments, which are comprised of crushed tuff. The crushed tuff has formed a thick layer on the ground of the west side of the surface impoundments and clearly limits vegetative growth from the surface impoundments to the edge of the mesa. The development of a lightly pigmented crushed tuff layer to the mesa top may be increasing the albedo of the surrounding area which can have profound effects on vegetative development.
Are there obvious ecological effects? (yes/no/uncertain). Provide explanation	Yes. The area has pathways to receptors and there are receptors present. It is unclear, without further site-specific evaluation, as to the direct effects on populations and individuals that are in contact with contaminants from the site. Additionally, it is unclear from the site visit that the site is being actively managed in a manner that prevents the dispersal of contaminants and physical disturbances into the surrounding area. The presence of the surface impoundments and the surrounding bone yard has had profound impact on the area's vegetative assemblage and continues to have such an impact due to the erosional processes active on the surface impoundment embankments.

No Receptor/ No Pathways:

If there are no receptors and no offsite transport pathways the remainder of the checklist should not be completed. Stop here and provide any additional explanation/justification for proposing an ecological No Further Action recommendation (if needed). N/A

Data Adequacy:

Do existing data provide information on the nature, rate and extent of contamination? (yes/no/uncertain) Provide explanation. (consider if the maximum value was captured by existing sample data).	No. The sludge, liner, and tuff below the surface impoundments have been analyzed for metals, radionuclides, semivolatiles, volatiles, pesticides, and PCBs. The results of this sampling have indicated that PCBs, some pesticides, several radionuclides (tritium, cobalt-60, and sodium-22), and a few metals are present in the sludge and to a lesser degree the liner and tuff. Data quality issues require that the surface impoundments be resampled for PCBs and pesticides to determine the nature of the contamination. In addition, drilling deeper into the tuff below the surface impoundments is necessary to determine vertical extent. The sampling conducted for metals and radiological contaminants inside the surface impoundments is sufficient to characterize the sludge, liner, and tuff. However, the area outside of the surface impoundments as well as the south (active) surface impoundment have not been adequately characterized and require additional sampling. Therefore, the data are not adequate for conducting an ecological screening assessment for the whole area without a high degree of uncertainty of the values obtained. Hazard quotient and hazard index calculations for this site would be incomplete, especially given that adequate sampling outside of the surface impoundments has not occurred. The data are incomplete for characterizing the nature of site contamination and are nonexistent for characterizing lateral extent of contamination, especially with respect to down-gradient surface water run-off and surface sediments transported by wind.

Ecological Scoping Checklist: Part B
Site Visit Documentation Continued

Do existing data for the PRS address potential pathways of off-site contamination? (yes/no/uncertain) Provide explanation (consider if other sites could be impacting this PRS)	No. The data are incomplete for characterizing the nature of site contamination and are nonexistent for characterizing lateral extent of contamination, especially for receptors down gradient of surface water run-off and surface sediments transported by wind. The data are incomplete for characterizing pathways of contaminants to ecological receptors.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.

It must be emphasized that the PRS 53-002 (a) and (b) surface impoundments and PRS 53-008 are inseparable as ecologically definitive units. The contiguity of the PRSs and the current activity of PRS 53-002(b) and 53-008 is contrary to consideration of PRS 53-002(a) in isolation when considering the biotic nature and ecological processes at work in the area. Additionally, these PRSs lie at the periphery of a mesa where it is unclear that the area is not reclaimable by natural biotic processes. Biotic processes in place are indicative of an area that is not being managed for the exclusion of vegetative succession and natural reclamation of the site.

ECOLOGICAL SCOPING CHECKLIST: PART C

Ecological Pathways Conceptual Exposure Model

Provide answers to Questions A to Q and use this information to complete the Ecological Pathways Conceptual Exposure Model

Question A: Could soil contaminants reach receptors via vapors?

- Volatility of the hazardous substance (volatile chemicals generally have Henry's Law constant $>10^{-5}$ atm-me/mol and molecular weight <200 g/mol).

Answer (yes/no/uncertain): Uncertain.

Provide explanation: The lateral and deep vertical extent of volatile and semivolatile compounds has not been characterized.

Question B: Could the soil contaminants identified above reach receptors through fugitive dust carried in air?

- Soil contamination would have to be on the actual surface of the soil to become available for dust.
- In the case of dust exposures to burrowing animals, the contamination would have to occur in the depth interval where these burrows occur.

Answer (yes/no/uncertain): Yes.

Provide explanation: Contaminants present at the site are vulnerable to airborne transport due to the exposed nature of the site to wind. Fossorial animals are present and active at the site.

Question C: Can contaminated soil be transported to aquatic ecological communities (use AP 4.5 run-off score and terminal point of surface water runoff to help answer this question)?

- If the AP 4.5 run-off score* equal to zero, this suggests that erosion at PRS is not a transport pathway. (* note that the runoff score is not the entire erosion potential score, rather it is a subtotal of this score with a maximum value of 46 points)
- If erosion is a transport pathway, evaluate the terminal point to see if aquatic receptors could be affected.

Answer (yes/no/uncertain) Yes.

Provide explanation: There is clear evidence of surface transport of waterborne contaminants to the westerly and easterly hanging canyons (see Part B). Surface measures of gamma emissions (per Tyson Lansford) indicate that historical flow of effluents reached the easterly hanging canyon.

Question D: Is contaminated groundwater potentially available to biological receptors through seeps or springs?

- Known or suspected presence of contaminants in groundwater.
- The potential for contaminants to migrate via groundwater and discharge into habitats and/or surface waters.
- Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1 m depth).
- Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.

Answer (yes/no/uncertain): Uncertain.

Provide explanation: The hydrology of the area is not characterized.

Question E: Is infiltration/percolation from contaminated subsurface material a viable transport pathway?

- Suspected ability of contaminants to migrate to groundwater.
- The potential for contaminants to migrate via groundwater and discharge into habitats and/or surface waters.
- Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1 m depth).
- Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.
- Also consider the importance of mass wasting as a potential release mechanism for subsurface material.

Answer (yes/no/uncertain): Uncertain.

Provide explanation: This seems like an unlikely pathway, however, without sufficient knowledge of the extent of subsurface contamination, the integrity of the surface impoundments' lay lining, and the understanding of subsurface hydrology in the area, this pathway cannot be evaluated adequately. The southwestern-most corner of PRS 53-002(b) is very near (within 5 ft of) the westerly hanging canyon and would appear to have the greatest potential for mass wasting events.

Question F: Could airborne contaminants interact with plants or animals through respiration of vapors?

- Contaminants must be present as volatiles in the air.
- Consider the importance of inhalation of vapors for burrowing animals.
- Foliar uptake of organic vapors is typically not a significant pathway.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 1.

Provide explanation: Process knowledge does not indicate that volatile compounds were ever released at the site. However, analytical data indicates that acetone, 2-butanone, and methylene chloride were detected in the sludge and acetone was detected in the liner and tuff. These volatile compounds are common laboratory contaminants and may be present as a result of laboratory contamination. In addition, if volatile compounds were released into the surface impoundments, it is unlikely that volatile constituents would remain at the site since the site has been inactive and exposed to the open air for some time (several years).

Question G: Could airborne contaminants interact with plants or animals through deposition of particulates or with animals through inhalation of fugitive dust?

- Contaminants must be present as particulates in the air or as dust for this pathway to be viable.
- Exposure via inhalation of fugitive dust is particularly applicable to ground-dwelling species that would be exposed to dust disturbed by their foraging or burrowing activities or by wind movement.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 2

Provide explanation: See Part B of the scoping checklist for explanation.

Question H: Could contaminants interact with plants through root uptake or rain splash from surface soils?

- Contaminants in bulk soil may partition into soil solution, making them available to roots.
- Exposure of terrestrial plants to contaminants present in particulates deposited on leaf and stem surfaces by rain striking contaminated soils (i.e., rain splash).

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3

Provide explanation: There are currently plants growing inside of the surface impoundments. Additionally, there is a likely pathway of contaminant transport outside of the surface impoundments from historical effluent releases (see Part B, above).

Question I: Could contaminants interact with receptors through food web transport from surface soils?

- The chemicals may bioaccumulate in animals (see list of potentially persistent bioaccumulators and biomagnifiers, presented in Table 1).
- Animals may ingest contaminated prey.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3

Provide explanation: PCBs, potentially persistent bioaccumulators and/or biomagnifiers, have been detected in the sludge; they are readily available in the food chain from this site.

Question J: Could contaminants interact with receptors via incidental ingestion of surface soils?

- Incidental ingestion of contaminated soil could occur while animals grub for food resident in the soil, feed on plant matter covered with contaminated soil or while grooming themselves clean of soil.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3

Provide explanation: Ingestion of soils would be likely per the dietary regimen of any given receptor.

Question K: Could contaminants interact with receptors through dermal contact with surface soils?

- Significant exposure via dermal contact would generally be limited to organic contaminants which are lipophilic and can cross epidermal barriers.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3

Provide explanation: For fossorial invertebrates and vertebrates, this is a viable pathway.

Question L: Could contaminants interact with plants or animals through external irradiation?

- External irradiation effects are most relevant for gamma emitting radionuclides.
- Burial of contamination severely attenuates radiological exposure.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3

Provide explanation: There is surface contamination from Cobalt 60.

Question M: Could contaminants interact with plants through direct uptake from water and sediment or sediment rain splash?

- Contaminants may be taken up by terrestrial plants whose roots are in contact with surface waters.
- Terrestrial plants may be exposed to particulates deposited on leaf and stem surfaces by rain striking contaminated sediments (i.e., rain splash). in an area that is only periodically inundated with water.
- Contaminants in sediment may partition into soil solution, making them available to roots.
- Aquatic plants are in direct contact with water.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3 terrestrial, 1 aquatic.

Provide explanation: There are currently plants rooted in the PRS 53-002(a) surface impoundments which gather seasonally available water. Pathways off-site (see Part B) have terrestrial plants directly in their course. Aquatic receptors may lie in downstream reaches of Los Alamos Canyon.

Question N: Could contaminants interact with receptors through food web transport from water and sediment?

- The chemicals may bioaccumulate in animals (see list of potentially persistent bioaccumulators and biomagnifiers, presented in Table 1.)
- Animals may ingest contaminated prey.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3 terrestrial, 1 aquatic.

Provide explanation: PCBs, potentially persistent bioaccumulators and/or biomagnifiers, have been detected in the sludge; they are readily available in the food chain from this site. Aquatic receptors may lie in downstream reaches of Los Alamos Canyon.

Question O: Could contaminants interact with receptors via incidental ingestion of water and sediment?

- If sediments are present in an area that is only periodically inundated with water, terrestrial receptors may incidentally ingest sediments.
- Terrestrial receptors may ingest waterborne contaminants if contaminated surface waters are used as a drinking water source.
- Aquatic receptors may regularly or incidentally ingest sediment while foraging.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3 terrestrial, 1 aquatic.

Provide explanation: It is likely that mammals and birds visit this site specifically for the purpose of accessing water for grooming and consumption. Aquatic receptors may lie in downstream reaches of Los Alamos Canyon.

Question P: Could contaminants interact with receptors through dermal contact with water and sediment?

- If sediments are present in an area that is only periodically inundated with water, terrestrial species may be dermally exposed during dry periods.
- Terrestrial organisms may be dermally exposed to water-borne contaminants as a result of wading or swimming in contaminated waters.
- Aquatic receptors may be directly exposed to sediments or may be exposed through osmotic exchange, respiration, or ventilation of sediment pore waters.
- Aquatic receptors may be exposed through osmotic exchange, respiration, or ventilation of surface waters.

Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3 terrestrial, 1 aquatic.

Provide explanation: It is likely that mammals and birds visit this site specifically for the purpose of accessing water for grooming. The surface impoundments are likely accessible to fossorial invertebrates. Aquatic receptors may lie in downstream reaches of Los Alamos Canyon.

Question Q: Could contaminants interact with plants or animals through external irradiation?

- External irradiation effects are most relevant for gamma emitting radionuclides.
- Burial of contamination severely attenuates radiological exposure.
- The water column acts to absorb radiation, thus external irradiation is typically more important for sediment dwelling organisms.

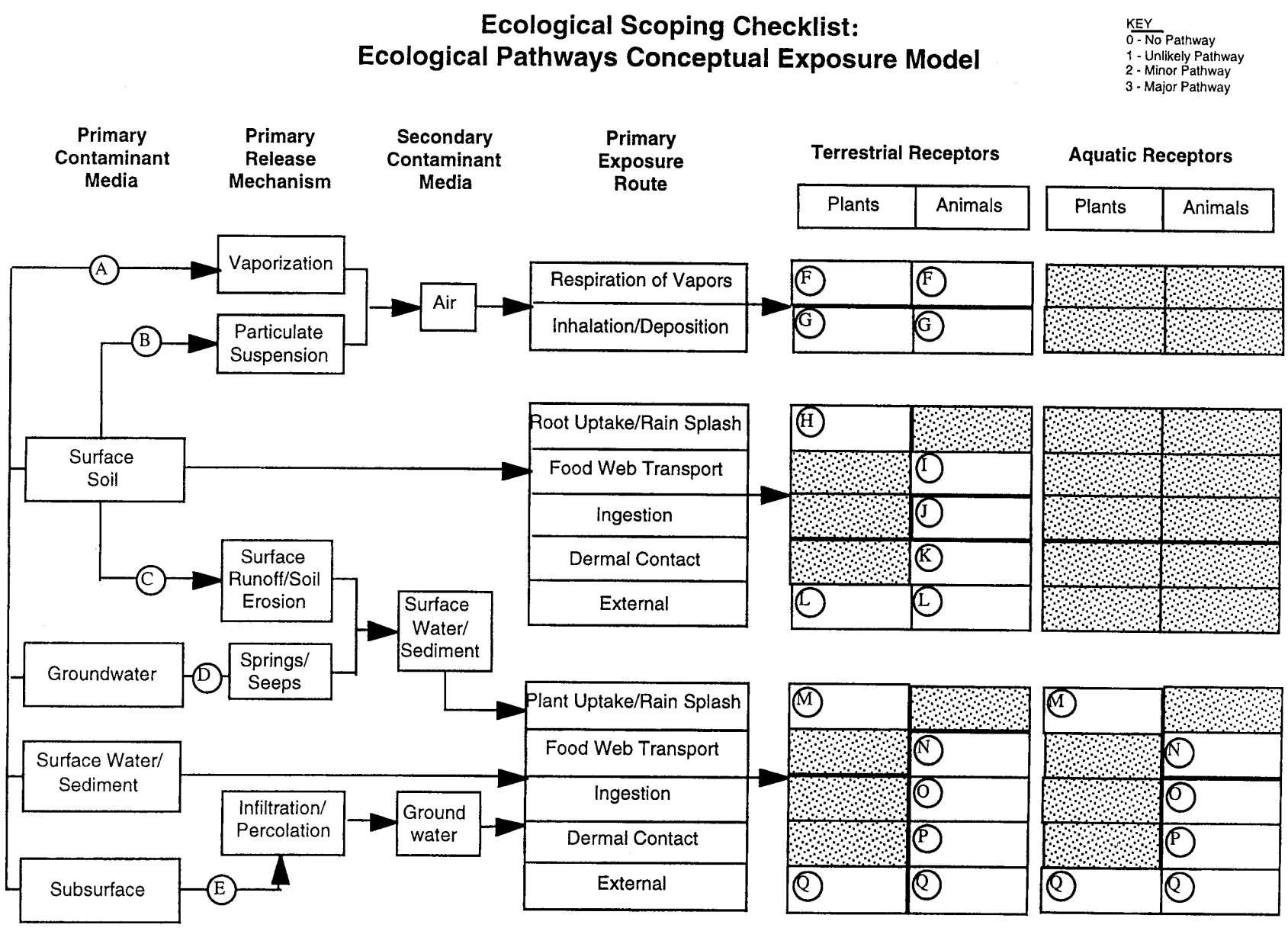
Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway): 3 terrestrial, 1 aquatic.

Provide explanation: There is surface contamination from Cobalt 60. Aquatic receptors may lie in downstream reaches of Los Alamos Canyon.

Table A-1
List of Bioaccumulating Chemicals

Volatile Organics	**PCBs/Pesticides**
Bis(2-ethylhexyl)phthalate	All Aroclors
Butyl benzyl phthalate	beta-BHC
Dichlorobenzene[1,4-]	BHC-mixed isomers
Di-n-butyl phthalate	Chlordane
Di-n-octyl phthalate	Chlorecone (Kepone)
Trichlorobenzene[1,2,4-]	DDT and metabolites
Xylene (mixed isomers)	Dieldrin
	Endosulfan
Semivolatile Organics	Endrin
Acenaphthene	Heptaclor
Anthracene	Lindane
Benzo(a)anthracene	Methoxyclor
Benzo(a)pyrene	Toxaphene
Benzo(b)fluoranthene	
Benzo(g,h,i)perylene	**Inorganics**
Benzo(k)fluoranthene	Aluminum
Chrysene	Cadmium
Dibenzo(a,h)anthracene	Copper
Fluoranthene	Lead
Fluorene	Mercury
Indeno(1,2,3-cd)pyrene	Nickel
Phenanthrene	Selenium
Pyrene	
Pentachloronitrobenzene	**Radionuclides**
Pentachlorophenol	Americium-241
	Cesium-137
Dioxins/Furans	Radium-226,-228
Dibenzofuran	Strontium-90
2,3,7,8-tetrachloro-dibenzo(p)dioxin	Thorium-228,-230,-232
2,3,7,8-tetrachloro-dibenzo(p)furan	Uranium-234,-235,-238

Ecological Scoping Checklist: Ecological Pathways Conceptual Exposure Model



Signatures and Certifications:

Checklist completed by (provide name, organization and phone number)

Name (printed):	Mark M. Hooten
Name (signature):	Mark M. Hooten
Organization:	Neptune and Co., Inc.
Phone number:	505-662-2121
Date completed:	Feb. 27, 1998; Revised to current format May 10, 1998.

Verification by a member of ER Project Ecological Risk Task Team (provide name, organization and phone number)

Name (printed):	**Richard Mirenda**
Name (signature):	Richard Mirenda
Organization:	**Program Management Company**
Phone number:	**(505) 662-1329**

Los Alamos National Laboratory

Environment, Safety and Health Division
ESH-18 Water Quality and Hydrology Group

AP 4.5 Surface Water Assessment Erosion Matrix for PRS 53-002(a)

CRITERIA EVALUATED	Value	Erosion/Sediment Transport Potential Low 0.1	Medium 0.5	High 1.0	Calculated Score
Site Setting (43)					
On mesa top	1	Defined based on topographic setting			1.0
Within bench of canyon	4				
Within the canyon floodplain but not watercourse	13				
Within bottom of canyon channel in watercourse	17				
Estimated % ground and canopy cover	13	>75%	25-75%	<25%	6.5
Slope	13	0-10%	10-30%	>30%	1.3
Surface Water Factors-Run-off (46)					
Visible evidence of runoff discharging? (Yes/No)	5	If no, score of 0 for runoff section. If yes, score 5 and proceed with section.			5.0
Where does runoff terminate?	19	Other	Bench Setting	Drainage/Wetland	19.0
Has runoff caused visible erosion? (Yes/No)	22	Sheet	Rill	Gully	11.0
		If no, score as 0. If yes, calculate as appropriate.			
Surface Water Factors-Run-on (11)					
Structures adversely affecting run-on (Yes/No)	7*	If yes, score as 7. If no, score as 0.			0.0
Current operations adversely impacting (Yes/No)	4	If yes, score as 4. If no, score as 0.			4.0
Natural drainages onto site (Yes/No)	7*	If yes, score as 7. If no, score as 0.			0.0
**Select either structures or natural drainages.*					
MAX. POSSIBLE EROSION MATRIX SCORE:	**100**			**Total Score**	47.8**

** Indicates BMPs in place. Erosion potential without BMPs may be greater.

Los Alamos National Laboratory
SURFACE WATER
SITE ASSESSMENT

SITE INFORMATION

1a) PRS Number 53-002(a) **1b) Structure Number** [ ] **1c) FMU Number** 61

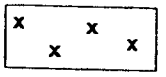
2. Date/Time (M/D/Y H:M am/pm) 10/29/97 1:40:00 PM

SITE SETTING (check all that apply)

3. ◉ **On mesa top (a).** ○ **In the canyon floor, but not in an established channel (c).**
○ **Within a bench of a canyon (b).** ○ **Within established channel in the canyon floor (d).**

Explanation: Located between Sandia and Los Alamos canyons. NPDES outfall from lagoons at TA-53. Outfall at east end of lagoons.

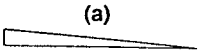
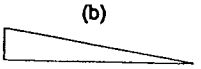
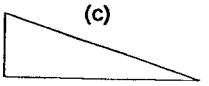
4. Estimated ground and/or canopy cover at site: (deciduous leaves, pine needles, rocks, vegetation, trees, structures, asphalt, etc.)

(illustration) (a)  (b) (c)

Estimated % of ground/canopy cover: ○ 0% to 25% ◉ 25% to 75% ○ 75% to 100%

Explanation: Riprap extends from base of the outfall to a culvert under the roadway. Sparse ground cover extends from the culvert, across the mesa top, to the canyon edge.

5. Steepest slope at the area impacted:

(a)  (b)  (c) 

◉ Less than 10% ○ 10% to 30% ○ 30% and greater

Explanation:

RUNOFF FACTORS

Y / N

☑ ☐ **6. Is there visible evidence of runoff discharging from site? If yes, answer a) - c) below:**

☐ ☑ 6a) Is runoff channelized? If yes, describe: ○ Man-made channel. ○ Natural channel.

Explanation: Lagoons are dry and the outfall is not active. However, there is evidence of discharge (erosion) from the culvert under the roadway. This area is within the PRS boundary.

RUNOFF FACTORS, CONT'D

6b) Where does evidence of runoff terminate?

- (●) **Drainage or wetland (name)** Los Alamos Canyon
- ( ) **Within bench of canyon setting (name)**
- ( ) **Other (i.e., retention pond, meadow, mesa top)**

Explanation:

Y / N

☑ ☐ 6c) **Has runoff caused visible erosion at the site? If yes, explain below:** ( ) Sheet (●) Rill ( ) Gully

Explanation: Adjacent to the NPDES outfall, a culvert is placed under the roadway. This culvert conveys storm water as well as discharges from the outfall. Minor rill erosion is present at the culvert outlet.

RUN-ON FACTORS

Please rate the potential for storm water to run on to this site: (Check EITHER #7 or #9)

☐ ☑ **7.** Are structures (i.e., buildings, roof drains, parking lots, storm drains) creating run-on to the site?

Explanation:

☑ ☐ **8.** Are current operations (i.e., fire hydrants, NPDES outfalls) adversely impacting run-on to the site?

Explanation: Site is not active but is still classified as active NPDES outfall EPASSS095.

☐ ☑ **9.** Are natural drainage patterns directing stormwater onto site?

Explanation:

ASSESSMENT FINDING:

☐ ☑ **10. Based on the above criteria and the assessment of this site, does soil erosion potential exist? (REFER TO EROSION POTENTIAL MATRIX.)**

T. Lemke

11. Signature of Water Quality/Hydrology Representative

SJ Initials of independent reviewer.

Check here when information is entered in database: ☑

This page is for ESH-18 notes, recommendations, and photos.

	Y	N	
12. a)	○	◉	Is there visible trash/debris on the site?
b)	○	◉	Is there visible trash/debris in a watercourse?

Description of existing BMPs:

Riprap extends from the NPDES outfall to the inlet of the culvert under the adjacent roadway.

◉ ○ Are BMPs being properly maintained? If no, describe in "Other Internal Notes."

◉ ○ Are BMPs effectively keeping sediment in place and reducing erosion potential?

OTHER INTERNAL NOTES:

Outfall is no longer active. Area is relatively flat so only a minimal amount of storm water would flow across the site. Outfall is a concrete flume with a metal wire.

Los Alamos National Laboratory

Environment, Safety and Health Division
ESH-18 Water Quality and Hydrology Group

AP 4.5 Surface Water Assessment Erosion Matrix for PRS 53-002(b)

CRITERIA EVALUATED	Value	Erosion/Sediment Transport Potential Low 0.1	Medium 0.5	High 1.0	Calculated Score
Site Setting (43)					
On mesa top	1	Defined based on topographic setting			1.0
Within bench of canyon	4				
Within the canyon floodplain but not watercourse	13				
Within bottom of canyon channel in watercourse	17				
Estimated % ground and canopy cover	13	>75%	25-75%	<25%	1.3
Slope	13	0-10%	10-30%	>30%	1.3
Surface Water Factors-Run-off (46)					
Visible evidence of runoff discharging? (Yes/No)	5	If no, score of 0 for runoff section. If yes, score 5 and proceed with section.			0.0
Where does runoff terminate?	19	Other	Bench Setting	Drainage/Wetland	0.0
Has runoff caused visible erosion? (Yes/No)	22	Sheet	Rill	Gully	0.0
		If no, score as 0. If yes, calculate as appropriate.			
Surface Water Factors-Run-on (11)					
Structures adversely affecting run-on (Yes/No)	7*	If yes, score as 7. If no, score as 0.			0.0
Current operations adversely impacting (Yes/No)	4	If yes, score as 4. If no, score as 0.			0.0
Natural drainages onto site (Yes/No)	7*	If yes, score as 7. If no, score as 0.			0.0
**Select either structures or natural drainages.*					
MAX. POSSIBLE EROSION MATRIX SCORE:	**100**			**Total Score**	3.6

Los Alamos National Laboratory
SURFACE WATER
SITE ASSESSMENT

SITE INFORMATION

1a) PRS Number 53-002(b) **1b) Structure Number** [ ] **1c) FMU Number** 61

2. Date/Time (M/D/Y H:M am/pm) 10/29/97 2:10:00 PM

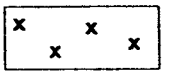
SITE SETTING (check all that apply)

3. ◉ **On mesa top (a).** ○ **In the canyon floor, but not in an established channel (c).**

○ **Within a bench of a canyon (b).** ○ **Within established channel in the canyon floor (d).**

Explanation: Active lagoon located on mesa top between Sandia and Los Alamos canyons. Located south of lagoons classified as PRS 53-002(a).

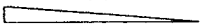
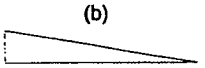
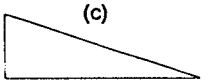
4. Estimated ground and/or canopy cover at site: (deciduous leaves, pine needles, rocks, vegetation, trees, structures, asphalt, etc.)

(illustration) (a)  (b) (c)

Estimated % of ground/canopy cover: ○ 0% to 25% ○ 25% to 75% ◉ 75% to 100%

Explanation: Sides and bottom of lagoon are covered with an impermeable membrane.

5. Steepest slope at the area impacted:

(a)  (b)  (c) 

◉ Less than 10% ○ 10% to 30% ○ 30% and greater

Explanation:

RUNOFF FACTORS

Y / N

☐ ☑ **6. Is there visible evidence of runoff discharging from site? If yes, answer a) - c) below:**

☐ ☑ 6a) Is runoff channelized? If yes, describe: ○ Man-made channel. ○ Natural channel.

Explanation: Lagoon is situated below grade. An overflow outlet that discharges to the same outfall as 53-002(a) is located within the lagoon.

RUNOFF FACTORS, CONT'D

6b) Where does evidence of runoff terminate?

- ○ **Drainage or wetland (name)**
- ○ **Within bench of canyon setting (name)**
- ○ **Other (i.e., retention pond, meadow, mesa top)**

Explanation:

Y / N

☐ ☑ **6c) Has runoff caused visible erosion at the site? If yes, explain below:** ○ **Sheet** ○ **Rill** ○ **Gully**

Explanation:

RUN-ON FACTORS

Please rate the potential for storm water to run on to this site: (Check EITHER #7 or #9)

☐ ☑ **7. Are structures (i.e., buildings, roof drains, parking lots, storm drains) creating run-on to the site?**

Explanation:

☐ ☑ **8. Are current operations (i.e., fire hydrants, NPDES outfalls) adversely impacting run-on to the site?**

Explanation:

☐ ☑ **9. Are natural drainage patterns directing stormwater onto site?**

Explanation:

ASSESSMENT FINDING:

☐ ☑ **10. Based on the above criteria and the assessment of this site, does soil erosion potential exist? (REFER TO EROSION POTENTIAL MATRIX.)**

T. Lemke

11. Signature of Water Quality/Hydrology Representative

SV Initials of independent reviewer.

Check here when information is entered in database: ☑

53-002(b)... page 4 of 4

This page is for ESH-18 notes, recommendations, and photos.

	Y	N	
12. a)	○	◉	Is there visible trash/debris on the site?
b)	○	◉	Is there visible trash/debris in a watercourse?

Description of existing BMPs:

○	○	Are BMPs being properly maintained? If no, describe in "Other Internal Notes."
○	○	Are BMPs effectively keeping sediment in place and reducing erosion potential?

OTHER INTERNAL NOTES:

Contents of lagoon are contained. The current liquid level in the lagoon is much lower than the overflow outlet.

SPECIES OF POTENTIAL CONCERN FOR TA-53:

northern goshawk (*Accipiter gentilis* - federal candidate)
common black hawk (*Buteogallus anthracinus* - New Mexico state endangered)
Mississippi kite (*Ictinia mississippiensis* - New Mexico state endangered)
peregrine falcon (*Falco peregrinus* - federally endangered and New Mexico state endangered)
Mexican spotted owl (*Strix occidentalis lucida* - federally threatened)
broad-billed hummingbird (*Cyanthus latirostris* - New Mexico state endangered)
willow flycatcher (*Empidonax trailii* - New Mexico state endangered and federal candidate)
spotted bat (*Euderma maculatum* - New Mexico state endangered and federal candidate)
Wright's fishhook cactus (*Mammillaria wrightii* - New Mexico state endangered)
Santa Fe cholla (*Opuntia viridiflora* - New Mexico state endangered)
grama grass cactus (*Toumeya papyracantha* - New Mexico state endangered and federal candidate)
sessile-flowered false carrot (*Aletes sessiliflorus* - New Mexico state endangered)
threadleaf horsebrush (*Tetradymia filifolia* - New Mexico state endangered)
Plank's catchfly (*Silene plankii* - New Mexico state sensitive)
Santa Fe milkvetch (*Astragalus feensis* - New Mexico state endangered)
Mathew's woolly milkvetch (*Astragalus mollissimus var. mathewsii* - New Mexico state sensitive)
Taos milkvetch (*Astragalus puniceus var. gertrudis* - New Mexico state sensitive)
cyanic milkvetch (*Astagalus cyaneus* - New Mexico state sensitive)
tufted sand verbena (*Abronia bigelovii* - New Mexico state sensitive)
Pagosa phlox (*Phlox caryophylla* - New Mexico state sensitive)

Table D-1
Average Monthly Discharge Rate (Millions of Gallons Per Day) From TA-53 Surface Impoundment PRS 53-002(a)

Year	January	February	March	April	May	June	July	August	September	October	November	January
1978	NI	NI	NI	NI	NI	NI	NI	NI	NI	0.009	0.03	0.02
1979	0.016	0.02	0.018	0.01	0.0144	0.013	0.0068	0.0121	0.0033	0.006	0.014	0.0192
1980	0.0187	0.02	0.013	0.013	0.0095	0.00049	0.0035	0.0114	0.0164	0.0185	0.0212	0.0269
1981	0.0206	0.0216	0.0195	0.0149	0.0086	0.0032	0.0142	0.0196	0.0222	0.0187	0.0214	0.0259
1982	0.0241	0.0264	0.0169	0.0162	0.0168	0.0159	0.0125	0.0211	0.0179	0.0152	0.0207	0.0298
1983	0.0258	0.0224	0.0167	0.0083	0.00132	0.0075	0.0046	0.0134	0.0071	0.0168	0.0132	0.0159
1984	0.0193	0.0154	0.0165	0.0078	0.0075	0.0007	0.0058	0.0159	0.0116	0.0232	0.013	0.0162
1985	0.0153	0.0153	0.0154	0.0133	0.0083	0.0072	0.0049	0.0104	0	0	0	0
1986	0	0	0	0	0	0	0.0124	0	0	0	0.0066	0.0045
1987	0.0075	0.009	0.0207	0.0008	0	0	0	0	0	0	0	0
1988	0	0	0.0129	0.0009	0.0095	0	0	0	0	0	0	0.0106
1989	0.0106	0.0442	0.0535	0	0	0	0	0	0	0	0	0
1990	0.031	0.0573	0.0512	0.0544	0.0058	0.0326	0	0	0	0	0.0429	0
1991	0.0142	0.0912	0.0284	0	0	0	0.039	0.0199	0.0009	0	0	0
1992	0.0073	0.0184	0.0068	0.0065	0.0065	0.008	0.0028	0.0062	0.0057	0.0029	0.0063	0.0081
1993	0.0102	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

NI - No information availabel for discharges prior to October, 1978

ND - No discharge, discharge from the impoundments was stopped on February 1, 1993

TABLE E-1
VOLATILE ORGANIC COMPUNDS DETECTED IN SLUDGE SAMPLES-
NORTHERN SURFACE IMPOUNDMENTS, 1988, 1991, AND 1992

Sample Location [a] No figures were located for samples from 1988 and 1991	Acetone, mg/kg	2-Butanone, mg/kg	Carbon Disulfide mg/kg	Chloroform mg/kg	4-Isopropyl-toluene, mg/kg	Toluene, mg/kg	1,2,4-Trimethyl - benzene, mg/kg
1988 Samples							
NW Impoundments - 01	0.66 B[b]	ND[c]	ND	ND	ND	3.6 J[d]	ND
NW Impoundments - 02	ND	ND	ND	ND	ND	0.2	ND
NW Impoundments - 03	0.97 B	ND	ND	ND	ND	0.87	ND
NE Impoundments – 04	4.9	ND	ND	ND	ND	ND	ND
NE Impoundments – 05	0.25	ND	ND	ND	ND	ND	ND
NE Impoundments – 06	9.0 B	ND	ND	ND	ND	ND	ND
July 1991 Samples							
AB-53-NW-1S	ND	ND	ND	ND	ND	0.068	ND
AB-53-NW-2S	ND	ND	ND	ND	ND	0.042	ND
AB-53-NW-4SQ	ND	ND	ND	ND	ND	0.025	ND

TABLE E-1CONTINUED
VOLATILE ORGANIC COMPOUNDS DETECTED IN SLUDGE SAMPLES-NORTHERN SURFACE IMPOUNDMENTS, 1988, 1991, AND 1992

Sample Location No figures were located for samples from 1988 and 1991	Acetone, mg/kg	2-Butanone, mg/kg	Carbon Disulfide mg/kg	Chloroform mg/kg	4-Isopropyl-toluene, mg/kg	Toluene, mg/kg	1,2,4-Trimethyl - benzene, mg/kg
April 1992 Samples	See Figures E-1 and E-2 for sample locations						
53-NW-A-S	ND	ND	ND	ND	0.025	ND	ND
53-NW-B-S	0.03	ND	ND	ND	ND	ND	ND
53-NW-E-S	0.087	ND	ND	ND	ND	ND	ND
53-NW-G-S	ND	ND	ND	ND	ND	0.1	ND
53-NW-H-S	ND	ND	ND	ND	ND	0.0066	ND
53-NW-I-S	0.14	ND	0.011	ND	ND	ND	0.019
53-NW-L-S	ND	ND	ND	ND	ND	0.092	ND
53-NW-N-S	ND	ND	0.021	ND	ND	ND	ND
53-NW-M-S	0.23	0.034	0.006	ND	ND	0.035	ND
53-NW-N-S-QA	0.11	ND	0.014	ND	ND	ND	ND
53-NW-O-S	ND	ND	ND	ND	ND	0.061	ND
53-NW-O-S-QA	ND	ND	0.5	ND	ND	0.2	ND
53-NE-B1-S	0.031	ND	ND	ND	ND	ND	ND
53-NE-C1-S	0.16	ND	0.0094	ND	ND	ND	ND
53-NE-D1-S	0.025	ND	ND	ND	ND	ND	ND
53-NE-S-S	0.12	ND	ND	ND	ND	ND	ND
53-NE-T-S	ND	ND	ND	0.011	ND	ND	ND
53-NE-W-S	ND	ND	ND	0.0054	ND	ND	ND
53-NE-X-S	0.066	ND	ND	ND	ND	ND	ND
53-NE-Y-S	ND	ND	ND	0.0069	ND	ND	ND
53-NE-Z-S	0.17	ND	ND	0.0086	ND	ND	ND

(a) Q and QA indicate duplicate samples.

(b) B – Data flag indicating that the analyte was detected in analytical method blank.

(c) ND- Not detected

(d) J – Data flag indicating that the analyte was positively identified, but the numerical value may not be representative of amount actually present.

TABLE E-2
SEMIVOLATILE ORGANIC COMPOUNDS DETECTED IN SLUDGE SAMPLES-
NORTHERN SURFACE IMPOUNDMENTS, 1988, 1991 AND 1992

Sample Location [a] No figures were located for samples from 1988 and 1991	Benzidine, mg/kg	Benzoic Acid, mg/kg	Benzyl Alcohol, mg/kg	Bis-2-ethylhexyl-phthalate, mg/kg	Di-n-butyl-phthalate, mg/kg	Fluoranthene, mg/kg	2-Methyl phenol, mg/kg	4-Methyl phenol, mg/kg	Pyrene, mg/kg
1988 Samples									
NW Impoundments - 01	ND[b]	ND	ND	ND	ND	ND	ND	ND	0.05 JB[c,d]
NW Impoundments - 02	ND	ND	0.057 J	ND	ND	ND	0.03 J	1.1	ND
NW Impoundments - 03	ND	ND	ND	ND	ND	0.088 J	ND	ND	0.12 JB
NE Impoundments - 04	ND	0.11 JB	ND	ND	ND	ND	ND	ND	ND
NE Impoundments - 05	ND	ND	ND	ND	ND	ND	ND	ND	ND
NE Impoundments - 06	ND	ND	ND	ND	ND	ND	ND	ND	ND
July 1991 Samples									
AB-53-NW-1S	3.9	ND	ND	1.2	1.4	ND	ND	ND	ND
AB-53-NW-2S	1.9	ND	ND	1.1	ND	ND	ND	ND	ND
AB-53-NW-3S	ND	ND	ND	ND	1.4	ND	ND	ND	ND

TABLE E-2 CONTINUED
SEMIVOLATILE ORGANIC COMPOUNDS DETECTED IN SLUDGE SAMPLES-NORTHERN SURFACE IMPOUNDMENTS, 1988, 1991 AND 1992

Sample Location [a] No figures were located for samples from 1988 and 1991	Benzidine, mg/kg	Benzoic Acid, mg/kg	Benzyl Alcohol, mg/kg	Bis-2-ethylhexyl-phthalate, mg/kg	Di-n-butyl-phthalate, mg/kg	Fluoranthene, mg/kg	2-Methyl phenol, mg/kg	4-Methyl phenol, mg/kg	Pyrene, mg/kg
April 1992 Samples See Figures E-1 and E-2 for sample locations									
53-NW-A-S	ND	4.4	ND	6.3	ND	ND	ND	ND	ND
53-NW-B-S	ND	4.2	ND	4.3	ND	ND	ND	ND	ND
53-NW-C-S	ND	ND	ND	1.8	1.3	ND	ND	ND	ND
53-NW-D-S	ND	5.2	ND	2.7	ND	ND	ND	ND	ND
53-NW-E-S	ND	4.6	ND	5.5	ND	ND	ND	ND	ND
53-NW-F-S	ND	ND	ND	2.1	ND	ND	ND	ND	ND
53-NW-H-S	ND	ND	ND	2.1	ND	ND	ND	ND	ND
53-NW-I-S	ND	3.8	ND	22.7	ND	ND	ND	ND	ND
53-NW-J-S	ND	ND	ND	13.3	ND	ND	ND	ND	ND
53-NW-K-S	ND	ND	ND	2.9	ND	ND	ND	ND	ND
53-NW-N-S	ND	3.9	ND	5.3	ND	ND	ND	ND	ND
53-NW-M-S	ND	ND	ND	8.8	ND	ND	ND	ND	ND
53-NW-N-S-QA	ND	2.7	ND	6.6	ND	ND	ND	ND	ND
53-NW-O-S	ND	ND	ND	1.3	ND	ND	ND	ND	ND
53-NW-O-S-QA	ND	ND	ND	0.99	ND	ND	ND	ND	ND
53-NE-A1-S	ND	ND	ND	1.1	ND	ND	ND	ND	ND
53-NE-B1-S	ND	ND	ND	1.3	3.8	ND	ND	ND	ND
53-NE-C1-S	ND	ND	ND	2.6	ND	ND	ND	ND	ND
53-NE-D1-S	ND	ND	ND	ND	1.1	ND	ND	ND	ND
53-NE-Q-S	ND	ND	ND	ND	4	ND	ND	ND	ND
53-NE-Q-S-QA	ND	ND	ND	ND	1.5	ND	ND	ND	ND
53-NE-R-S	ND	ND	ND	ND	0.98	ND	ND	ND	ND
53-NE-S-S	ND	ND	ND	2	1.9	ND	ND	ND	ND
53-NE-T-S	ND	2.5	ND	3.4	ND	ND	ND	ND	ND
53-NE-U-S	ND	ND	ND	2	5.3	ND	ND	ND	ND
53-NE-V-S	ND	ND	ND	ND	2.6	ND	ND	ND	ND

(a) Q and QA indicate duplicate samples.

(b) ND- Not detected

(c) J – Data flag indicating that the analyte was positively identified, but the numerical value may not be representative of amount actually present.

(d) B – Data flag indicating that the analyte was detected in analytical method blank..

TABLE E-3
METALS DETECTED IN SLUDGE SAMPLES-
NORTHERN SURFACE IMPOUNDMENTS, 1988, 1991 AND 1992

Sample Location [a] No figures were found for samples from 1988 and 1991	Ag, mg/kg	As, mg/kg	Ba, mg/kg	Be, mg/kg	Cd, mg/kg	Cr, mg/kg	Cu, mg/kg	Hg, mg/kg	Pb, mg/kg	Se, mg/kg	Zn, mg/kg
1988 Samples											
NW Impoundments - 01	ND[b]	ND	112 B	ND	ND	ND	303	1.1	ND	ND	578
NW Impoundments - 02	4.9 B	ND	ND	0.59 B	ND	12.8	119	0.5	ND	ND	166
NW Impoundments S - 03	7.1 B	ND	ND	0.67 B	ND	17.7	241	0.49	ND	ND	385
NE Impoundments - 04	ND	ND	41.2 B	ND	ND	ND	78.2	ND	ND	ND	118
NE Impoundments - 05	ND	ND	85 B	0.9 B	ND	14	97.6	ND	ND	ND	178
NE Impoundments - 06	ND	ND	102 B	0.9 B	ND	ND	122	ND	ND	ND	244
July 1991 Samples (results reported in mg/L)											
53-NW-1S	0.018	0.02	0.5	ND	ND	ND	ND	ND	ND	ND	ND
53-NW-2S	ND	0.03	0.57	ND	ND	ND	ND	ND	ND	ND	ND
53-NW-3S	ND	0.03	0.56	ND	ND	0.01	ND	ND	ND	ND	ND
53-NW-4SQ	ND	0.03	0.63	ND	ND	ND	ND	ND	ND	0.03	ND
53-NE-1S	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
53-NE-2S	0.015	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
53-NE-3S	0.011	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE E-3 CONTINUED
METALS DETECTED IN SLUDGE SAMPLES-
NORTHERN SURFACE IMPOUNDMENTS, 1988, 1991 AND 1992

Sample Location No figures were found for samples from 1988 and 1991	Ag, mg/kg	As, mg/kg	Ba, mg/kg	Be, mg/kg	Cd, mg/kg	Cr, mg/kg	Cu, mg/kg	Hg, mg/kg	Pb, mg/kg	Se, mg/kg	Zn, mg/kg
April 1992 Samples See Figures E-1 and E-2 for sample locations											
53-NW-A-S	2.3	2.3	26.6	ND	ND	6.3	ND	0.229	9.5	ND	ND
53-NW-B-S	2.1	2.8	44.8	ND	ND	11.1	ND	0.252	17.9	ND	ND
53-NW-C-S	ND	2.7	43.8	ND	ND	7.7	ND	0.165	13.5	ND	ND
53-NW-D-S	ND	2	48.5	ND	ND	5.9	ND	0.081	21.7	ND	ND
53-NW-E-S	2.3	2.4	50.2	ND	ND	7.1	ND	0.269	16.5	ND	ND
53-NW-F-S	ND	2.7	31.4	ND	ND	6.4	ND	0.302	12.6	ND	ND
53-NW-G-S	ND	2.9	46.1	ND	ND	14.8	ND	0.08	11.4	ND	ND
53-NW-H-S	ND	2.2	45.3	ND	ND	9.8	ND	0.178	11.5	ND	ND
53-NW-I-S	3.2	3.6	28.2	ND	1.9	8.4	ND	0.388	26.8	ND	ND
53-NW-J-S	3.8	2.8	29.4	ND	3.1	16.4	ND	0.407	44.8	ND	ND
53-NW-K-S	ND	2.7	36	ND	2.8	11.3	ND	0.48	27.3	2.1	ND
53-NW-L-S	ND	2.3	43.3	ND	ND	8.7	ND	0.096	20.2	2	ND
53-NW-N-S	2	2.6	26	ND	ND	7.3	ND	0.24	14.1	ND	ND
53-NW-M-S	5.1	2.5	33.5	ND	ND	7.4	ND	0.34	14.4	ND	ND
53-NW-N-S-QA	1.5	3	33.2	ND	ND	7.6	ND	0.159	13.3	ND	ND

TABLE E-3 CONTINUED
METALS DETECTED IN SLUDGE SAMPLES-
NORTHERN SURFACE IMPOUNDMENTS, 1988, 1991 AND 1992

Sample Location No figures were found for samples from 1988 and 1991	Ag, mg/kg	As, mg/kg	Ba, mg/kg	Be, mg/kg	Cd, mg/kg	Cr, mg/kg	Cu, mg/kg	Hg, mg/kg	Pb, mg/kg	Se, mg/kg	Zn, mg/kg
April 1992 Samples See Figures E-1 and E-2 for sample locations											
53-NW-O-S	ND	2.3	28.5	ND	ND	6.9	ND	0.108	13.5	ND	ND
53-NW-O-S-QA	ND	2.3	44.2	ND	ND	6.5	ND	0.098	15.2	5.9	ND
53-NE-A1-S	ND	2.2	28.9	ND	ND	7	ND	0.057	6.1	ND	ND
53-NE-B1-S	ND	2.8	38.9	ND	ND	6	ND	0.039	6.2	5.8	ND
53-NE-C1-S	2.5	2.4	15.3	ND	ND	3.6	ND	0.101	5.3	2.6	ND
53-NE-D1-S	ND	3	41.4	ND	ND	6.1	ND	0.043	6.9	3.6	ND
53-NE-E1-S	ND	2.8	34.9	ND	ND	5.6	ND	0.046	5.1	4.5	ND
53-NE-Q-S	ND	1.8	21.7	ND	ND	3.5	ND	0.035	3.7	3.2	ND
53-NE-Q-S-QA	ND	2.1	22.7	ND	ND	5.3	ND	0.042	4.1	1.6	ND
53-NE-R-S	ND	3.3	38.3	ND	ND	7.9	ND	0.034	5.6	2.5	ND
53-NE-S-S	ND	4.3	52.4	ND	ND	9.4	ND	0.036	10.3	2.6	ND
53-NE-T-S	2.8	2.8	9.3	ND	ND	3	ND	0.089	4.4	6.8	ND
53-NE-U-S	ND	2.5	24.4	ND	ND	6.1	ND	0.043	6.2	5.3	ND
53-NE-V-S	ND	3.6	39.6	ND	ND	8.3	ND	0.029	5.7	ND	ND
53-NE-W-S	ND	3.4	35.1	ND	ND	7.7	ND	0.03	4.9	ND	ND
53-NE-W-S-QA	ND	4.8	33.8	ND	ND	11.3	ND	0.05	6.8	ND	ND
53-NE-X-S	ND	3.9	36	ND	ND	7.7	ND	0.019	5.4	ND	ND
53-NE-Y-S	ND	2.8	13.2	ND	ND	5.4	ND	0.114	4.4	ND	ND
53-NE-Z-S	2.6	2.5	22.6	ND	ND	6.4	ND	0.429	4.4	ND	ND

(a) Q and QA indicate duplicate samples.

(b) ND- Not detected

TABLE E-4
METALS DETECTED IN WATER SAMPLES-
NORTHERN SURFACE IMPOUNDMENTS,
1991 AND 1992

Sample Location [a] No figures were located for samples from 1988 and 1991	Ag, µg/L	As, µg/L	Ba, µg/L	Cd, µg/L	Cr, µg/L	Pb, µg/L	Se, µg/L
July 1991 Samples							
AB-53-NW-1W	23	ND[b]	60	ND	ND	ND	ND
AB-53-NW-2W	ND	ND	70	ND	ND	ND	ND
AB-53-NW-3W	ND	ND	70	ND	ND	ND	ND
AB-53-NE-1W	ND	ND	80	ND	ND	ND	ND
AB-53-NE-2W	ND	ND	80	ND	ND	ND	ND
AB-53-NE-3W	ND	ND	80	ND	ND	ND	ND
April 1992 Samples	See Figures E-1 and E-2 for sample locations						
53-NW-O-W	ND	6.8	27.9	4.5	5.8	2.4	4.5
53-NW-O-W-QA	ND	6.3	33.4	4.4	5.7	3.1	3.4
53-NE-Y-W	ND	4.6	28.3	2.8	2.9	ND	1.3
53-NE-Y-W-QA	ND	4.8	28.5	2.5	2.4	ND	ND

(a) Q and QA indicate duplicate samples.

(b) ND- Not Detected

TABLE E-5
PCBS DETECTED IN SLUDGE SAMPLES-
NORTHERN SURFACE IMPOUNDMENTS, 1992

Sample Location [a]	Total PCBs (mg/kg)	Aroclor 1242 (mg/kg)	Aroclor 1254 (mg/kg)
April 1992 Samples	See Figures E-1 and E-2 for sample locations		
53-NE-C1-S	0.57	0.31	0.26
53-NE-Y-S	0.33	0.17	0.16
53-NE-Z-S	0.27	0.14	0.13

(a) Q and QA indicate duplicate samples.

TABLE E-6
RESULTS OF PESTICIDE AND HERBICIDE ANALYSIS OF SLUDGE SAMPLES-NORTHERN SURFACE IMPOUNDMENTS, 1992

Chemical	Sample PF-NE-IT-1S, µg/kg	Sample PF-NW-IT-1S, µg/kg
April 1992 Samples	See Figures E-1 and E-2 for sample locations	
Pesticides		
Aldrin	< 2.3	< 12
alpha-BHC	< 1.7	< 9.4
beta-BHC	< 3.4	< 19
delta-BHC	< 5.1	< 28
Chlordane	< 8.0	< 44
p-p'-DDD	11	< 34
p-p'-DDE	57	17
p-p'-DDT	16	< 37
Dieldrin	9.7	< 6.2
Endosulfan I	< 8.0	< 44
Endosulfan II	154	53
Endosulfan sulfate	< 38	< 200
Endrin	< 3.4	< 19
Endrin aldehyde	< 13	< 72
Heptachlor	6.6	< 9.4
Heptachlor epoxide	< 47	< 260
Lindane	< 2.3	< 12
Methoxychlor	< 100	< 550
Toxaphene	< 140	< 750
Herbicides		
2,4-D	< 41	< 45
2,4,5-T	< 6.9	< 7.5
2,4,5-TP	< 5.9	< 6.4

TABLE E-7
RADIONUCLIDES DETECTED IN SLUDGE AND WATER SAMPLES- NORTHERN SURFACE IMPOUNDMENTS, 1988 AND 1991

Chemical	1988 Sludge Samples (nCi/kgW)	1991 Water Samples (nCi/l) NW Impoundment	1991 Water Samples (nCi/l) NE Impoundment	1991 Sludge Samples (pCi/g) NW Impoundment	1991 Sludge Samples (pCi/g) NE Impoundment
Beryllium-7	400-14,970	0.85	0.67	8.89	42.5
Cadmium-109	1,060	ND[a]	ND	ND	ND
Cobalt-57	238-5,740	0.346	ND	ND	ND
Cobalt-58	43.7-1,610	0.095	0.066	0.955	21
Cobalt-60	61.8-1,060	0.23	0.096	200	46.4
Cesium-134	325-1,380	0.262	0.09	14.8	263
Cesium-137	ND	ND	ND	ND	0.245
European-154	ND	0.99	0.67	ND	ND
Hafnium-175	ND	0.31	0.23	ND	0.601
Iridium-190	ND	ND	ND	0.747	7.01
Lutetium-173	ND	ND	ND	0.383	0.912
Manganese-54	235-3,100	0.116	ND	12.9	31.9
Managanese-56	15-540	82.5	ND	64.8	18.2
Rubidium-83	46.5-240	0.198	0.113	ND	ND
Selenium-75	4.3-57.5	ND	ND	ND	ND
Scandium-46	1.8-5.3	ND	ND	ND	ND
Silver-110	2.9-3.0	ND	ND	ND	ND
Sodium-22	7.9-28.6	ND	ND	0.171	0.103
Tritium	ND	1.7	4.0	ND	ND
Yttrium--88	0.3-12.3	ND	ND	ND	ND
Zinc-65	2.5-154	ND	ND	ND	ND
Zirconium-88	1.1-1.8	ND	ND	ND	ND

(a) ND- Not Detected

TABLE E-8
VOLATILE AND SEMIVOLATILE ORGANIC COMPOUNDS DETECTED IN SLUDGE SAMPLES-SOUTH IMPOUNDMENT, 1991 AND 1992

Volatile Organic Compounds					Semivolatile Organic Compounds	
Sample Location [a] No figures were found for samples from 1988 and 1991	Acetone, mg/kg	4-Isopropyl-toluene, mg/kg	Toluene, mg/kg	1,1,1-Trichloro-ethane mg/kg	Bis-2-ethylhexyl-phthalate, mg/kg	Di-n-butyl-phthalate, mg/kg
July 1991 Samples						
AB-53-SO-2S	ND[b]	0.0087	0.014	ND	ND	ND
AB-53-SO-1S	ND	ND	ND	ND	ND	1.4 B
April 1992 Samples See Figure E-3 for sample locations						
53-SC-G1-S	0.040	ND	ND	ND	ND	ND
53-SC-H1-S	ND	ND	ND	0.0078	ND	ND
53-SC-I1-S	ND	ND	ND	0.016	ND	ND
53-SC-J1-S	ND	ND	ND	0.0053	ND	ND
53-SC-L1-S	ND	ND	ND	0.0065	ND	ND
53-SC-N1-S	0.038	ND	ND	ND	ND	ND
53-SC-U1-S	0.680	ND	ND	ND	ND	ND
53-SC-P1-S	ND	ND	ND	ND	1.3	ND

(a) Q and QA indicate duplicate samples.

(b) ND- Not Detected

TABLE E-9
METALS DETECTED IN SLUDGE SAMPLES-
SOUTH IMPOUNDMENT, 1991 AND 1992

Sample Location [a]	Ag, mg/kg	As, mg/kg	Ba, mg/kg	Cd, mg/kg	Cr, mg/kg	Hg, Tg/kg	Pb, mg/kg	Se, mg/kg
July 1991 Samples (results reported in mg/L)								
AB-53-SO-1S	0.014	ND[b]	0.74	0.02	0.02	ND	0.18	0.03
AB-53-SO-2S	0.010	ND	1.2	0.03	0.03	ND	0.29	0.03
April 1992 Samples (results reported in mg/kg, except mercury, reported in Tg/kg) See Figure E-3 for sample locations								
53-SC-G1-S	ND	1.7	9.0	ND	2.6	0.019	1.0	ND
53-SC-H1-S-Q	ND	ND	6.4	ND	2.1	0.016	1.4	2.4
53-SC-H1-S	ND	ND	6.8	ND	2.3	0.017	ND	1.6
53-SC-I1-S	ND	ND	4.0	ND	2.2	0.013	ND	ND
53-SC-J1-S	ND	ND	4.4	ND	2.0	0.015	1.5	ND
53-SC-K1-S	ND	1.8	9.9	ND	3.4	0.024	2.9	ND
53-SC-L1-S	ND	ND	3.5	ND	2.6	0.018	ND	ND
53-SC-M1-S	ND	ND	4.3	ND	2.0	0.013	ND	ND
53-SC-N1-S	ND	ND	4.1	ND	ND	0.014	ND	4.5
53-SC-O1-S	ND	1.8	4.4	ND	2.4	0.017	ND	2.2
53-SC-P1-S	ND	ND	5.8	ND	2.7	0.019	ND	4.9
53-SC-Q1-S	ND	ND	4.4	ND	2.3	0.016	ND	1.7
53-SC-R1-S	ND	ND	5.7	ND	2.2	0.018	ND	3.3
53-SC-S1-S	ND	1.5	6.5	ND	2.3	0.021	1.5	2.1
53-SC-T1-S	ND	ND	4.5	ND	2.3	0.019	ND	ND
53-SC-U1-S	ND	2.0	4.8	ND	2.4	0.022	ND	1.9
53-SC-CBS-S	ND	ND	4.0	ND	2.6	0.052	1.8	ND
53-SC-GI-S (Duplicate)	ND	1.7	9.3	ND	2.6	ND	1.8	ND
53-SC-P1-S (Duplicate)	ND	ND	5.7	ND	2.3	ND	ND	ND

(a) Q and QA indicate duplicate samples.

(b) ND- Not Detected

TABLE E-10
METALS DETECTED IN WATER SAMPLES-
SOUTH IMPOUNDMENT, 1991 AND 1992

Sample Location [a] No figures were located for samples from 1988 and 1991	Ag, µg/L	As, µg/L	Ba, µg/L	Cd, µg/L	Cr, µg/L	Hg, µg/L	Pb, µg/L	Se, µg/L
July 1991 Samples								
AB-53-SO-1W	ND[b]	ND	40	ND	ND	ND	ND	ND
AB-53-SO-2W	ND	ND	40	ND	ND	ND	ND	ND
AB-53-SO-3W	ND	ND	40	ND	ND	ND	ND	ND
April 1992 Samples See Figure E-3 for sample locations								
53-NW-SC-G1-W	ND	9.6	45.7	ND	1.8	ND	ND	ND
53-NW-SC-G1 W-QA	ND	9.4	40.9	ND	1.2	ND	1.0	ND
53-SC-EBK-W	ND	1.7	1.3	ND	ND	ND	8.2	ND
53-NE-SC-G1-W (Duplicate)	ND	9.2	41.0	ND	1.6	ND	ND	ND

(a) Q and QA indicate duplicate samples.

(b) ND- Not Detected

TABLE E-11
RESULTS OF PESTICIDE AND HERBICIDE ANALYSIS OF SLUDGE AND WATER SAMPLES FOR APRIL 1992 SAMPLING EVENT- SOUTH IMPOUNDMENT

Chemical	Sample PF-RAD-IT-1S µg/kg	Sample PF-RAD- IT-1W µg/L
Pesticides		
Aldrin	< 1.7	< 0.04
alpha-BHC	< 1.3	< 0.03
beta-BHC	< 2.6	< 0.06
delta-BHC	< 3.9	< 0.09
Chlordane	< 6.0	< 0.14
p-p'-DDD	< 4.7	< 0.11
p-p'-DDE	< 1.7	< 0.04
p-p'-DDT	< 5.2	< 0.12
Dieldrin	< 0.86	< 0.02
Endosulfan I	< 6.0	< 0.14
Endosulfan II	< 1.7	< 0.04
Endosulfan sulfate	< 28	< 0.66
Endrin	< 2.6	< 0.06
Endrin aldehyde	< 9.9	< 0.23
Heptachlor	< 1.3	< 0.03
Heptachlor epoxide	< 36	< 0.83
Lindane (gamma-BHC)	< 1.7	< 0.04
Methoxychlor	< 76	< 1.8
Toxaphene	< 100	< 2.4
Herbicides		
2,4-D	< 31	< 1.3
2,4,5-T	< 5.2	< 0.21
2,4,5-TP	< 4.4	< 0.18

TABLE E-12
RADIONUCLIDES DETECTED IN WATER SAMPLES-
SOUTHERN SURFACE IMPOUNDMENTS, 1992

Chemical	Water Samples (nCi/l)	Sludge Samples (pCi/g)
Beryllium-7	0.118	320
Cobalt-57	ND[a]	180
Cobalt-58	0.068	59.7
Cobalt-60	0.073	103
Cesium-134	ND	29
Cesium-137	0.063	3.44
European-154	0.70	1.08
Hafnium-175	0.23	27.6
Iridium-190	ND	81.5
Lutetium-173	0.4	127
Manganese-54	0.086	359
Manganese-56	ND	461 500
Sodium-22	ND	7
Tritium	8000	ND

(a) ND- Not Detected

TABLE 13
BOREHOLE 53-1 RESULTS

Lithologic Unit of the Bandelier Tuff	Depth (feet)	Tritium Concentrations nCi/L	Gravimetric Moisture Content (%)
fill	0	4.2	2.9
Tshirege 2b	5	8.5	8.8
Tshirege 2b	10	2.1	2.2
Tshirege 2b	15	2.1	2.6
Tshirege 2b	20	1.5	2.6
Tshirege 2b	25	0.5	2.7
Tshirege 2b	30	0.5	2.8
Tshirege 2b	35	2.6	2.5
Tshirege 2b	40	2.4	2.4
Tshirege 2b	45	0.2	2.7
Tshirege 2b	50	3.4	2.8

TABLE 14
BOREHOLE 53-2 RESULTS

Lithologic Unit of the Bandelier Tuff	Depth (feet)	Tritium Concentrations nCi/L	Gravimetric Moisture Content (%)
fill	0	2.4	3.2
Tshirege 2b	5	2.4	3.8
Tshirege 2b	10	1.9	12.6
Tshirege 2b	15	3.2	7.4
Tshirege 2b	20	3.7	7.7
Tshirege 2b	25	3.2	6.8
Tshirege 2b	30	6.1	6.3
Tshirege 2b	35	5.6	5.9
Tshirege 2b	40	6.1	-
Tshirege 2b	45	5.8	6.1
Tshirege 2b	50	6.9	6.3

TABLE 15
BOREHOLE 53-3 RESULTS

Lithologic Unit of the Bandelier Tuff	Depth (feet)	Tritium Concentrations nCi/L	Gravimetric Moisture Content (%)
fill	0	19.6	3.5
Tshirege 2b	5	9.0	20.8
Tshirege 2b	10	6.1	8.7
Tshirege 2b	15	1.6	16.4
Tshirege 2b	20	1.3	8.4
Tshirege 2b	25	1.5	6.9
Tshirege 2b	30	1.3	9.7
Tshirege 2b	35	0.7	2.7
Tshirege 2b	40	0.7	3.2
Tshirege 2b	45	1.6	6.4
Tshirege 2b	50	0.1	3.8

TABLE 16
BOREHOLE 53-4 RESULTS

Lithologic Unit of the Bandelier Tuff	Depth (feet)	Tritium Concentrations nCi/L	Gravimetric Moisture Content (%)
fill	0	16.4	3.7
Tshirege 2b	5	9.8	11.0
Tshirege 2b	10	2.9	6.2
Tshirege 2b	15	1.2	9.1
Tshirege 2b	20	1.3	8.0
Tshirege 2b	25	0.4	7.8
Tshirege 2b	30	0.2	3.1
Tshirege 2b	35	0.5	5.5
Tshirege 2b	40	0.3	4.5
Tshirege 2b	45	0.2	1.9
Tshirege 2b	50	0.3	8.0

TABLE 17
BOREHOLE 53-5 RESULTS

Lithologic Unit of the Bandelier Tuff	Depth (feet)	Tritium Concentrations nCi/L	Gravimetric Moisture Content (%)
fill	0	16.3	0.3
Tshirege 2b	5	32.1	9
Tshirege 2b	10	48.7	4.3
Tshirege 2b	15	66.5	2.5
Tshirege 2b	20	54.6	6.9
Tshirege 2b	25	38.6	7.4
Tshirege 2b	30	34.2	7.3
Tshirege 2b	35	48.5	6.5
Tshirege 2b	40	66.9	1
Tshirege 2b	45	65.9	5.6
Tshirege 2b	50	69.3	6.4
Tshirege 2b	60	26.5	7.3
Tshirege 2a	70	62.4	6.4
Tshirege 2a	80	100.4	3.4
Tshirege 2a	90	88.4	2
Tshirege 2a	100	60.3	6.5

TABLE 18
BOREHOLE 53-6 RESULTS

Lithologic Unit of the Bandelier Tuff	Depth (feet)	Tritium Concentrations nCi/L	Gravimetric Moisture Content (%)	Initial Gravimetric Moisture Content (%)	Volumetric Moisture Content (%)	Density (g/cm3)	Porosity (%)	Saturated Hydraulic Conductivity (cm/sec)
Tshirege Unit								
fill	0	-	-	-	-	-	-	-
2b	5	15	8.5	-	-	-	-	-
2b	10	40	7	-	-	-	-	-
2b	15	35	5	-	-	-	-	-
2b	20	22	6.5	-	-	-	-	-
2b	25	18	6	-	-	-	-	-
2b	30	8	5.5	-	-	-	-	-
2b	35	-	-	-	-	-	-	-
2b	40	4	6	17.3	23.4	1.35	48.96	3.70E-04
2b	50	0.8	6.5	-	-	-	-	-
2b	60			32.1	44.0	1.37	48.25	3.50E-03
2a	70	0.5	15	-	-	-	-	-
2a	80	0.4	5.5	-	-	-	-	-
2a	90	0.3	20	-	-	-	-	-
2a	100	0	7.5	8.2	10.4	1.27	52.01	8.80E-04
2a	110	0.2	8	14.8	21.7	1.47	44.70	7.40E-05
1a	140	0	13	-	-	-	-	-
1a	150	0.2	14.5	17.3	22.8	1.32	50.22	6.10E-05

TABLE 19
BOREHOLE 53-7 RESULTS

Lithologic Unit of the Bandelier Tuff	Depth (feet)	Tritium Concentrations nCi/L	Gravimetric Moisture Content (%)	Initial Gravimetric Moisture Content (%)	Initial Volumetric Moisture Content (%)	Density (g/cm3)	Porosity (%)	Saturated Hydraulic Conductivity (cm/sec)
soil	0	1	3	-	-	-	-	-
1a	5	2	2.5	-	-	-	-	-
1a	10	0.7	4	-	-	-	-	-
1a	15	0.8	3.5	-	-	-	-	-
1a	20	1	19	-	-	-	-	-
Tsankawi	25	0.8	9	-	-	-	-	-
Tsankawi	30	0.7	20	-	-	-	-	-
Tsankawi	35	0.9	17.5	-	-	-	-	-
Tsankawi	40	0.9	9	-	-	-	-	-
Otowi	50	0.9	13	-	-	-	-	-
Otowi	60	0.7	16	-	-	-	-	-
Otowi	70	0.9	15.5	14.1	17.50	1.24	53.04	1.70E-04
Otowi	80	0.6	16.5	18.0	19.90	1.10	58.44	2.20E-04

TABLE 20
BOREHOLE "B" RESULTS

Lithologic Unit of the Bandelier Tuff	Depth (feet)	Tritium Concentrations nCi/L	Gravimetric Moisture Content (%)
fill	0	<0.1	12.7
Tshirege 2b	5	0.1	9.8
Tshirege 2b	10	<0.1	1.9
Tshirege 2b	15	1.0	0.9
Tshirege 2b	20	0.7	1.7
Tshirege 2b	25	0.4	2.6
Tshirege 2b	30	0.4	2.0
Tshirege 2b	35	0.1	1.7
Tshirege 2b	40	0.3	1.7
Tshirege 2b	45	0.5	2.2
Tshirege 2b	50	0.5	2.7

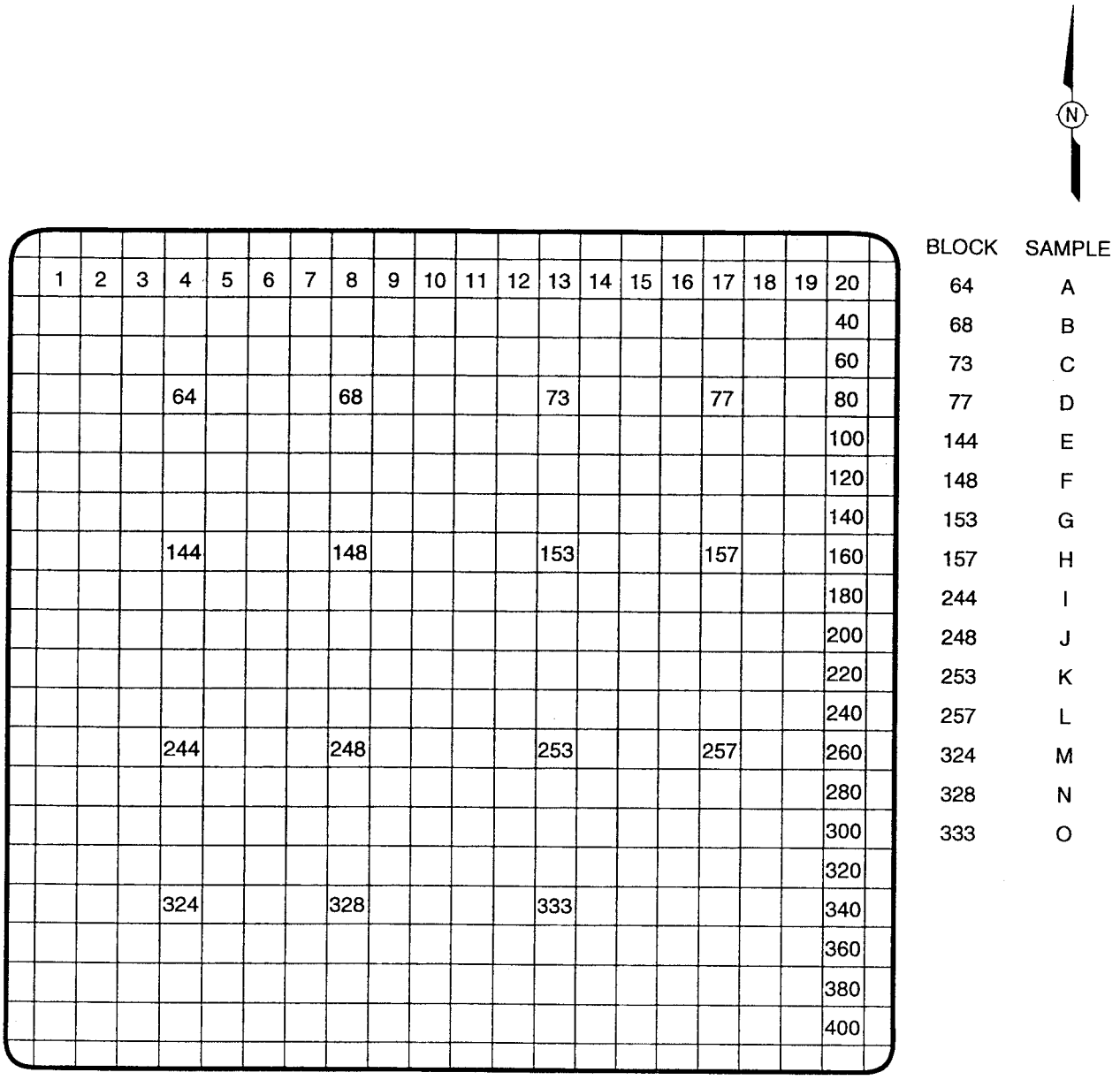
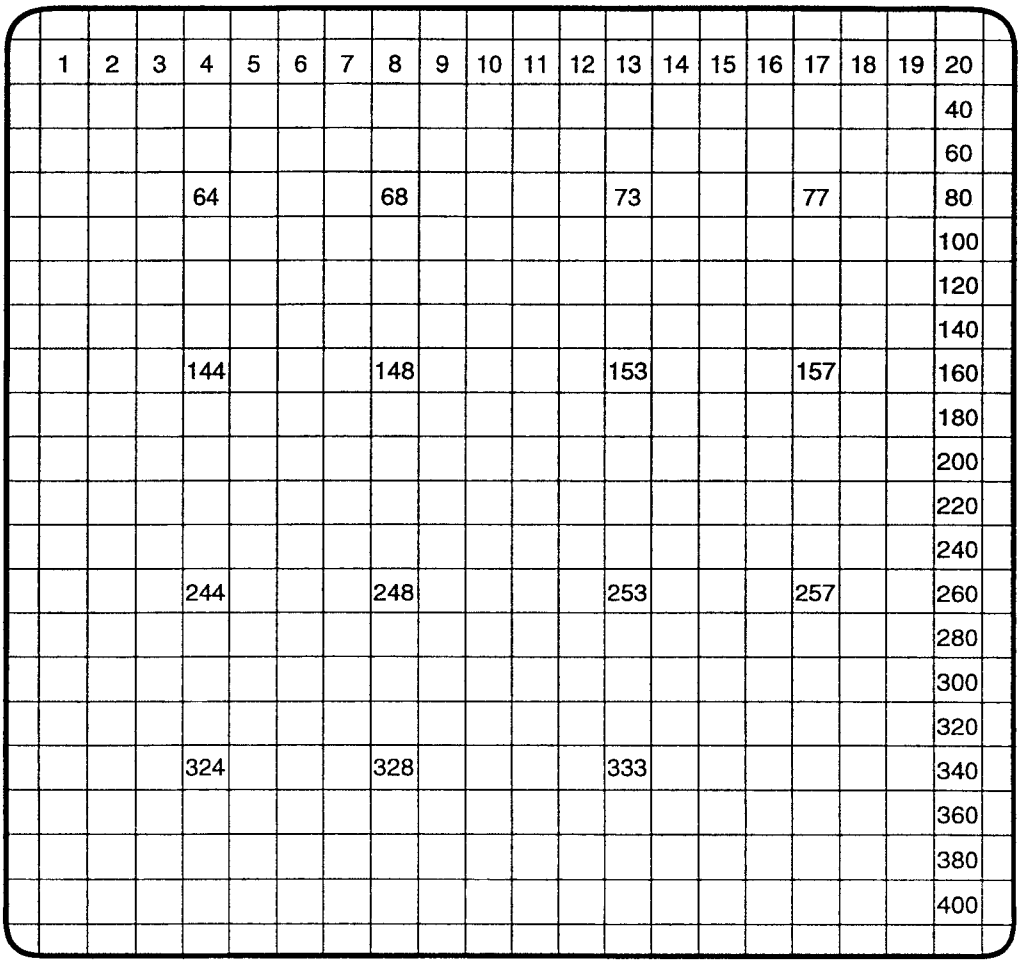


Figure E-1 Locations of sludge samples in the northwestern impoundment, April 1992



BLOCK	SAMPLE
64	Q
68	R
73	S
77	T
144	R
148	V
153	W
157	X
244	Y
248	Z
253	A1
257	B1
324	C1
328	D1
333	E1

Figure E-2 Locations of sludge samples in northeastern impoundment, April 1992

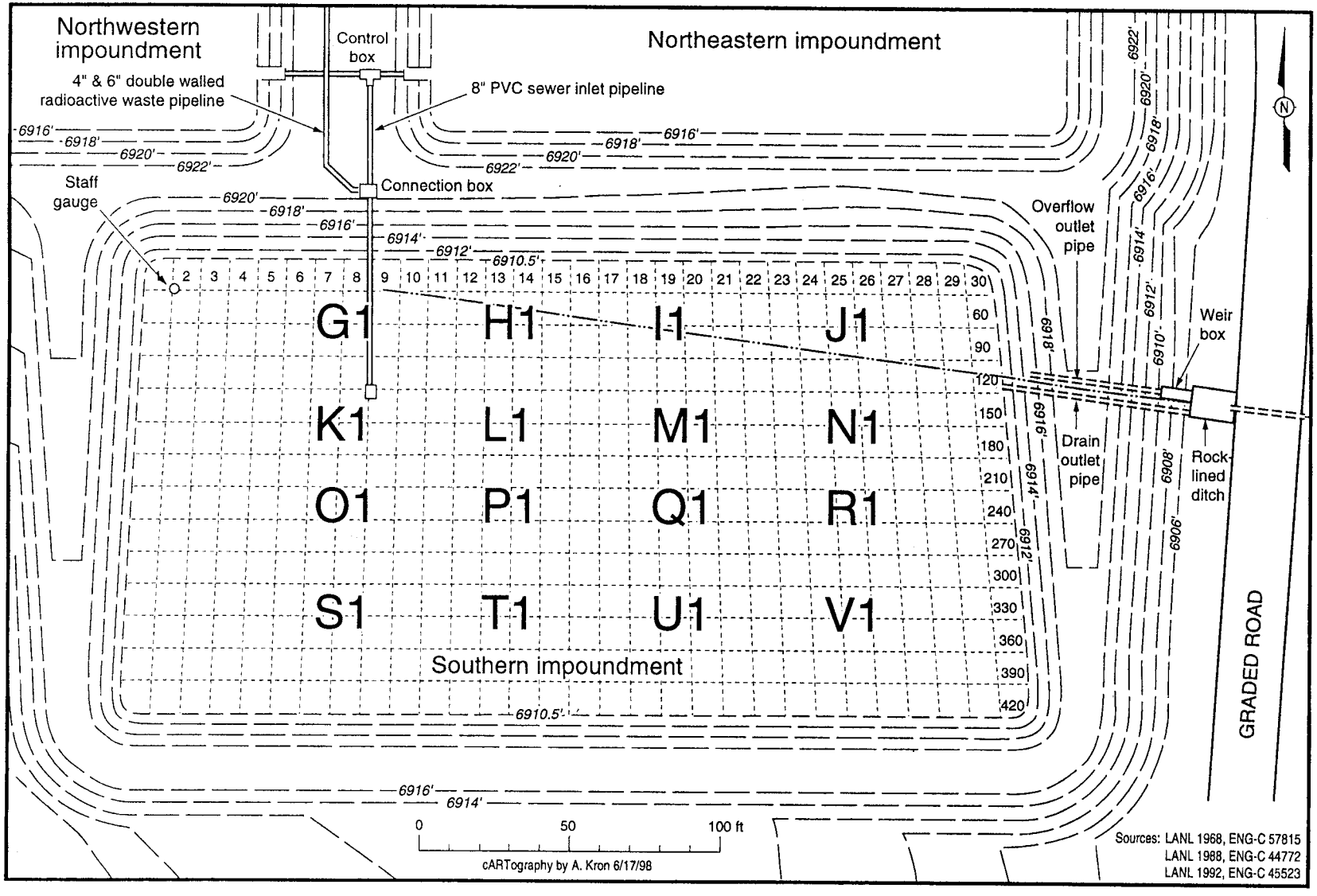


Figure E-3 Locations of sludge samples in southern impoundment, April 1992

DATA ASSESSMENT SUMMARY OF 1994/1995 DATA FOR THE NORTHERN SURFACE IMPOUNDMENTS AT PRS 53-002(a)

Samples of the sludge, bentonite (clay) liner, the tuff below the clay liner, and the tuff below the gunite liner around the periphery were collected from the northern surface impoundments at PRS 53-002(a). See Figure F-1 for sample locations from the 1994/1995 sampling campaign. These samples were analyzed for TAL metals plus mercury and cyanide, radionuclides by gamma and alpha spectroscopy, strontium-90, tritium, SVOCs, VOCs, pesticides, herbicides, and PCBs. Analyses for total cyanide and reactive sulfides in the sludge were also conducted for waste characterization purposes and were not requested for the clay liner and tuff. All laboratory analyses and validation were conducted by an off-site analytical laboratory, General Engineering Laboratories (GEL). Analytical methods used included:

- TAL metals (EPA Method 6010A),
- Mercury (EPA Method 7471),
- Total Cyanide (EPA Method SW846, Chapter 7),
- Reactive Sulfides (EPA Method SW846, Chapter 7),
- Semivolatile Organics (EPA Method 8270),
- Volatile Organics (EPA Method 8260),
- Pesticides/PCBs (EPA Method 8080),
- Herbicides (EPA Method 8152),
- Isotopic uranium and plutonium (Alpha Spectroscopy), and
- Strontium-90, Tritium, and Gamma Spectroscopy (HASL-300).

Quality Assurance/ Quality Control

In addition to the field samples, QA/QC samples were analyzed by the analytical laboratory to assist in determining the quality and usability of the inorganic, organic, and radionuclide data. The QA/QC samples included laboratory duplicates, surrogates, matrix spikes/matrix spike duplicates, laboratory and rinsate blanks, and blank spikes/blank spike duplicates. Data from these samples were compared to numerical criteria established by the analytical laboratory and/or EPA guidelines (EPA 1994, 1205; EPA 1994, 1206). The data that did not meet the criteria were qualified to indicate potential low or high bias associated with the sample analysis. This baseline validation process was based on EPA's *Contract Laboratory Program National Functional Guidelines For Inorganic Data Review* (EPA 1994, 1206) and *Contract Laboratory Program National Functional Guidelines For Organic Data Review* (EPA 1994, 1205).

In general, the QA/QC samples indicated no QC issues associated with the inorganic data that affected data usability. The results of the laboratory duplicates, matrix spikes/matrix spikes duplicates, blind QC samples, laboratory and rinsate blanks, and blank spikes/blank spike duplicates analyses were within control limits with the following exceptions:

- Low concentrations of several inorganics including chromium, nickel, lead, and mercury, were detected in some laboratory blanks.
- Silver recoveries in two blank spike samples were outside of the limits.
- Matrix spikes/matrix spike duplicate recoveries for several inorganics, aluminum, iron, manganese, and magnesium, were outside of the limits for several samples.
- Laboratory duplicate results for mercury were outside of the limits.
- The sample results for several inorganics were detected below the estimated detection limits (EDLs) in some samples.

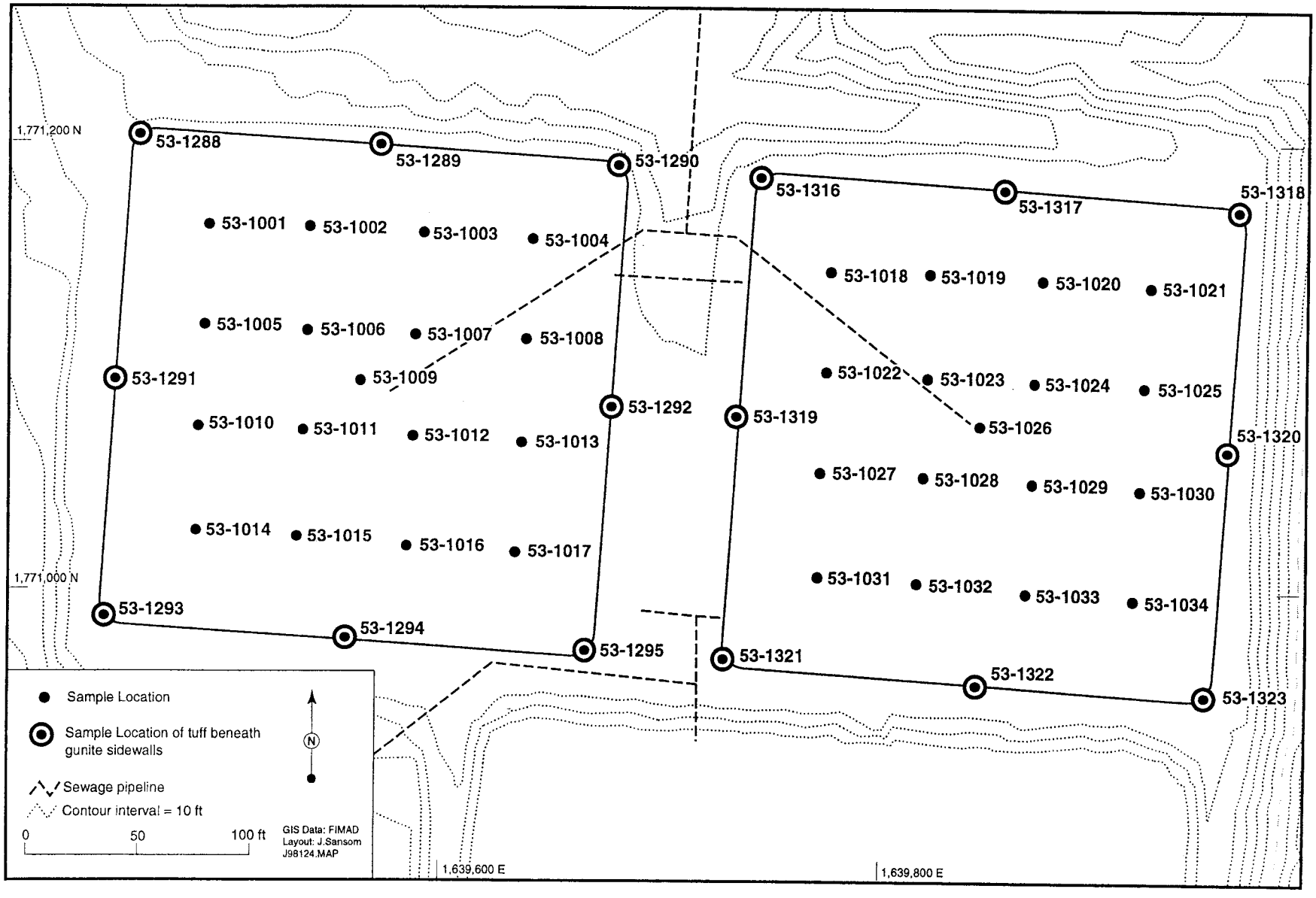


Figure F-1 1994/1995 sample locations at PRS 53-002(a), northern impoundments

The sample data affected by these QC issues were qualified as J (estimated) or UJ (estimated undetected); none of the inorganic data were qualified as R (unusable). These data are usable because the recoveries were sufficient to detect and quantify the affected analytes. The inorganic data are, therefore, of good quality and sufficient for decision-making purposes.

Organics

The QA/QC samples indicate no QC issues associated with most of the organic data that affected data usability. The exception to this was the PCB analysis. Several of the surrogates and matrix spike recoveries associated with this analysis were reported as zero because of matrix interference with the sludge and liner media. The results of the surrogate and matrix spike analyses were qualified as R (unusable) and the corresponding field data are questionable. The data are presented in this report because some aroclors were detected and are assumed to be present. However, re-sampling of the sludge will be performed using ultra-clean preparation methods in an attempt to avoid the matrix problems encountered in the analyses and provide a better estimate of the concentrations of these analytes. The matrix interference problems also resulted in the detection limits for the sludge analyses to be elevated for SVOCs, pesticides, and PCBs.

The results of the other QC samples for the sludge, clay liner, and tuff were within control limits with the following exceptions.

- Matrix spike recoveries for VOCs and SVOCs of several sludge and liner samples were outside of the limits.
- Surrogate recoveries for VOCs and SVOCs of several sludge and liner samples were outside of the limits.
- The sample results for several organics were detected below the estimated quantitation limits (EQLs) in some samples.
- Low concentrations of methylene chloride and dibromomethane were detected in some laboratory blanks.

The sample data affected by these QC issues were qualified as J (estimated) or UJ (estimated undetected). These data are usable because the recoveries were sufficient to detect and quantify the affected analytes. The organic data with the possible exception of the PCB data are of good quality and sufficient for decision making purposes.

Radionuclides

A review of the QA/QC samples indicate no QC issues associated with the radionuclide data that affected data usability. The results of the laboratory duplicates, matrix spikes/matrix spike duplicates, blind QC samples, laboratory and rinsate blanks, and blank spikes/blank spike duplicates analyses were within criteria with the following exceptions.

- The blind QC sample recoveries for several radionuclides, plutonium-238, plutonium-239, and tritium, in the sludge samples were outside of control limits.
- Low concentrations of several radionuclides were detected in some laboratory blanks.

The radionuclide data associated with the blind QC recoveries were assigned J qualifiers because the data were potentially biased low; none of the radionuclide data were qualified as R (unusable). These data are usable because the recoveries were sufficient to detect and quantify the affected analytes. The radionuclide data are, therefore, of good quality and sufficient for decision-making purposes.

The sample activity values for each radionuclide were compared to the uncertainty values associated with each analysis. Those sample values that were less than three times the standard deviation were validated as being below the minimum detectable activity (MDA) and were considered to be undetected. Radionuclides belonging to a naturally occurring radioactive series and with activity levels within the range normally expected were eliminated from further evaluation. In addition, radionuclides with short half-lives, artifacts of the gamma spectroscopy analysis, isotopes used as quality control analytes, and those not likely to be detected as a result of past activities were eliminated from further evaluation. Based on this evaluation, the radionuclides carried forward to the data comparison included americium-241, cesium-134, cesium-137, cobalt-57, cobalt-60, manganese-54, neptunium-237, plutonium-238, plutonium-239, strontium-90, sodium-22, tritium, uranium-234, uranium-235, and uranium-238.

DATA COMPARISONS FOR THE NORTHERN SURFACE IMPOUNDMENTS

The samples were collected from 17 locations within the each surface impoundment and included 17 samples and one field duplicate sample for each of three media; the sludge, the clay liner, and the tuff below the liner. In addition, the gunite liner along the periphery of the surface impoundments was penetrated and the tuff below the gunite liner was sampled at a depth of 1.5-2.0 ft at eight locations plus a field duplicate from the northeastern surface impoundment. As a result, a total of 18 samples of the sludge and clay liner were collected from both surface impoundments, while 27 and 26 samples of the tuff below the clay and gunite liners were collected from the northeastern and northwestern surface impoundments, respectively. The inorganic analytical results from each medium were compared to the approved Laboratory BVs (i.e., sludge and clay liner data were compared to the soil BVs and the tuff data were compared to the appropriate laboratory tuff BVs [Qbt 2,3,4]). The data from the tuff were combined and analyzed as one data set. Although BVs for sludge and clay liner do not exist and the physical properties of the sludge and the liner material are not the same as soil, the comparison of the sludge and clay liner analytical results to the soil BVs was made for two reasons. First, the comparison of the sludge and clay liner sample data to the BVs will provide an indication of whether the detected inorganic concentrations are elevated, i.e., indicative of a release to the environment. Second, inorganics detected below the BVs need not be evaluated further, because they would not pose a risk greater than background. Because the sludge and clay liner do not have the same chemical composition as the background soils, the BVs may be markedly different from the detected concentrations of some inorganics in the sludge and clay liner (Tables F1 through F3 and F9 through F11). Figures F-2 and F-3 depict the contaminants greater than SAL or 0.1 SAL at their respective locations. These figures are located at the end of this Appendix.

Data evaluation and human health screening assessments are presented separately below for the northeastern and northwestern surface impoundments.

Northeastern Surface Impoundment

Inorganics

Twenty-three inorganic chemicals were detected in the sludge, clay liner, and tuff from the northeastern surface impoundment (Table F-1). Ten inorganics, aluminum, arsenic, beryllium, chromium, cobalt, iron, manganese, nickel, potassium, and vanadium, were not detected above BVs in any of the three media; sludge, clay liner, or tuff. These ten inorganics will not be evaluated further.

Thirteen inorganics, antimony, barium, cadmium, calcium, copper, lead, magnesium, mercury, selenium, silver, sodium, thallium, and zinc, were detected at concentrations greater than BVs in at least one medium and were evaluated further. The data for antimony, cadmium, copper, lead, mercury, selenium, silver, sodium, thallium, and zinc indicates that the inorganics were elevated in the sludge and/or clay liner. Four of the thirteen inorganics, antimony, selenium, sodium, and silver, were detected above the BVs in the sludge, but not in the clay liner or tuff. Three of the thirteen inorganics, cadmium, thallium, and zinc, were detected at concentrations greater than the BVs in the sludge and clay liner, but not in the tuff.

The maximum detected concentrations of cadmium and zinc decreased from the sludge to the clay liner and subsequently to the tuff (<BVs), while the maximum detected concentrations of thallium increased from the sludge to the clay liner but tuff concentrations were lower than both overlying media. This may be related to the chemical composition of the clay liner rather than the result of migration from the sludge to the clay liner. The maximum detected concentrations of cadmium in the sludge and clay liner and thallium in the sludge were slightly above the respective BVs and within the range of detected values used to calculate the BVs. In all cases, the maximum detected concentrations for these three inorganics were below the BVs for the tuff.

Six of the thirteen inorganics, barium, calcium, copper, lead, magnesium, and mercury, were detected above the BVs in the tuff and, except for barium, in at least one other medium (Table F-1). Barium was not detected above the BV in the sludge and clay liner, but was detected in five of 18 samples above the tuff BV. The highest concentration of barium in each of the three media was relatively constant at 112 mg/kg for sludge, 94 mg/kg for clay liner, and 111 mg/kg for tuff, respectively. Calcium was detected above the BV in the sludge and tuff in 13 of 18 samples, respectively, but was not detected above the BV in the clay liner. The highest concentrations of calcium showed no trend in the media with 19,900 mg/kg in the sludge, 4,600 in the clay liner, and 29,600 in the tuff. Copper, lead, magnesium and mercury were each detected above the respective tuff BV in one or two tuff samples. Copper was detected above the BVs in all three media and demonstrated a decreasing trend in the maximum detected concentrations with 1070 mg/kg in the sludge, 44.8 mg/kg in the clay liner, and 5.4 mg/kg in the tuff. The maximum detected concentration of copper in the tuff was slightly above the BV and within the range of detected values used to calculate the BV. Lead, magnesium, and mercury were detected above the BVs in the sludge in two, three, and 18 samples, respectively, but not above the BVs in the clay liner. These three inorganics demonstrated a decrease in the maximum detected concentrations from the sludge to the clay liner and tuff, but not from the clay liner to tuff (Table F-1).

Based on the above comparison, the sludge in the northeastern surface impoundment is characterized by elevated concentrations of cadmium, calcium, copper, mercury, selenium, silver, sodium, and zinc in thirteen to eighteen samples. Antimony, lead, magnesium, and thallium were also elevated in the sludge in one to three samples. Of these inorganics, five plus barium were also detected above the BVs for tuff and four inorganics were detected above the BVs in the clay liner. Based on this comparison, thirteen inorganics, antimony, barium, cadmium, calcium, copper, lead, magnesium, mercury, selenium, silver, sodium, thallium, and zinc, were identified as COPCs and were carried forward to the screening assessment.

TABLE F-1
SUMMARY OF DETECTED INORGANIC CHEMICALS IN THE NORTHEASTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Samples Analyzed	Number of Detects	Range of Detected Values (mg/kg)	Background Value (mg/kg)	Frequency of Detects Above Background
Aluminum	Sludge	18	18	1370-7220	29200	0/18
	Clay Liner	18	18	3080-9000	29200	0/18
	Tuff	27	27	262-4440	7340	0/27
Antimony	Sludge	18	13	0.1-3.0	0.83	1/18
	Clay Liner	18	10	0.1-0.3	0.83	0/18
	Tuff	27	5	0.12-0.24	0.5	0/18
Arsenic	Sludge	18	18	1.0-5.7	8.17	0/18
	Clay Liner	18	18	1.0-3.7	8.17	0/18
	Tuff	27	27	0.23-1.8	2.79	0/27
Barium	Sludge	18	18	27.8-112	295	0/18
	Clay Liner	18	18	40.5-94	295	0/18
	Tuff	27	27	3.3-111	46	5/27
Beryllium	Sludge	18	18	0.1-0.7	1.83	0/18
	Clay Liner	18	18	0.5-0.9	1.83	0/18
	Tuff	27	27	0.2-0.6	1.21	0/27
Cadmium	Sludge	18	18	0.2-1.7	0.4	14/18
	Clay Liner	18	18	0.04-0.5	0.4	1/18
	Tuff	27	17	0.01-0.14	1.63	0/27
Calcium	Sludge	18	18	2970-19900	6120	13/18
	Clay Liner	18	18	1400-4600	6120	0/18
	Tuff	27	27	240-29600	2200	14/27
Chromium	Sludge	18	18	7.6-16.1	19.3	0/18
	Clay Liner	18	18	2.6-10	19.3	0/18
	Tuff	27	27	0.4-4.1	7.14	0/27
Cobalt	Sludge	18	18	1.6-3.9	8.64	0/18
	Clay Liner	18	18	1.0-2.7	8.64	0/18
	Tuff	27	27	0.03-2.5	3.14	0/27
Copper	Sludge	18	18	39-1070	14.7	18/18
	Clay Liner	18	18	3.8-44.8	14.7	7/18
	Tuff	27	27	0.1-5.4	4.66	2/27
Iron	Sludge	18	18	3380-10300	21500	0/18
	Clay Liner	18	18	3280-7890	21500	0/18
	Tuff	27	27	463-5280	14500	0/27

TABLE F-1 CONTINUED
SUMMARY OF DETECTED INORGANIC CHEMICALS IN THE NORTHEASTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Samples Analyzed	Number of Detects	Range of Detected Values (mg/kg)	Background Value (mg/kg)	Frequency of Detects Above Background
Lead	Sludge	18	18	8.7-135	22.3	2/18
	Clay Liner	18	18	7.8-19.4	22.3	0/18
	Tuff	27	27	1.6-27.5	11.2	1/27
Magnesium	Sludge	18	18	484-6160	4610	3/18
	Clay Liner	18	18	875-1760	4610	0/18
	Tuff	27	27	77.4-3110	1690	1/27
Manganese	Sludge	18	18	49.2-369	671	0/18
	Clay Liner	18	18	63.4-168	671	0/18
	Tuff	27	27	63.4-271	482	0/27
Mercury	Sludge	18	18	0.2-2.0	0.1	18/18
	Clay Liner	18	18	0.003-0.04	0.1	0/18
	Tuff	27	18	0.003-0.3	0.1	1/27
Nickel	Sludge	18	18	3.1-8.1	15.4	0/18
	Clay Liner	18	18	2.4-5.6	15.4	0/18
	Tuff	27	27	0.8-4.4	6.58	0/27
Potassium	Sludge	18	18	473-2810	3460	0/18
	Clay Liner	18	18	854-1880	3460	0/18
	Tuff	27	27	128-1000	3500	0/27
Selenium	Sludge	18	17	0.4-2.2	1.52	7/18
	Clay Liner	18	7	0.15-0.4	1.52	0/18
	Tuff	27	5	0.17-0.23	0.3	0/27
Silver	Sludge	18	18	0.7-6.3	1	14/18
	Clay Liner	18	0	Not Detected	1	0/18
	Tuff	27	0	Not Detected	1	0/27
Sodium	Sludge	18	18	266-3530	915	14/18
	Clay Liner	18	18	119-387	915	0/18
	Tuff	27	27	62.2-230	2770	0/27
Thallium	Sludge	18	8	0.3-0.9	0.73	1/18
	Clay Liner	18	10	0.2-2.1	0.73	6/18
	Tuff	27	6	0.29-0.56	1.10	0/27
Vanadium	Sludge	18	18	4.8-19.1	39.6	0/18
	Clay Liner	18	18	6.1-12.6	39.6	0/18
	Tuff	27	27	0.9-10.2	17	0/27
Zinc	Sludge	18	18	69.4-325	48.8	18/18
	Clay Liner	18	18	14.1-78.8	48.8	6/18
	Tuff	27	27	6.5-23	63.5	0/27

TABLE F-2 CONTINUED
SUMMARY OF DETECTED ORGANIC CHEMICALS IN THE NORTHEASTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Samples Analyzed	Number of Detects	EQL (mg/kg)	Range of Detected Concentrations (mg/kg)
DDT(4,4'-)	Sludge	18	1	0.33	0.4
	Clay Liner	18	2	0.03	0.02-0.07
	Tuff	27	1	0.003	0.002
Dieldrin	Sludge	18	0	0.16	Not Detected
	Clay Liner	18	1	0.016	0.03
	Tuff	27	0	0.0016	Not Detected
Endosulfan I	Sludge	18	4	0.16	0.1-0.2
	Clay Liner	18	0	0.016	Not Detected
	Tuff	27	1	0.0016	0.005
Endrin	Sludge	18	0	0.16	Not Detected
	Clay Liner	18	7	0.016	0.006-0.05
	Tuff	27	0	0.0016	Not Detected
Heptachlor	Sludge	18	0	0.16	Not Detected
	Clay Liner	18	0	0.016	Not Detected
	Tuff	27	5	0.0016	0.0009-0.0013
Methylene Chloride	Sludge	18	15	0.005	0.025-0.063
	Clay Liner	18	0	0.005	Not Detected
	Tuff	27	0	0.005	Not Detected
Toluene	Sludge	18	2	0.005	0.0126-0.0133
	Clay Liner	18	0	0.002	Not Detected
	Tuff	27	0	0.002	Not Detected
Trichlorofluoro-methane	Sludge	18	0	0.005	Not Detected
	Clay Liner	18	0	0.002	Not Detected
	Tuff	27	1	0.002	0.002

TABLE F-2
SUMMARY OF DETECTED ORGANIC CHEMICALS IN THE NORTHEASTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Samples Analyzed	Number of Detects	EQL (mg/kg)	Range of Detected Concentrations (mg/kg)
Acetone	Sludge	18	16	0.02	0.09-0.8
	Clay Liner	18	3	0.02	0.005-0.03
	Tuff	27	16	0.02	0.002-0.1
Aroclor-1254	Sludge	18	16	0.4	0.3-3.9
	Clay Liner	18	1	0.04	0.07
	Tuff	27	0	0.004	Not Detected
Aroclor-1260	Sludge	18	0	.04	Not Detected
	Clay Liner	18	6	0.04	0.07-0.3
	Tuff	27	0	0.004	Not Detected
BHC(alpha-)	Sludge	18	3	0.08	0.053-0.062
	Clay Liner	18	0	0.008	Not Detected
	Tuff	27	1	0.0008	0.0008
BHC(gamma-)	Sludge	18	0	0.08	Not Detected
	Clay Liner	18	1	0.008	0.0006
	Tuff	27	5	0.0008	0.0007-0.001
Butanone(2-)	Sludge	18	15	0.02	0.02-0.2
	Clay Liner	18	0	0.005	Not Detected
	Tuff	27	0	0.005	Not Detected
DDD(4,4'-)	Sludge	18	0	0.33	Not Detected
	Clay Liner	18	1	0.03	0.05
	Tuff	27	1	0.003	0.003
DDE(4,4'-)	Sludge	18	1	0.16	0.1
	Clay Liner	18	0	0.016	Not Detected
	Tuff	27	0	0.0016	Not Detected

TABLE F-3
SUMMARY OF RADIONUCLIDES DETECTED IN THE NORTHEASTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Samples Analyzed	Number of Detects	Range of Detected Concentrations (pCi/g)	Background/ Fallout Value (pCi/g)	Frequency of Detects Above Background
Americium-241	Sludge	18	0	Not Detected	0.013	0/18
	Clay Liner	18	0	Not Detected	Not Applicable[a]	0/18
	Tuff	27	0	Not Detected	0.05	0/27
Cesium-134[b]	Clay Liner	18	18	3.1 - 22.6	No Background	18/18
	Tuff	27	7	0.16 - 2.3	No Background	7/27
Cesium-137	Sludge	18	0	Not Detected	1.65	0/18
	Clay Liner	18	0	Not Detected	Not Applicable	0/18
	Tuff	27	0	Not Detected	0.1	0/27
Cobalt-57	Clay Liner	18	0	Not Detected	No Background	0/18
	Tuff	27	0	Not Detected	No Background	0/27
Cobalt-60	Sludge	18	18	46 - 1070	No Background	18/18
	Clay Liner	18	17	0.45 - 6.2	No Background	17/18
	Tuff	27	13	0.2 - 3.5	No Background	13/27
Manganese-54	Clay Liner	18	9	0.25 - 1.3	No Background	9/18
	Tuff	27	0	Not Detected	No Background	0/27
Neptunium-237	Sludge	18	0	Not Detected	No Background	0/18
	Clay Liner	18	0	Not Detected	No Background	0/18
	Tuff	27	1	0.98	No Background	0/27
Plutonium-238	Sludge	18	10	0.01 - 0.02	0.023	0/18
	Clay Liner	18	0	Not Detected	Not Applicable	0/18
	Tuff	27	0	Not Detected	0.05	0/27
Plutonium-239	Sludge	18	6	0.02- 0.08	0.054	1/18
	Clay Liner	18	0	Not Detected	Not Applicable	0/18
	Tuff	27	1	0.2	0.05	1/27
Sodium-22	Sludge	18	5	0.5 - 2.4	No Background	5/18
	Clay Liner	18	0	Not Detected	No Background	0/18
	Tuff	27	7	0.3 - 1.7	No Background	7/27

[a] Fallout value applies to samples collected from 0-6 inches only., and the data assessed).

Organics

Sixteen organic chemical, acetone, aroclor-1254, 2-butanone, BHC (alpha-) BHC (gamma-), DDD(4,4'-), DDE(4,4'-), dieldrin, endosulfan I, endrin, heptachlor, methylene chloride, toluene, and trichlorofluoromethane, were detected in one or more media from the northeastern surface impoundment (Table F-2). The remaining organics were not detected in any medium and were not evaluated further. Four organics, 2-butanone, DDE(4,4'-), methylene chloride, and toluene, were detected in one to fifteen samples of the sludge, but not in the clay liner or tuff. Aroclor-1254 was detected in sixteen samples of the sludge and one sample of the clay liner, and three organics, aroclor-1260, dieldrin, and endrin were detected in one to seven samples of the clay line, but not in the sludge or tuff. The maximum detected concentrations decreased from the sludge to the clay liner and from the clay liner to the tuff.

Eight organics, acetone, BHC(alpha-), BHC(gamma-), DDD(4,4'-), endosulfan I, heptachlor, and trichlorofluoromethane, were detected in at least one tuff sample. Acetone and DDT(4.4'-) were detected in all three media, while BHC(gamma-) and DDD(4,4') were detected in one to five samples of the clay liner and one to five samples of tuff, but not in the sludge. BHC(alpha-) and endosulfan I were detected in three and four sludge samples, respectively, as well as one sample of tuff, but not in the clay liner. Trichlorofluoromethane was only detected in one tuff sample at the detection limit and heptachlor was detected in only five samples of tuff, but not in the clay liner and sludge. The maximum detected concentrations for BHC (gamma-) and DDD(4,4'-) decreased from the clay liner to the tuff, and the maximum concentrations for DDT(4,4'-), BHC(alpha-), and endosulfan I decreased from the sludge to the tuff. The maximum concentrations for acetone decreased from the sludge to the clay liner, but were increased slightly between the clay liner and the tuff. The maximum detected concentrations for heptachlor increased from the clay liner and to the tuff.

Acetone, methylene chloride, and 2-butanone are considered common laboratory contaminants (EPA 1994, 1205), while toluene has also been found to be a laboratory contaminant. Although they were not detected in any or some of the laboratory blanks associated with the surface impoundment samples, it is unlikely that these volatile compounds would still be present in the top few inches of sludge after several years of exposure to the elements. However, all sixteen organics (acetone, aroclor-1254, aroclor-1260, 2-butanone, BHC (alpha-), BHC (gamma-), DDD(4,4'-), DDE(4,4'-), DDT(4,4'-), dieldrin, endosulfan I, endrin, heptachlor, methylene chloride, toluene, and trichlorofluoromethane) detected in the media associated with the northeastern surface impoundment were identified as COPCs and were carried forward to the screening assessment.

Radionuclides

Of the radionuclides carried forward from the data analysis, twelve were detected in at least one medium from the northeastern surface impoundment (Table F-3). Americium-241, cobalt-57, and cesium-137 were not detected in any medium, while plutonium-238, uranium-234, uranium-235, and uranium-238 were not detected above their BVs in any medium (Table F-3). These radionuclides were eliminated from further evaluation. Cesium-134, cobalt-60, manganese-54, neptunium-237, and sodium-22 have no background/ fallout values and were evaluated further in the screening assessment (Table F-3). Plutonium-239 was detected above the fallout values in one sludge sample and one tuff sample, but was not detected in the clay liner (Table F-3). Strontium-90 was detected in four sludge samples above its fallout value and three clay liner samples, but was not detected in the tuff (Table F-3). Tritium was detected above its background/fallout values in all samples of sludge and tuff collected from the northeastern surface impoundment. It was also detected in all samples of the clay liner samples, but does not have a fallout value for comparison because the fallout value applies to only the top six inches (Table F-3). The maximum detected activity concentrations of cobalt-60, manganese-54, sodium-22, and strontium-90 demonstrated a decrease in the maximum detected concentrations from the sludge to the other sampled

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Thirteen inorganic noncarcinogenic chemicals, antimony, barium, cadmium, calcium, copper, lead, magnesium, mercury, selenium, silver, sodium, thallium, and zinc, were carried forward from the background comparison and evaluated against the respective SALs. Because there is more than one noncarcinogen, the COPCs were also screened against 0.1 SAL to address potential additive effects. Three inorganic noncarcinogens were detected at concentrations greater than 0.1 SAL, copper, lead and thallium; none of the inorganic noncarcinogens were above their respective SALs (Table F-4). All three inorganics were detected above 0.1 SAL in one sludge sample, but only thallium was detected above 0.1 SAL in the clay liner; none of the inorganics were detected above 0.1 SAL in the tuff (Table F-5). The concentrations of copper, lead, and thallium in the sludge were approximately 0.13 to 0.4 SAL. Thallium was detected above 0.1 SAL in six samples of the clay liner and ranged from just above 0.1 SAL to approximately four times 0.1 SAL. The other inorganic noncarcinogenic chemicals were detected below 0.1 SAL will not be evaluated further, while copper, lead, and thallium will be evaluated further in a risk assessment to be conducted once all the data for this site has been collected.

Calcium, magnesium, and sodium do not have risk-based values (i.e., SALs) to compare against detected concentrations in order to evaluate potential risk. Calcium and magnesium were detected at elevated concentrations in the sludge and tuff, while sodium was detected at elevated concentrations only in the sludge. These inorganics are essential nutrients that are prevalent in all environmental media and may be present at elevated concentrations. The reason calcium, magnesium, and sodium were detected above BVs in the sludge is probably related to the type of waste discharged into the surface impoundments, e.g., waste with high total dissolved solids. The reason for calcium and magnesium to be elevated in the tuff is not clear. Although there are no SALs available for these inorganics, there are recommended daily allowances (RDAs) for each because they are essential nutrients. Based on an ingestion rate of 200 mg soil/day for a child and 100 mg soil/day for an adult, the daily intake of calcium given the maximum detected concentration of 29,600 mg/kg would be approximately 6 mg/day and 3 mg/day, respectively.

TABLE F-4
SCREENING ASSESSMENT FOR NONCARCINOGENIC INORGANIC CHEMICALS IN THE NORTHEASTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Detects Above BVs	Range of Detected Concentrations Above BVs (mg/kg)	SAL (mg/kg)	0.1 SAL (mg/kg)	Number of Detects Above 0.1 SAL
Antimony	Sludge	1	3.0	31	3.1	0
Barium	Tuff	5	50.8-111	5300	530	0
Cadmium	Sludge	14	0.44-1.7	38	3.8	0
	Clay Liner	1	0.45			0

TABLE F-3 (CONTINUED)
SUMMARY OF RADIONUCLIDES DETECTED IN THE NORTHEASTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Samples Analyzed	Number of Detects	Range of Detected Concentrations (pCi/g)	Background/ Fallout Value (pCi/g)	Frequency of Detects Above Background
Strontium-90	Sludge	18	8	0.6 - 3.7	1.31	4/18
	Clay Liner	18	3	0.9 - 1.9	Not Applicable[a]	3/18
	Tuff	27	0	Not Detected	1.0	0/27
Tritium	Sludge	18	18	17.1 - 405	0.084	18/18
	Clay Liner	18	18	1.4 - 4.8	Not Applicable	18/18
	Tuff	27	27	0.4 - 31	0.03	27/27
Uranium-234	Sludge	18	18	0.7 - 1.8	2.59	0/18
	Clay Liner	18	17	0.7 - 1.2	2.59	0/27
	Tuff	27	26	0.8 - 1.2	1.98	0/18
Uranium-235	Sludge	18	16	0.02 - 0.1	0.2	0/18
	Clay Liner	18	0	Not Detected	0.2	0/27
	Tuff	27	0	Not Detected	0.09	0/18
Uranium-238	Sludge	18	18	0.6 - 1.5	2.29	0/18
	Clay Liner	18	16	0.7 - 1.2	2.29	0/27
	Tuff	27	26	0.9 - 1.5	1.93	0/18

[a] Fallout value applies to samples collected from 0-6 inches only., and the data assessed).

media, while cesium-134 demonstrated a decrease in the maximum detected concentrations from the clay liner to the tuff. Neptunium-237 was only detected in one tuff sample, while plutonium-239 showed a slight increase in the maximum detected concentrations from the sludge to the tuff. The maximum detected activity concentrations of tritium demonstrated a definite decrease from the sludge to the clay liner and a marked increase from the clay liner to the tuff.

Based on the above comparison, the sludge in the northeastern surface impoundment is characterized by elevated concentrations of cobalt-60, plutonium-239, sodium-22, strontium-90, and tritium in five to eighteen samples. Cesium-134 and manganese-54 were detected in the clay liner, while of the above radionuclides, plutonium-239 and sodium-22 were not detected in the clay liner. Cesium-134, cobalt-60, neptunium-237, plutonium-239, sodium-22, and tritium were also detected or detected above background in one to eighteen samples of tuff. Therefore, eight radionuclides, cesium-134 , cobalt-60, manganese-54, neptunium-237, plutonium-239, sodium-22, strontium-90, and tritium from the northeastern surface impoundment were identified as COPCs and were carried forward to the screening assessment.

Although extent is not completely defined, we believe that the maximum contamination values were found, with the exception of PCBs, and that this screening assessment can be used for development of a COPC list for future sampling.

Based on the same ingestion rates, the daily intake of magnesium given the maximum detected concentration of 3110 would be approximately 0.6 mg/day and 0.3 mg/day, respectively. These daily intakes are well below the RDAs of 800-1200 mg/day for calcium and 300-400 mg/day for magnesium and are therefore not a concern. Based on this information, calcium, magnesium, and sodium will not be evaluated further.

Six organic noncarcinogenic chemicals, acetone, 2-butanone, endosulfan I, endrin, toluene, and trichlorofluoromethane, were detected in the surface impoundment and evaluated against the respective SALs. Because there is more than one noncarcinogen, the COPCs were also screened against 0.1 SAL to address potential additive effects. None of the organic noncarcinogenic chemicals were detected above SAL or 0.1 SAL (Table F-6) and will not be evaluated further.

Ten organic carcinogenic chemicals, aroclor-1254, aroclor-1260, BHC(alpha-), BHC(gamma-), DDD(4,4'-), DDE(4,4'-), DDT(4,4'-), dieldrin, heptachlor, and methylene chloride were detected in the northeastern surface impoundment and evaluated against their respective SALs. Two carcinogens, aroclor-1254 and dieldrin, were detected at concentrations greater than their respective SALs (Table F-7). Aroclor-1254 was detected above its SAL in six sludge samples, not above SAL in the clay liner, and was not detected in the tuff (Table F-8). Dieldrin was detected above SAL in one clay liner sample, but was not detected in the sludge or tuff (Table F-8). The remaining organic carcinogenic chemicals, aroclor-1260, BHC(alpha-), BHC(gamma-), DDD(4,4'-), DDE(4.4'-), DDT(4,4'-), heptachlor, and methylene chloride, were not detected above their respective SALs (Table F-7). These organic carcinogenic chemicals will not be evaluated further, while aroclor-1254 and dieldrin will be evaluated further in a risk assessment to be conducted once all the data for this site has been collected. Although aroclor-1254 had QA/QC issues associated with matrix interference for the sludge and clay liner samples, it is retained as a COPC, because it has been detected in several samples. The re-sampling proposed for the surface impoundments will verify the presence and concentrations of this analyte for the risk assessment.

Eight radionuclide chemicals, cesium-134, cobalt-60, manganese-54, neptunium-237, plutonium-239, sodium-22, strontium-90, and tritium, were carried forward from the background comparison and evaluated against their respective SALs. Four radionuclides, cesium-134, cobalt-60, sodium-22, and tritium, were detected at concentrations greater than their respective SALs in least one sample (Table F-9). Cobalt-60, sodium-22, and tritium were detected above their SALs in eighteen, three, and four sludge samples, respectively, while cesium-134 and manganese-54 were not analyzed for in the sludge (Table F-10). Cesium-134 and cobalt-60 were detected above SALs in eighteen clay liner samples each (Table F-10). Tritium was not detected above SAL in the clay liner and tuff samples (Table F-10). The radionuclides detected below SALs will not be evaluated further, while cesium-134, cobalt-60, sodium-22, and tritium will be evaluated further in a risk assessment to be conducted once all the data have been collected.

TABLE F-4 CONTINUED
SCREENING ASSESSMENT FOR NONCARCINOGENIC INORGANIC CHEMICALS IN THE NORTHEASTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Detects Above BVs	Range of Detected Concentrations Above BVs (mg/kg)	SAL (mg/kg)	0.1 SAL (mg/kg)	Number of Detects Above 0.1 SAL
Calcium	Sludge	13	7240-19,900	No SAL	-	-
	Tuff	14	2580-29,600	No SAL	-	-
Copper	Sludge	18	39-1070	2800	280	1
	Clay Liner	7	18.8 - 44.8			0
	Tuff	2	5.3 - 5.4			0
Lead	Sludge	2	28.3-135	400	40	1
	Tuff	1	27.5			0
Magnesium	Sludge	3	4850-6160	No SAL	-	-
	Tuff	1	3110	No SAL	-	-
Mercury	Sludge	18	0.2-2.0	23	2.3	0
	Tuff	1	0.3			0
Selenium	Sludge	7	1.6-2.2	380	38	0
Silver	Sludge	14	1.4-6.3	380	38	0
Sodium	Sludge	14	1010-3530	No SAL	-	-
Thallium	Sludge	1	0.9	5.4	0.54	1
	Clay Liner	6	0.74-2.1			6
Zinc	Sludge	18	69.4-325	23,000	2300	0
	Clay Liner	6	49.8-78.8			0

TABLE F-5
SUMMARY OF NONCARCINOGENIC INORGANIC CHEMICALS IN THE NORTHEASTERN SURFACE IMPOUNDMENT GREATER THAN 0.1 SAL

Analyte	Location ID	Sample ID	Depth (in)	Media	Result (mg/kg)	SAL (mg/kg)	0.1 SAL (mg/kg)
Copper	53-1026	0253-95-0206	0-6	Sludge	1070	2800	280
Lead	53-1026	0253-95-0206	0-6	Sludge	135	400	40
Thallium	53-1025	0253-95-0197	0-3	Sludge	0.9	5.4	0.54
Thallium	53-1024	0253-95-0195	0.5-4	Liner	0.7	5.4	0.54
Thallium	53-1023	0253-95-0192	0.5-6	Liner	0.9	5.4	0.54
Thallium	53-1025	0253-95-0198	4-10	Liner	1.5	5.4	0.54
Thallium	53-1025	0253-95-0199	1-5	Liner	1.5	5.4	0.54
Thallium	53-1026	0253-95-0207	3-7	Liner	2.1	5.4	0.54
Thallium	53-1022	0253-95-0189	0.5-6	Liner	2.1	5.4	0.54

TABLE F-8
SUMMARY OF CARCINOGENIC CHEMICALS IN THE NORTHEASTERN SURFACE IMPOUNDMENT GREATER THAN SAL

Analyte	Location ID	Sample ID	Depth (in)	Media	Result (mg/kg)	SAL (mg/kg)
Aroclor-1254	53-1018	0253-95-0175	0-1	Sludge	1.1(J)	1.0[a]
Aroclor-1254	53-1026	0253-95-0206	0-6	Sludge	1.3(J)	1.0
Aroclor-1254	53-1025	0253-95-0197	0-3	Sludge	1.8(J)	1.0
Aroclor-1254	53-1021	0253-95-0185	0-4	Sludge	2.9(J)	1.0
Aroclor-1254	53-1031	0253-95-0221	0-2	Sludge	3.4(J)	1.0
Aroclor-1254	53-1020	0253-95-0182	0-2	Sludge	3.9(J)	1.0
Dieldrin	53-1022	0253-95-0189	0.5-6	Liner	0.032(J)	0.028

[a] SAL for aroclor-1254 is based on an industrial land use scenario.

TABLE F-9
SCREENING ASSESSMENT FOR RADIONUCLIDES IN THE NORTHEASTERN SURFACE IMPOUNDMENT GREATER THAN SAL

Analyte	Media	Number of Detects	Range of Detected Concentrations (pCi/g)	SAL (pCi/g)	Number of Detects Above SAL
Cesium-134	Clay Liner	18	3.1 - 22.6	1.9	18
	Tuff	7	0.16 - 2.3	1.9	2
Cobalt-60	Sludge	18	46 - 1070	1.1	18
	Clay Liner	17	0.45 - 6.2	1.1	13
	Tuff	13	0.2 - 3.5	1.1	4
Manganese-54	Clay Liner	9	0.25 - 1.3	3.5	0
Neptunium-237	Tuff	1	0.98	1.9	0
Plutonium-239	Sludge	1	0.02 - 0.08	24	0
	Tuff	1	0.2	24	0
Sodium-22	Sludge	5	0.5 - 2.4	1.3	3
	Tuff	6	0.3 - 1.7	1.3	1
Strontium-90	Sludge	8	0.6 - 3.7	4.4	0
	Clay Liner	3	0.9 - 1.9	4.4	0
Tritium	Sludge	18	17 - 405	260	4
	Clay Liner	18	1.4 - 4.8	260	0
	Tuff	27	0.4 - 31	260	0

TABLE F-6
SCREENING ASSESSMENT FOR NONCARCINOGENIC ORGANIC CHEMICALS IN THE NORTHEASTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Detects	Range of Detected Concentrations (mg/kg)	SAL (mg/kg)	0.1 SAL (mg/kg)	Number of Detects Above 0.1 SAL
Acetone	Sludge	16	0.09-0.8	2100	210	0
	Clay Liner	3	0.01-0.03			0
	Tuff	16	0.002-0.1			0
2-Butanone	Sludge	15	0.02-0.2	7100	710	0
Endosulfan I	Sludge	4	0.1-0.2	390	39	0
	Tuff	1	0.005			0
Endrin	Clay Liner	7	0.006-0.05	20	2	0
Toluene	Sludge	2	0.0126-0.0133	790	79	0
Trichlorofluoro-methane	Tuff	1	0.002	380	38	0

TABLE F-7
SCREENING ASSESSMENT FOR CARCINOGENIC ORGANIC CHEMICALS IN THE NORTHEASTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Detects	Range of Detected Concentrations (mg/kg)	SAL (mg/kg)	Number of Detects Above SAL
Aroclor-1254	Sludge	16	0.3-3.9	1.0	6
	Clay Liner	1	0.07		0
Aroclor-1260	Clay Liner	6	0.07-0.3	1.0	0
BHC(alpha-)	Sludge	3	0.05-0.06	0.71	0
	Clay Liner	1	0.0008		0
BHC(gamma-)	Clay Liner	1	0.0006-0.0013	0.34	0
	Tuff	5	0.0007		0
DDD(4,4'-)	Clay Liner	1	0.05	1.9	0
	Tuff	1	0.003		0
DDE(4,4'-)	Sludge	1	0.11	1.3	0
DDT(4,4'-)	Sludge	1	0.4	1.3	0
	Clay Liner	2	0.02-0.07		0
	Tuff	1	0.0002		0
Dieldrin	Clay Liner	1	0.03	0.028	1
Heptachlor	Tuff	5	0.0009-0.0013	0.099	0
Methylene chloride	Sludge	15	0.03-0.06	7.8	0

TABLE F-10 CONTINUED
SUMMARY OF RADIONUCLIDES IN THE NORTHEAST SURFACE IMPOUNDMENT GREATER THAN SAL

Analyte	Location ID	Sample ID	Depth (in)	Media	Result (pCi/g)	SAL (pCi/g)
Cobalt-60 cont	53-1029	AAB9991	0 - 6	Sludge	87.2	1.1
	53-1030	AAB9992	0 - 6	Sludge	129	1.1
	53-1031	AAB9993	0 - 6	Sludge	1070	1.1
	53-1032	AAB9994	0 - 6	Sludge	46	1.1
	53-1033	AAB9995	0 - 6	Sludge	79.4	1.1
	53-1034	AAB9996	0 - 6	Sludge	290	1.1
	53-1018	0253-95-0176	0.5 - 4	Liner	2.5	1.1
	53-1021	0253-95-0186	1 - 5	Liner	1.9	1.1
	53-1022	0253-95-0189	0.5 - 6	Liner	6.1	1.1
	53-1023	0253-95-0192	0.5 - 6	Liner	2.3	1.1
	53-1025	0253-95-0198	4 - 10	Liner	1.4	1.1
	53-1027	0253-95-0210	4 - 10	Liner	1.6	1.1
	53-1028	0253-95-0213	0.5 - 4	Liner	5.0	1.1
	53-1029	0253-95-0216	0.5 - 4.5	Liner	6.2	1.1
	53-1030	0253-95-0219	1 - 4	Liner	2.4	1.1
	53-1031	0253-95-0222	2 - 6	Liner	2.5	1.1
	53-1032	0253-95-0225	0.5 - 9	Liner	1.8	1.1
	53-1033	0253-95-0229	1 - 4	Liner	1.7	1.1
	53-1034	0253-95-0232	2 - 4	Liner	1.3	1.1
	53-1316	0253-95-0234	24 - 44	Tuff	1.9	1.1
	53-1316	0253-95-0235	24 - 44	Tuff	2.2	1.1
	53-1319	0253-95-0238	18 - 28	Tuff	3.5	1.1
	53-1321	0253-95-0241	18 - 32	Tuff	3.5	1.1
Sodium-22	53-1021	AAB9980	0 - 6	Sludge	1.6	1.3
	53-1023	AAB9982	0 - 6	Sludge	0.5	1.3
	53-1025	AAB9984	0 - 6	Sludge	2.4	1.3
	53-1020	0253-95-0184	44 - 54	Tuff	1.7	1.3
Tritium	53-1020	AAB9979	0 - 6	Sludge	405	260
	53-1021	AAB9980	0 - 6	Sludge	288	260
	53-1025	AAB9984	0 - 6	Sludge	305	260
	53-1031	AAB9993	0 - 6	Sludge	286	260

TABLE F-10
SUMMARY OF RADIONUCLIDES IN THE NORTHEASTERN SURFACE IMPOUNDMENT GREATER THAN SAL

Analyte	Location ID	Sample ID	Depth (in)	Media	Result (pCi/g)	SAL (pCi/g)
Cesium-134	53-1018	0253-95-0176	0.5 - 4	Liner	11.3	1.9
	53-1019	0253-95-0180	0.5 - 4	Liner	3.1	1.9
	53-1020	0253-95-0183	1 - 10	Liner	4.2	1.9
	53-1021	0253-95-0186	1 - 5	Liner	4.1	1.9
	53-1022	0253-95-0189	0.5 - 6	Liner	17.6	1.9
	53-1023	0253-95-0192	0.5 - 6	Liner	9.7	1.9
	53-1024	0253-95-0195	0.5 - 4	Liner	4.4	1.9
	53-1025	0253-95-0198	4 - 10	Liner	7.8	1.9
	53-1025	0253-95-0199	1 - 5	Liner	5.9	1.9
	53-1026	0253-95-0207	3 - 7	Liner	5.1	1.9
	53-1027	0253-95-0210	4 - 10	Liner	5.9	1.9
	53-1028	0253-95-0213	0.5 - 4	Liner	17.7	1.9
	53-1029	0253-95-0216	0.5 - 4.5	Liner	22.6	1.9
	53-1030	0253-95-0219	1 - 4	Liner	22.6	1.9
	53-1031	0253-95-0222	2 - 6	Liner	13	1.9
	53-1032	0253-95-0225	0.5 - 9	Liner	9.7	1.9
	53-1033	0253-95-0229	1 - 4	Liner	9.5	1.9
	53-1034	0253-95-0232	2 - 4	Liner	8.9	1.9
Cesium-134	53-1316	0253-95-0234	24 - 44	Tuff	2.3	1.9
	53-1321	0253-95-0241	18 - 32	Tuff	1.91	1.9
Cobalt-60	53-1018	AAB9977	0 - 6	Sludge	268	1.1
	53-1019	AAB9978	0 - 6	Sludge	62	1.1
	53-1020	AAB9979	0 - 6	Sludge	707	1.1
	53-1021	AAB9980	0 - 6	Sludge	708	1.1
	53-1022	AAB9981	0 - 6	Sludge	430	1.1
	53-1023	AAB9982	0 - 6	Sludge	104	1.1
	53-1024	AAB9983	0 - 6	Sludge	52.8	1.1
	53-1025	AAB9984	0 - 6	Sludge	717	1.1
	53-1026	AAB9985	0 - 6	Sludge	54.1	1.1
	53-1026	AAB9986	0 - 6	Sludge	56.6	1.1
	53-1027	AAB9989	0 - 6	Sludge	277	1.1
	53-1028	AAB9990	0 - 6	Sludge	188	1.1

TABLE F-11
SUMMARY OF INORGANICS DETECTED IN THE NORTHWESTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Samples Analyzed	Number of Detects	Range of Detected Values (mg/kg)	Background Value (mg/kg)	Frequency of Detects Above Background
Aluminum	Sludge	18	18	1660 – 8110	29200	0/18
	Clay Liner	18	18	215 - 9160	29200	0/18
	Tuff	26	26	142 - 7980	7340	1/26
Antimony	Sludge	18	14	0.1 - 0.7	0.83	0/18
	Clay Liner	18	8	0.09 - 0.3	0.83	0/18
	Tuff	26	7	0.1 - 0.2	0.5	0/26
Arsenic	Sludge	18	18	1.0 - 6.7	8.17	0/18
	Clay Liner	18	18	0.6 - 2.3	8.17	0/18
	Tuff	26	26	0.2 - 1.7	2.79	0/26
Barium	Sludge	18	18	23 - 173	295	0/18
	Clay Liner	18	18	2.9 - 95	295	0/18
	Tuff	26	26	1.5 - 70.7	46	1/26
Beryllium	Sludge	18	18	0.1 - 0.6	1.83	0/18
	Clay Liner	18	18	0.2 - 0.9	1.83	0/18
	Tuff	26	26	0.07 - 0.7	1.21	0/26
Cadmium	Sludge	18	18	0.9 - 3.3	0.4	18/18
	Clay Liner	18	18	0.03 - 0.8	0.4	1/18
	Tuff	26	18	0.01 - 0.1	1.63	0/26
Calcium	Sludge	18	18	2370 - 10500	6120	4/18
	Clay Liner	18	18	540 - 2580	6120	0/18
	Tuff	26	26	355 - 1690	2200	0/26
Chromium	Sludge	18	18	8.1 - 31.7	19.3	9/18
	Clay Liner	18	18	1.1 - 16.1	19.3	0/18
	Tuff	26	26	0.7 - 7.4	7.14	1/26
Cobalt	Sludge	18	18	1.8 - 7.2	8.64	0/18
	Clay Liner	18	18	0.06 - 3.3	8.64	0/18
	Tuff	26	26	0.03 - 2.2	3.14	0/26

Northwestern Surface Impoundment

Inorganics

Twenty-three inorganic chemicals were detected in the sludge, clay liner, and tuff from the northwestern surface impoundment (Table F-11). Eleven inorganics, antimony, arsenic, beryllium, cobalt, iron, magnesium, manganese, potassium, sodium, thallium, and vanadium were not detected above BVs in any of the three media; sludge, clay liner, or tuff. These eleven inorganics will not be evaluated further. Twelve inorganics, aluminum, barium, cadmium, calcium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc were detected at concentrations greater than BVs in at least one medium and were evaluated further (Table F-11). Three of the fourteen inorganics, calcium, nickel, and silver, were detected above the BVs in one to eighteen sludge samples, but not in the clay liner or tuff. Cadmium, lead, mercury, and zinc were detected at concentrations greater than the BVs in the sludge and clay liner, but not in the tuff. The maximum detected concentrations of cadmium, lead, mercury, and zinc decreased from the sludge to the clay liner and subsequently to the tuff (<BV). In all cases, the maximum detected concentrations for the inorganics were below the BVs for the tuff. The data for cadmium, calcium, lead, mercury, nickel, silver, and zinc indicates that the inorganics were elevated in the sludge, while cadmium, lead, mercury, and zinc had elevated concentrations in the clay liner. The elevated concentrations of cadmium, lead, mercury, and zinc may be related to chemical composition of the liner rather than the result of migration from the sludge to the clay liner.

Five of the fourteen inorganics, aluminum, barium, chromium, copper, and selenium, were detected above their respective BVs in one sample of tuff (Table F-11). Aluminum and barium were not detected above the BVs in the other media. Chromium and selenium were detected above the BVs in nine and six samples of the sludge but not in the clay liner, while copper was detected above the BVs in 18 samples of sludge and eight samples of the clay liner. The elevated copper may be related to chemical composition of the clay liner rather than the result of migration from the sludge to the clay liner. The maximum detected concentrations of the inorganics in the tuff were only slightly above the BVs and are within the range of detected values used to calculate the BVs. All of the inorganics demonstrated a decreasing trend in the maximum detected concentrations going from the sludge to the clay liner to the tuff (Table F-11).

Based on the above comparison, the sludge in the northwestern surface impoundment is characterized by elevated concentrations of cadmium, calcium, chromium, copper, lead, mercury, selenium, silver, and zinc in four to eighteen samples. Nickel was slightly elevated above the BV in the sludge in only one sample. Copper and zinc were also detected above the BVs in more than one sample of the clay liner, while cadmium, lead, and mercury were detected above the BVs in only one sample of the clay liner. Aluminum, barium, chromium, copper, and selenium were detected slightly above the BVs in one sample of tuff. Therefore, twelve inorganics, aluminum, barium, cadmium, calcium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc, from the northwestern surface impoundment were identified as COPCs and were carried forward to the screening assessment.

TABLE F-11 CONTINUED
SUMMARY OF INORGANICS DETECTED IN THE NORTHWEST SURFACE IMPOUNDMENT

Analyte	Media	Number of Samples Analyzed	Number of Detects	Range of Detected Values (mg/kg)	Background Value (mg/kg)	Frequency of Detects Above Background
Silver	Sludge	18	18	2.8 - 19.7	1	18/18
	Clay Liner	18	1	0.3	1	0/18
	Tuff	26	0	Not Detected	1	0/26
Sodium	Sludge	18	18	116 - 842	915	0/18
	Clay Liner	18	18	89.8 - 329	915	0/18
	Tuff	26	26	46.4 - 355	2770	0/26
Thallium	Sludge	18	15	0.2 - 0.7	0.73	0/18
	Clay Liner	18	6	0.2 - 0.4	0.73	0/18
	Tuff	26	3	0.3 - 0.5	1.1	0/26
Vanadium	Sludge	18	18	6.4 - 33.7	39.6	0/18
	Clay Liner	18	18	0.8 - 11.5	39.6	0/18
	Tuff	26	26	0.5 - 10.1	17	0/26
Zinc	Sludge	18	18	156 - 838	48.8	18/18
	Clay Liner	18	18	12.7 - 131	48.8	6/18
	Tuff	26	26	7.8 - 38.5	63.5	0/26

TABLE F-11 CONTINUED
SUMMARY OF INORGANICS DETECTED IN THE NORTHWESTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Samples Analyzed	Number of Detects	Range of Detected Values (mg/kg)	Background Value (mg/kg)	Frequency of Detects Above Background
Copper	Sludge	18	18	106 - 569	14.7	18/18
	Clay Liner	18	18	0.4 - 88.7	14.7	8/18
	Tuff	26	26	0.3 - 9.2	4.66	1/26
Iron	Sludge	18	18	3770 - 8410	21500	0/18
	Clay Liner	18	18	558 - 8340	21500	0/18
	Tuff	26	26	295 - 7890	14500	0/26
Lead	Sludge	18	18	15 - 77	22.3	15/18
	Clay Liner	18	18	5.9 - 33.9	22.3	1/18
	Tuff	26	26	1.1 - 7.9	11.2	0/26
Magnesium	Sludge	18	18	586 - 3580	4610	0/18
	Clay Liner	18	18	73.4 - 1700	4610	0/18
	Tuff	26	26	40.4 - 1560	1690	0/26
Manganese	Sludge	18	18	53.9 - 151	671	0/18
	Clay Liner	18	18	65.5 - 226	671	0/18
	Tuff	26	26	50.4 - 244	482	0/26
Mercury	Sludge	18	18	0.3 - 2.9	0.1	18/18
	Clay Liner	18	18	0.01 - 0.11	0.1	1/18
	Tuff	26	16	0.003 - 0.02	0.1	0/26
Nickel	Sludge	18	18	3.9 - 17.1	15.4	1/18
	Clay Liner	18	18	0.9 - 10.5	15.4	0/18
	Tuff	26	26	0.5 - 3.8	6.58	0/26
Potassium	Sludge	18	18	313 - 1840	3460	0/18
	Clay Liner	18	18	105 - 1630	3460	0/18
	Tuff	26	26	73.6 - 1590	3500	0/26
Selenium	Sludge	18	18	0.2 - 1.9	1.52	6/18
	Clay Liner	18	8	0.2 - 0.5	1.52	0/18
	Tuff	26	6	0.2 - 0.4	0.3	1/26

TABLE F-12 CONTINUED
SUMMARY OF DETECTED ORGANICS IN THE NORTHWESTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Samples Analyzed	Number of Detects	EQL (mg/kg)	Range of Detected Concentrations (mg/kg)
Bis(2-ethylhexyl) phthalate	Sludge	18	15	0.33	25 - 94.9
	Clay Liner	18	7	0.33	0.2 - 0.4
	Tuff	26	1	0.33	0.3
Butanone[2-]	Sludge	18	6	0.02	0.03 - 0.08
	Clay Liner	18	0	0.005	Not Detected
	Tuff	26	0	0.005	Not Detected
DDE[4,4'-]	Sludge	18	7	0.16	0.08 - 0.6
	Clay Liner	18	0	0.016	Not Detected
	Tuff	26	0	0.0016	Not Detected
DDT[4,4'-]	Sludge	18	2	0.16	0.251 - 0.254
	Clay Liner	18	0	0.016	Not Detected
	Tuff	26	0	0.0016	Not Detected
Dieldrin	Sludge	18	0	0.16	Not Detected
	Clay Liner	18	3	0.016	0.02 - 0.03
	Tuff	26	3	0.0016	0.0009 - 0.00097
Endosulfan I	Sludge	18	4	0.16	0.08 - 0.2
	Clay Liner	18	2	0.016	0.02 - 0.04
	Tuff	26	0	0.0016	Not Detected
Endrin	Sludge	18	3	0.16	0.6 - 0.6
	Clay Liner	18	1	0.016	0.025
	Tuff	26	2	0.0016	0.000835 - 0.000846
Heptachlor	Sludge	18	0	0.16	Not Detected
	Clay Liner	18	0	0.016	Not Detected
	Tuff	26	2	0.0016	0.001 - 0.002
Methylene Chloride	Sludge	18	1	0.005	0.025
	Clay Liner	18	9	0.005	0.003 - 0.007
	Tuff	26	3	0.005	0.0037 - 0.0046
Toluene	Sludge	18	1	0.005	0.012
	Clay Liner	18	1	0.002	0.0012
	Tuff	26	0	0.002	Not Detected

Organics

Fifteen organic chemicals, acetone, aroclor-1254, aroclor-1260, 2-butanone, bis(2-ethylhexyl)phthalate, BHC(alpha-), BHC (gamma-), DDE(4,4'-), DDT(4,4'-), dieldrin, endosulfan I, endrin, heptachlor, methylene chloride, and toluene, were detected in one or more media from the northwestern surface impoundment (Table F-12). The remaining organics were not detected in any medium and were not evaluated further. Five organics, acetone, aroclor-1254, bis(2-ethylhexyl)phthalate, endrin, and methylene chloride, were detected in at least one sample of each medium (Table F-12). Three organics, 2-butanone, DDE(4,4'-), and DDT(4,4'-), were detected in two to seven samples of the sludge, but not in the clay liner or tuff (Table F-12). Endosulfan I was detected in four sludge samples and two clay liner samples, while toluene was detected in one sample of the sludge and clay liner; these organics were not detected in the tuff (Table F-12). Two organics, BHC (gamma-) and dieldrin, were detected in the one to three samples of the clay liner and three samples of the tuff, but not in the sludge (Table F-12). The maximum detected concentrations for the organics demonstrated a decrease from the sludge to the clay liner and either decreased or remained relatively the same from the clay liner to the tuff.

TABLE F-12
SUMMARY OF DETECTED ORGANICS IN THE NORTHWESTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Samples Analyzed	Number of Detects	EQL (mg/kg)	Range of Detected Concentrations (mg/kg)
Acetone	Sludge	18	13	0.02	0.06 - 1.9
	Clay Liner	18	13	0.02	0.002 - 0.08
	Tuff	26	10	0.02	0.003 - 0.07
Aroclor-1254	Sludge	18	16	0.4	0.5 - 3.8
	Clay Liner	18	2	0.04	0.2 - 0.6
	Tuff	26	3	0.004	0.0051 - 0.0055
Aroclor-1260	Sludge	18	7	0.4	0.6 - 2.7
	Clay Liner	18	0	0.04	Not Detected
	Tuff	26	1	0.004	0.02
BHC[alpha-]	Sludge	18	2	0.08	0.05 - 0.1
	Clay Liner	18	0	0.008	Not Detected
	Tuff	26	2	0.0008	0.00077 - 0.0008
BHC[gamma-]	Sludge	18	0	0.08	Not Detected
	Clay Liner	18	1	0.008	0.0008
	Tuff	26	3	0.0008	0.00059 - 0.00069

TABLE F-13
SUMMARY OF RADIONUCLIDES DETECTED IN THE NORTHWESTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Samples Analyzed	Number of Detects	Range of Detected Concentrations (pCi/g)	Background/ Fallout Value (pCi/g)	Frequency of Detects Above Background
Americium-241	Sludge	18	0	Not Detected	0.013	0/18
	Clay Liner	18	0	Not Detected	Not Applicable[a]	0/18
	Tuff	26	0	Not Detected	0.05	0/26
Cesium-134[b]	Clay Liner	18	17	1.6 - 10.3	No Background	17/18
	Tuff	26	4	0.4 - 2.0	No Background	2/26
Cesium-137	Sludge	18	0	Not Detected	1.65	0/18
	Clay Liner	18	0	Not Detected	Not Applicable	0/18
	Tuff	26	0	Not Detected	0.1	0/26
Cobalt-57	Clay Liner	18	8	0.1 - 0.6	No Background	8/18
	Tuff	26	0	Not Detected	No Background	0/26
Cobalt-60	Sludge	18	18	35.8 - 4740	No Background	18/18
	Clay Liner	18	18	0.2 - 42.3	No Background	18/18
	Tuff	26	22	0.2 - 8.3	No Background	22/26
Manganese-54	Clay Liner	18	17	0.5 - 3.9	No Background	17/18
	Tuff	26	3	0.36 - 0.71	No Background	3/26
Neptunium-237	Sludge	18	2	1.5 - 4.1	No Background	2/18
	Clay Liner	18	3	0.87 - 1.0	No Background	3/18
	Tuff	26	4	0.94 - 0.96	No Background	4/26

[a] Fallout value applies to samples collected from 0-6 inches only.

[b] Cesium-134, cobalt-57, and manganese-54 were not analyzed for in the 1994 sludge samples collected from the Northwest surface impoundment.

Ten organics, acetone, aroclor-1254, aroclor-1260, BHC(alpha-), BHC (gamma-), bis(2-ethylhexyl)phthalate, dieldrin, endrin, heptachlor, and methylene chloride, were detected in at least one tuff sample (Table F-12). Of these organics, acetone, aroclor-1254, bis(2-ethylhexyl)phthalate, endrin, and methylene chloride, were detected in all three media, while BHC (gamma-) and dieldrin were detected in the clay liner and tuff, but not the sludge, and aroclor-1260 and BHC(alpha-) were detected in the sludge and tuff, but not the clay liner. Heptachlor was only detected in two samples of the tuff and not in the sludge and clay liner. The maximum detected concentrations for those organics detected in the tuff were markedly less than the maximum detected concentrations in the sludge. The maximum detected concentrations for acetone, BHC(alpha-), BHC(gamma-), and bis(2-ethylhexyl)phthalate were similar between the clay liner and the tuff, while the maximum detected concentrations for aroclor-1254, dieldrin, and endrin demonstrated a marked decrease in the maximum detected concentrations between the clay liner and tuff.

Acetone, bis(2-ethylhexyl)phthalate, methylene chloride, and 2-butanone are considered common laboratory contaminants (EPA 1994, 1205), while toluene has also been found to be a laboratory contaminant. Although acetone, methylene chloride, and 2-butanone were not detected in any or some of the laboratory blanks associated with the surface impoundment samples, it is unlikely that these volatile compounds would still be present in the top few inches of sludge after several years of exposure to the elements. However, all fifteen organics, acetone, aroclor-1254, aroclor-1260, BHC(alpha-), BHC (gamma-), bis(2-ethylhexyl)phthalate, 2-butanone, DDE(4,4'-), DDT(4,4'-), dieldrin, endosulfan I, endrin, heptachlor, methylene chloride, and toluene, detected in the three media associated with the northwestern surface impoundment were identified as COPCs and were carried forward to the screening assessment.

Radionuclides

Of the radionuclides carried forward from the data analysis, thirteen were detected in at least one medium from the northwestern surface impoundment (Table F-13). Americium-241 and cesium-137 were not detected in any medium, while uranium-234, uranium-235, and uranium-238 were not detected above their BVs in any medium (Table F-13). These radionuclides were eliminated from further evaluation. Cesium-134, cobalt-57, cobalt-60, manganese-54, neptunium-237, and sodium-22 have no background/ fallout values and will be evaluated further in the screening assessment. Plutonium-238 and plutonium-239 were detected above their BVs in one sludge sample and one tuff sample, but were not detected in the clay liner (Table F-13). Strontium-90 was detected in one sludge sample above its fallout value and two tuff samples above its BV. It was also detected in three samples of the clay liner, which does not have any fallout value for comparison because the fallout value applies to only the top six inches (Table F-13). Tritium was detected above its background/fallout values in all samples of sludge and tuff collected from the northwestern surface impoundment. It was also detected in all of the clay liner samples, which does not have a fallout value for comparison for the reason mentioned above (Table F-13). The maximum detected activity concentrations of plutonium-238 and plutonium-239 demonstrated a slight increase from the sludge to the tuff. The maximum detected activity concentrations of cesium-134, cobalt-57, cobalt-60, manganese-54, and sodium-22 demonstrated a decrease from the sludge or clay liner to the tuff. The maximum detected activity concentrations of neptunium-237 showed a decrease from the sludge to the clay liner, but stayed approximately the same in the clay liner and tuff. Strontium-90 stayed approximately the same in each medium, while the maximum detected activity concentrations of tritium demonstrated a

large decrease from the sludge to the clay liner, and an increase from the clay liner to the tuff (Table F-13).

Based on the above comparison, the sludge in the northwestern surface impoundment is characterized by elevated concentrations of cobalt-60, neptunium-237, plutonium-238, plutonium-239, sodium-22, strontium-90, and tritium in one to eighteen samples. Cesium-134, cobalt-57, and manganese-54 were also detected in the clay liner, while of the above radionuclides, plutonium-238, plutonium-239, and sodium-22 were not detected in the clay liner. Cesium-134, cobalt-60, neptunium-237, manganese-54, plutonium-238, plutonium-239, sodium-22, strontium-90, and tritium were detected or detected above background in one to eighteen samples of tuff. Therefore, ten radionuclides, cesium-134, cobalt-57, cobalt-60, neptunium-237, manganese-54, plutonium-238, plutonium-239, sodium-22, strontium-90, and tritium, from the northwestern surface impoundment were identified as COPCs and carried forward to the screening assessment.

Although extent is not completely defined, we believe that the maximum contamination values were found, with the exception of PCBs, and that this screening assessment can be used for development of a COPC list for future sampling.

Screening Assessment for the Northwestern Surface Impoundment

Twelve inorganic noncarcinogenic chemicals, aluminum, barium, cadmium, calcium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc, were carried forward from the background comparison and evaluated against their respective SALs (Table F-14). Because there is more than one noncarcinogen, the COPCs were also screened against 0.1 SAL to address potential additive effects. Five inorganic noncarcinogens were detected at concentrations greater than 0.1 SAL, aluminum, chromium, copper, lead, and mercury; none of the inorganic noncarcinogens were above their respective SALs (Table F-14). Chromium, copper, lead, and mercury were detected above 0.1 SAL in the sludge, but only aluminum was detected above 0.1 SAL in the tuff; none of the other inorganics were detected above 0.1 SAL in the clay liner and tuff (Table F-15). The concentrations of aluminum, chromium, copper, lead, and mercury in the sludge were approximately 0.11 to 0.2 SAL. Aluminum was detected slightly above 0.1 SAL in the tuff. The inorganic noncarcinogenic chemicals detected below 0.1 SAL will not be evaluated further, while aluminum, chromium, copper, lead, and mercury will be evaluated further in a risk assessment to be conducted once all the data for this site has been collected.

Calcium, which was detected at elevated concentrations in the sludge, does not have a risk-based value (i.e., SALs) to compare against detected concentrations in order to evaluate potential risk. This inorganic is an essential nutrient that is prevalent in all environmental media and may be present at elevated concentrations. The reason calcium was detected above the BV in the sludge is probably related to the type of waste discharged into the surface impoundments, e.g., waste with high total dissolved solids. Although there are no SALs available for calcium, there is a recommended daily allowance (RDA) because it is an essential nutrient. Based on an ingestion rate of 200 mg soil/day for a child and 100 mg soil/day for an adult, the daily intake of calcium given the maximum detected concentration of 10,500 mg/kg would be approximately 2.1 mg/day and 1.1 mg/day, respectively. These daily intakes are well below the RDAs of 800-1200 mg/day for calcium and is therefore not a concern. Based on this information, calcium will not be evaluated further.

Five organic noncarcinogenic chemicals, acetone, 2-butanone, endosulfan I, endrin, and toluene, were detected in the surface impoundment and evaluated against their respective SALs. Because there is more than one noncarcinogen, the COPCs were also screened against 0.1 SAL to address potential

TABLE F-13 CONTINUED
SUMMARY OF RADIONUCLIDES DETECTED IN THE NORTHWESTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Samples Analyzed	Number of Detects	Range of Detected Concentrations (pCi/g)	Background/ Fallout Value (pCi/g)	Frequency of Detects Above Background
Plutonium-238	Sludge	18	14	0.01 - 0.03	0.023	1/18
	Clay Liner	18	0	Not Detected	Not Applicable	0/18
	Tuff	26	1	0.16	0.05	1/26
Plutonium-239	Sludge	18	11	0.01 - 0.06	0.054	1/18
	Clay Liner	18	0	Not Detected	Not Applicable	0/18
	Tuff	26	1	0.12	0.05	1/26
Sodium-22	Sludge	18	4	0.7 - 2.6	No Background	4/18
	Clay Liner	18	0	Not Detected	No Background	0/18
	Tuff	26	0	Not Detected	No Background	0/26
Strontium-90	Sludge	18	2	0.6 - 2.2	1.31	1/18
	Clay Liner	18	1	2.1	Not Applicable	1/18
	Tuff	26	4	1.0 - 3.6	1.0	3/26
Tritium	Sludge	18	18	2.4 - 66.2	0.084	18/18
	Clay Liner	18	18	0.3 - 2.2	Not Applicable	18/18
	Tuff	26	26	0.3 - 17.3	0.03	26/26
Uranium-234	Sludge	18	18	0.5 - 2.6	2.59	0/18
	Clay Liner	18	18	0.8 - 1.2	2.59	0/18
	Tuff	26	26	0.8 - 1.3	1.98	0/26
Uranium-235	Sludge	18	15	0.02 - 0.1	0.2	0/18
	Clay Liner	18	0	Not Detected	0.2	0/18
	Tuff	26	0	Not Detected	0.09	0/26
Uranium-238	Sludge	18	18	0.5 - 1.6	2.29	0/18
	Clay Liner	18	18	0.8 - 1.2	2.29	0/18
	Tuff	26	26	0.9 - 1.3	1.93	0/26

[a] Fallout value applies to samples collected from 0-6 inches only.

[b] Cesium-134, cobalt-57, and manganese-54 were not analyzed for in the 1994 sludge samples collected from the northwestern surface impoundment.

TABLE F-15
SUMMARY OF NONCARCINOGENIC INORGANIC CHEMICALS IN THE NORTHWESTERN SURFACE IMPOUNDMENT GREATER THAN 0.1 SAL

Analyte	Location ID	Sample ID	Depth (in)	Media	Result (mg/kg)	SAL (mg/kg)	0.1 SAL (mg/kg)
Aluminum	53-1013	0253-95-0142	18 - 30	Tuff	7980	77000	7700
Chromium	53-1001	0253-95-0101	0 - 4	Sludge	31.5	210	21
	53-1002	0253-95-0104	0 - 4	Sludge	25.3		
	53-1006	0253-95-0117	0 - 4	Sludge	31.7		
	53-1010	0253-95-0130	0 - 4	Sludge	22.7		
	53-1011	0253-95-0133	0 - 4	Sludge	29		
	53-1012	0253-95-0136	0 - 4	Sludge	23.1		
	53-1014	0253-95-0143	0 - 4	Sludge	28.2		
	53-1015	0253-95-0146	0 - 4	Sludge	24.7		
Copper	53-1001	0253-95-0101	0 - 4	Sludge	412	2800	280
	53-1002	0253-95-0104	0 - 4	Sludge	444		
	53-1006	0253-95-0117	0 - 4	Sludge	524		
	53-1009	0253-95-0127	0 - 4	Sludge	488		
	53-1010	0253-95-0130	0 - 4	Sludge	419		
	53-1011	0253-95-0133	0 - 4	Sludge	396		
Copper	53-1012	0253-95-0136	0 - 4	Sludge	315		
	53-1014	0253-95-0143	0 - 4	Sludge	569		
	53-1015	0253-95-0146	0 - 4	Sludge	489		
Lead	53-1001	0253-95-0101	0 - 4	Sludge	44.5	400	40
	53-1002	0253-95-0104	0 - 4	Sludge	48.2		
	53-1006	0253-95-0117	0 - 4	Sludge	64.4		
	53-1009	0253-95-0127	0 - 4	Sludge	77		
	53-1010	0253-95-0130	0 - 4	Sludge	40.2		
	53-1011	0253-95-0133	0 - 4	Sludge	43.5		
	53-1014	0253-95-0143	0 - 4	Sludge	56.7		
	53-1015	0253-95-0146	0 - 4	Sludge	51.9		
Mercury	53-1006	0253-95-0117	0 - 4	Sludge	2.9	23	2.3
	53-1007	0253-95-0120	0 - 4	Sludge	2.6		

TABLE F-14
SCREENING ASSESSMENT FOR NONCARCINOGENIC INORGANIC CHEMICALS IN THE NORTHWESTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Detects Above Background	Range of Detected Concentrations Above Background (mg/kg)	SAL (mg/kg)	0.1 SAL (mg/kg)	Number of Detects Above 0.1 SAL (mg/kg)
Aluminum	Tuff	1	7980	77000	770	1
Barium	Tuff	1	70.7	5300	530	0
Cadmium	Sludge	18	0.9 - 3.3	38	3.8	0
	Clay Liner	1	0.8			0
Calcium	Sludge	4	6910 - 10500	No SAL	-	-
Chromium	Sludge	9	20.2 - 31.7	210	21	8
	Tuff	1	7.4			0
Copper	Sludge	18	106 - 569	2800	280	9
	Clay Liner	8	15.7 - 88.7			0
	Tuff	1	9.2			0
Lead	Sludge	15	22.4 - 77	400	40	8
	Clay Liner	1	33.9			0
Mercury	Sludge	18	0.3 - 2.9	23	2.3	2
	Clay Liner	1	0.11			0
Nickel	Sludge	1	17.1	1500	150	0
Selenium	Sludge	6	1.53 - 1.9	380	38	0
	Tuff	1	0.4			0
Silver	Sludge	18	2.9 - 19.7	380	38	0
Zinc	Sludge	18	156 - 838	23000	2300	0
	Clay Liner	6	54.2 - 131			0

TABLE F-17
SCREENING ASSESSMENT FOR CARCINOGENIC ORGANIC CHEMICALS IN THE NORTHWESTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Detects	Range of Detected Concentrations (mg/kg)	SAL (mg/kg)	Number of Detects Above SAL (mg/kg)
Aroclor-1254	Sludge	16	0.5 - 3.8	1.0	9
	Clay Liner	2	0.006 - 0.2		0
	Tuff	3	0.0051 - 0.0055		0
Aroclor-1260	Sludge	7	0.6 - 2.7	1.0	3
BHC[alpha-]	Sludge	2	0.05 - 0.1	0.071	1
	Clay Liner	2	0.00077 - 0.0008		0
BHC[gamma-]	Clay Liner	1	0.0008	0.34	0
	Tuff	3	0.00059 - 0.00069		0
Bis(2-ethylhexyl)phthalate	Sludge	15	25-94.9	32	9
	Clay Liner	7	0.2-0.4		0
	Tuff	1	0.25		0
DDE[4,4'-]	Sludge	7	0.08 - 0.6	1.3	0
DDT(4,4'-)	Sludge	2	0.251 - 0.254	1.3	0
Dieldrin	Clay Liner	3	0.0009 - 0.02	0.028	0
	Tuff	3	0.0009 - 0.00097		0
Heptachlor	Tuff	2	0.001 - 0.002	0.99	0
Methylene Chloride	Sludge	1	0.025	7.8	0
	Clay Liner	9	0.003 - 0.007		0
	Tuff	3	0.0037 - 0.0046		0

TABLE F-16
SCREENING ASSESSMENT FOR NONCARCINOGENIC ORGANIC CHEMICALS IN THE NORTHWESTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Detects	Range of Detected Concentrations (mg/kg)	SAL (mg/kg)	0.1 SAL (mg/kg)	Number of Detects Above 0.1 SAL (mg/kg)
Acetone	Sludge	13	0.06 - 1.9	2100	210	0
	Clay Liner	13	0.002 - 0.08			0
	Tuff	10	0.003 - 0.07			0
2-Butanone	Sludge	6	0.03 - 0.08	7100	710	0
Endosulfan I	Sludge	4	0.08 - 0.2	390	39	0
	Clay Liner	2	0.02 - 0.04			0
Endrin	Sludge	3	0.6 - 0.61	20	2	0
	Clay Liner	1	0.025			0
	Tuff	2	0.000835 - 0.000846			0
Toluene	Sludge	1	0.012	790	79	0
	Clay Liner	1	0.0012			0

additive effects. None of the organic noncarcinogenic chemicals were detected above SAL or 0.1 SAL (Table F-16) and will not be evaluated further.

Ten organic carcinogenic chemicals, aroclor-1254, aroclor-1260, BHC(alpha-), BHC(gamma-), bis(2-ethylhexyl)phthalate, DDE(4,4'-), DDT(4,4'-), dieldrin, heptachlor, and methylene chloride, were detected in the northwestern surface impoundment and evaluated against the respective SALs (Table F-17). Four carcinogens, aroclor-1254, aroclor-1260, BHC(alpha-), and bis(2-ethylhexyl)phthalate, were detected at concentrations greater than their respective SALs (Table F-17). The remaining organic carcinogenic chemicals, BHC(gamma-), DDE(4,4'-), DDT(4,4'-), dieldrin, heptachlor, and methylene chloride, were not detected above their respective SALs (Table F-17). These organic carcinogenic chemicals will not be evaluated further. Aroclor-1254 was detected above its SAL in ten sludge samples, but not above SAL in the clay liner and tuff (Table F-18). Aroclor-1260 was detected above SAL in three sludge samples, but was not detected in the clay liner and was detected below the SAL in the tuff (Table F-18). BHC(alpha-) and bis(2-ethylhexyl)phthalate were detected above SALs in one and nine sludge samples, respectively, but were not detected above SALs in the clay liner or tuff (Table F-18). Aroclor-1254, aroclor-1260, BHC(alpha-), and bis(2-ethylhexyl)phthalate will be evaluated further in a risk assessment to be conducted once all the data for this site has been collected. Although aroclor-1254 and aroclor-1260 had QC issues associated with matrix interference for the sludge and clay liner samples, they are retained as

COPCs, because they have been detected in several samples. The re-sampling proposed for the surface impoundments will verify the presence and concentrations of these analytes.

Ten radionuclide chemicals, cesium-134, cobalt-57, cobalt-60, manganese-54, neptunium-237, plutonium-238, plutonium-239, sodium-22, strontium-90, and tritium, were carried forward from the background comparison and evaluated against their respective SALs (Table F-19). Five radionuclides, cesium-134, cobalt-60, manganese-54, neptunium-237, and sodium-22, were detected at concentrations greater than their respective SALs in least one sample (Table F-19). Cobalt-57, which was detected in eight samples of the clay liner, does not have a SAL (Table F-19). Cobalt-60, neptunium-237, and sodium-22 were detected above their SALs in seventeen, one, and two sludge samples, respectively, while cesium-134 and manganese-54 were not analyzed for in the sludge (Table F-20). Cesium-134, cobalt-60, and manganese-54 were detected above SALs in sixteen, seventeen, and one clay liner samples, respectively, and cobalt-57, which does not have a SAL, was also detected in the clay liner (Table F-20). Cesium-134 and cobalt-60 were the only radionuclides detected above their SALs in the tuff in one and nine, respectively (Table F-20). The radionuclides detected below SALs, plutonium-238, plutonium-239, and strontium-90 will not be evaluated further, while tritium was identified as a COPC in the northeastern surface impoundment and will be evaluated further in a risk assessment. Cesium-134, cobalt-57, cobalt-60, manganese-54, neptunium-237, and sodium-22 will be evaluated further in a risk assessment to be conducted once all the data for this site has been collected.

Based on the risk-based screening assessment conducted on the 1994/1995 analytical data for the sludge, the clay liner, and tuff from the northeastern and northwestern surface impoundments, several noncarcinogenic, carcinogenic, and radionuclide COPCs have been identified. The noncarcinogenic COPCs include, aluminum, antimony, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc. The carcinogenic COPCs include, aroclor-1254, aroclor-1260, BHC(alpha-), bis(2-ethylhexyl)phthalate and dieldrin. The radionuclide COPCs include, cesium-134, cobalt-57, cobalt-60, manganese-54, neptunium-237, sodium-22, and tritium. These COPCs will be evaluated further in a baseline risk assessment once all of the data for this PRS has been collected (i.e., after the samples proposed in this SAP are collected, analyzed, and the data assessed).

TABLE F-18
SUMMARY OF CARCINOGENIC CHEMICALS IN THE NORTHWESTERN SURFACE IMPOUNDMENT GREATER THAN SAL

Analyte	Location ID	Sample ID	Depth (in)	Media	Result (mg/kg)	SAL (mg/kg)
Aroclor-1254	53-1001	0253-95-0101	0 - 4	Sludge	2.7(J)	1.0[a]
	53-1002	0253-95-0104	0 - 4	Sludge	2.3(J)	
	53-1005	0253-95-0114	0 - 4	Sludge	1.9(J)	
	53-1006	0253-95-0117	0 - 4	Sludge	3.8(J)	
	53-1007	0253-95-0120	0 - 4	Sludge	1.2(J)	
	53-1008	0253-95-0124	0 - 4	Sludge	1.6(J)	
	53-1010	0253-95-0130	0 - 4	Sludge	2.3(J)	
	53-1011	0253-95-0133	0 - 4	Sludge	2.4(J)	
	53-1014	0253-95-0143	0 - 4	Sludge	2.2(J)	
	53-1015	0253-95-0146	0 - 4	Sludge	2.3(J)	
Aroclor-1260	53-1002	0253-95-0104	0 - 4	Sludge	1.6(J)	1.0[a]
	53-1005	0253-95-0114	0 - 4	Sludge	1.2(J)	
	53-1006	0253-95-0117	0 - 4	Sludge	2.7(J)	
BHC(alpha-)	53-1006	0253-95-0117	0-4	Sludge	0.12(J)	0.071
Bis(2-ethylhexyl)phthalate	53-1001	0253-95-0101	0 - 4	Sludge	59.3	32
	53-1002	0253-95-0104	0 - 4	Sludge	40.6	
	53-1005	0253-95-0114	0 - 4	Sludge	40(J)	
	53-1006	0253-95-0117	0 - 4	Sludge	94.9	
	53-1010	0253-95-0130	0 - 4	Sludge	40.4(J)	
	53-1011	0253-95-0133	0 - 4	Sludge	49.3(J)	
	53-1012	0253-95-0136	0 - 4	Sludge	35(J)	
	53-1014	0253-95-0143	0 - 4	Sludge	33.9(J)	
	53-1016	0253-95-0149	0-4	Sludge	32.8(J)	

[a] SAL for aroclor-1254 and aroclor-1260 is based on an industrial land use scenario.

TABLE F-20
SUMMARY OF RADIONUCLIDES IN THE NORTHWESTERN SURFACE IMPOUNDMENT GREATER THAN SAL

Analyte	Location ID	Sample ID	Depth (in)	Media	Result (pCi/g)	SAL (pCi/g)
Cesium-134	53-1001	0253-95-0102	4 - 10	Liner	6.3	1.9
	53-1002	0253-95-0105	4 - 12	Liner	2.6	1.9
	53-1003	0253-95-0108	4 - 10	Liner	1.94	1.9
	53-1004	0253-95-0112	4 - 10	Liner	3.7	1.9
	53-1005	0253-95-0115	4 - 9	Liner	4.7	1.9
	53-1006	0253-95-0118	4 - 8	Liner	6.9	1.9
	53-1007	0253-95-0121	4 - 10	Liner	2.6	1.9
	53-1008	0253-95-0125	4 - 10	Liner	7.5	1.9
	53-1010	0253-95-0131	4 - 10	Liner	9.5	1.9
	53-1011	0253-95-0134	4 - 10	Liner	9.4	1.9
	53-1012	0253-95-0137	4 - 10	Liner	10.3	1.9
	53-1014	0253-95-0144	4 - 10	Liner	7.5	1.9
	53-1015	0253-95-0147	4 - 10	Liner	6.3	1.9
	53-1016	0253-95-0150	4 - 10	Liner	5.8	1.9
Cesium-134	53-1017	0253-95-0153	4 - 10	Liner	3.3	1.9
	53-1324	0253-95-0128	4 - 10	Liner	2.9	1.9
	53-1013	0253-95-0142	18 - 30	Tuff	2.0	1.9
Cobalt-57	53-1001	0253-95-0102	4 - 10	Liner	0.57	No SAL
	53-1002	0253-95-0105	4 - 12	Liner	0.24	No SAL
	53-1005	0253-95-0115	4 - 9	Liner	0.31	No SAL
	53-1006	0253-95-0118	4 - 8	Liner	0.37	No SAL
	53-1007	0253-95-0121	4 - 10	Liner	0.13	No SAL
	53-1012	0253-95-0137	4 - 10	Liner	0.29	No SAL
	53-1016	0253-95-0150	4 - 10	Liner	0.23	No SAL
	53-1324	0253-95-0128	4 - 10	Liner	0.54	No SAL

TABLE F-19
SCREENING ASSESSMENT FOR RADIONUCLIDE CHEMICALS IN THE NORTHWESTERN SURFACE IMPOUNDMENT

Analyte	Media	Number of Detects	Range of Detected Concentrations (pCi/g)	SAL (pCi/g)	Number of Detects Above SAL
Cesium-134	Clay Liner	17	1.6 - 10.3	1.9	16
	Tuff	2	0.4 - 2.0		1
Cobalt-57	Liner	8	0.1 - 0.6	No SAL	-
Cobalt-60	Sludge	18	35.8 - 4740	1.1	17
	Clay Liner	18	0.2 - 42.3		17
	Tuff	22	0.2 - 8.3		9
Manganese-54	Clay Liner	17	0.5 - 3.9	3.5	1
	Tuff	3	0.36 - 0.71		0
Neptunium-237	Sludge	2	1.5 - 4.1	1.9	1
	Clay Liner	3	0.87 - 1.0		0
	Tuff	4	0.94 - 0.96		0
Plutonium-238	Sludge	14	0.01 - 0.03	27	0
	Tuff	1	0.16		0
Plutonium-239	Sludge	11	0.01 - 0.06	24	0
	Tuff	1	0.12		0
Sodium-22	Sludge	4	0.7 - 2.6	1.3	2
Strontium-90	Sludge	2	0.6 - 2.2	4.4	0
	Clay Liner	1	2.1		0
	Tuff	4	1.0 - 3.6		0
Tritium	Sludge	18	2.4 - 66.2	260	0
	Clay Liner	18	310 - 2160		0
	Tuff	26	262 - 17300		0

TABLE F-20 (CONTINUED)
SUMMARY OF RADIONUCLIDES IN THE NORTHWESTERN SURFACE IMPOUNDMENT GREATER THAN SAL

Analyte	Location ID	Sample ID	Depth (in)	Media	Result (pCi/g)	SAL (pCi/g)
Cobalt-60	53-1016	0253-95-0150	4 - 10	Liner	16.4	1.1
	53-1017	0253-95-0153	4 - 10	Liner	10.1	1.1
	53-1324	0253-95-0128	4 - 10	Liner	42.3	1.1
	53-1290	0253-95-0157	8 - 18	Tuff	4.7	1.1
	53-1291	0253-95-0158	18 - 26	Tuff	1.7	1.1
	53-1294	0253-95-0161	18 - 30	Tuff	4.0	1.1
	53-1295	0253-95-0162	18 - 30	Tuff	2.9	1.1
	53-1005	0253-95-0116	18 - 29	Tuff	1.5	1.1
	53-1010	0253-95-0132	18 - 30	Tuff	1.3	1.1
	53-1013	0253-95-0142	18 - 30	Tuff	8.3	1.1
	53-1014	0253-95-0145	18 - 30	Tuff	2.1	1.1
	53-1015	0253-95-0148	18 - 30	Tuff	2.2	1.1
Manganese-54	53-1005	0253-95-0115	4 - 9	Liner	3.9	3.5
Neptunium-237	53-1015	AAB9972	0 - 6	Sludge	4.1	1.9
Sodium-22	53-1002	AAB9957	0 - 6	Sludge	2.6	1.3
	53-1005	AAB9960	0 - 6	Sludge	2.1	1.3

TABLE F-20 CONTINUED
SUMMARY OF RADIONUCLIDES IN THE NORTHWESTERN SURFACE IMPOUNDMENT GREATER THAN SAL

Analyte	Location ID	Sample ID	Depth (in)	Media	Result (pCi/g)	SAL (pCI/g)
Cobalt-60	53-1001	AAB9956	0 - 6	Sludge	1400	1.1
	53-1002	AAB9957	0 - 6	Sludge	2160	1.1
	53-1003	AAB9958	0 - 6	Sludge	232	1.1
	53-1004	AAB9959	0 - 6	Sludge	57.2	1.1
	53-1005	AAB9960	0 - 6	Sludge	2260	1.1
	53-1006	AAB9961	0 - 6	Sludge	1200	1.1
	53-1007	AAB9962	0 - 6	Sludge	110	1.1
	53-1009	AAB9964	0 - 6	Sludge	461	1.1
	53-1009	AAB9965	0 - 6	Sludge	635	1.1
	53-1010	AAB9967	0 - 6	Sludge	4740	1.1
	53-1011	AAB9968	0 - 6	Sludge	1124.2	1.1
	53-1012	AAB9969	0 - 6	Sludge	597	1.1
	53-1013	AAB9970	0 - 6	Sludge	35.8	1.1
	53-1014	AAB9971	0 - 6	Sludge	1020	1.1
	53-1015	AAB9972	0 - 6	Sludge	4230	1.1
	53-1016	AAB9973	0 - 6	Sludge	75.2	1.1
	53-1017	AAB9974	0 - 6	Sludge	102	1.1
	53-1001	0253-95-0102	4 - 10	Liner	36.3	1.1
	53-1002	0253-95-0105	4 - 12	Liner	13.9	1.1
	53-1003	0253-95-0108	4 - 10	Liner	6.5	1.1
	53-1003	0253-95-0109	4 - 10	Liner	6	1.1
	53-1004	0253-95-0112	4 - 10	Liner	6.4	1.1
	53-1005	0253-95-0115	4 - 9	Liner	21.6	1.1
	53-1006	0253-95-0118	4 - 8	Liner	25.7	1.1
	53-1007	0253-95-0121	4 - 10	Liner	7.3	1.1
	53-1008	0253-95-0125	4 - 10	Liner	11	1.1
	53-1010	0253-95-0131	4 - 10	Liner	9.8	1.1
	53-1011	0253-95-0134	4 - 10	Liner	13.1	1.1
	53-1012	0253-95-0137	4 - 10	Liner	25.3	1.1
	53-1014	0253-95-0144	4 - 10	Liner	15.4	1.1
	53-1015	0253-95-0147	4 - 10	Liner	11.2	1.1

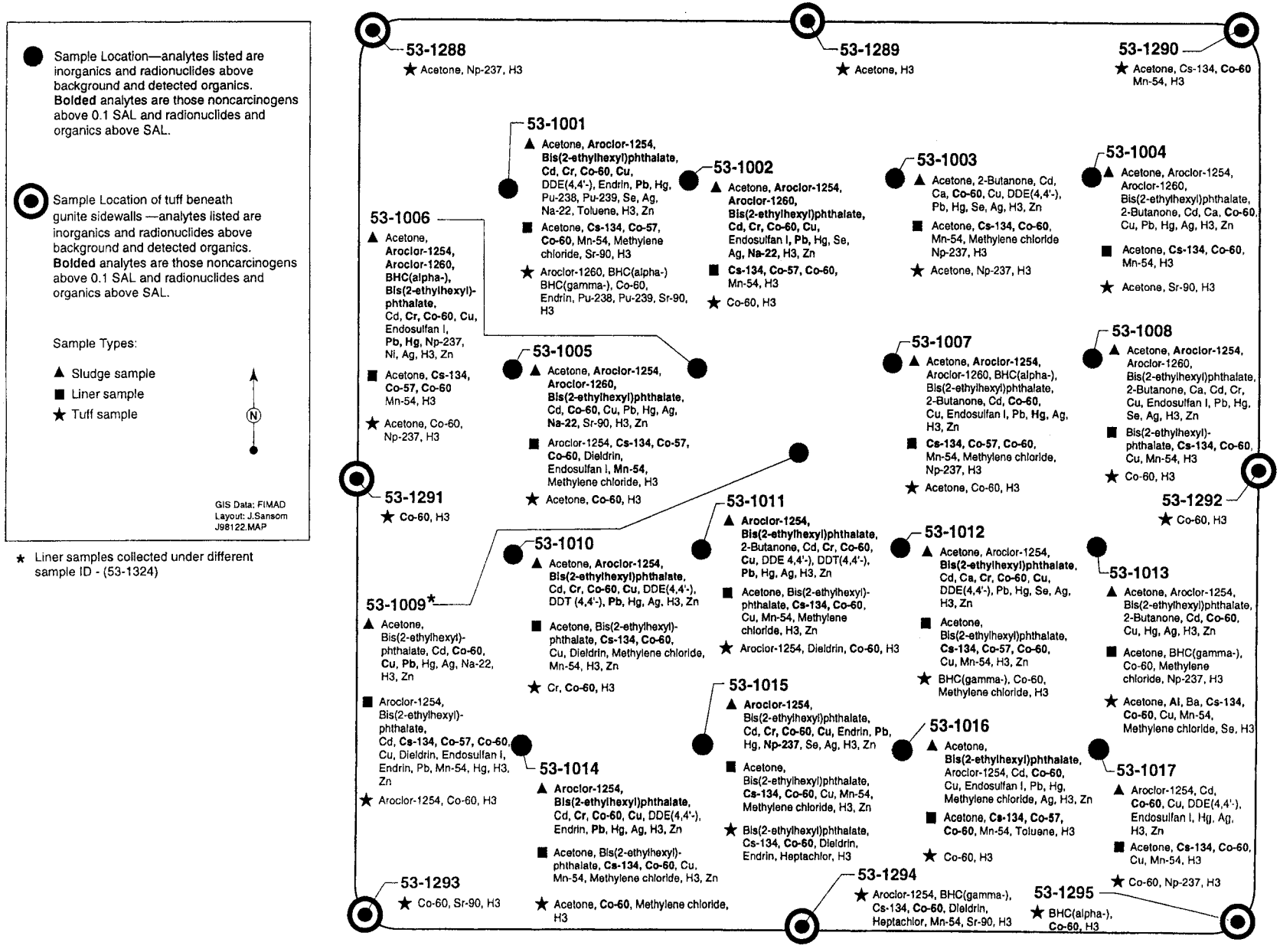


Figure F-3. Sample locations and sample results at PRS 53-002(a), northwestern surface impoundment

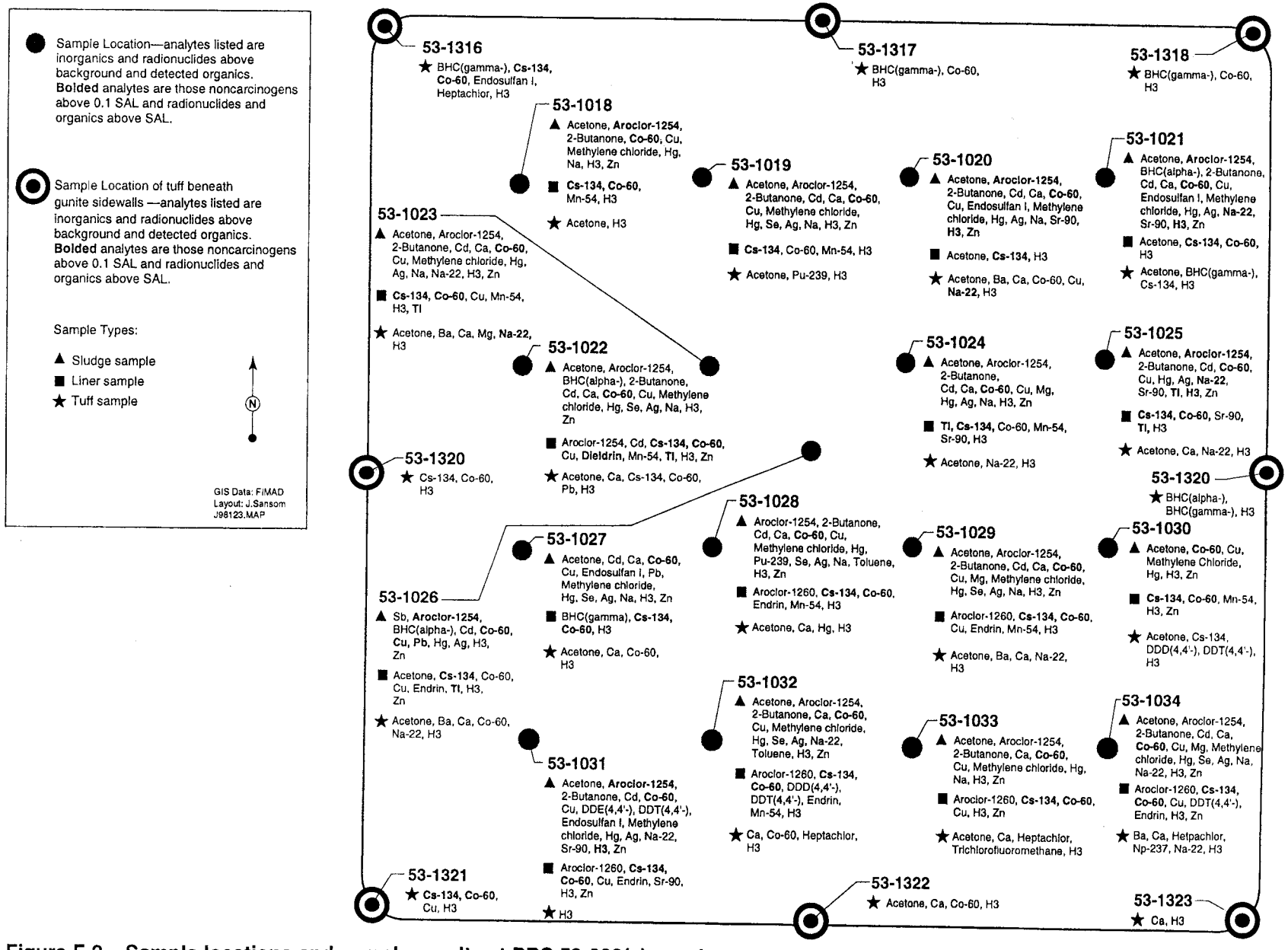


Figure F-2. Sample locations and sample results at PRS 53-002(a), northeastern surface impoundment

EXAMINATION OF 1995 DATA TO DETERMINE EXTENT DATA GAPS

A spatial assessment of the 1994/1995 data was performed to look at contaminant trends and determine where data gaps at depth existed below the northern surface impoundments. For the purpose of this assessment, a subset of analytes was identified as indicator contaminants based on historical disposals into the impoundments. This subset includes: arsenic, cadmium, chromium, copper, lead, mercury, selenium, zinc, cobalt-60, plutonium-239, and sodium-22.

Vertical extent of contamination for some indicator contaminants found in the northern surface impoundments has not been completely established through sampling. For the purpose of determining the number of locations to sample for vertical extent, the tuff data were examined spatially. In addition, 1995 sample locations were identified at which extent has not been determined for one or more indicator contaminants. In general, concentrations are lower in the tuff than in the sludge. The tuff beneath the northeastern impoundment contains many more locations with relatively high concentrations than the northwestern impoundment. This may be because of the slope of the undisturbed, welded tuff surface beneath the surface impoundments, which generally slopes from west to east. The tuff beneath the northwestern impoundment is welded; the tuff beneath the northeastern impoundment is crushed. It may be that when liquid penetrated the impoundment clay liner, it flowed along the clay liner/tuff interface of the northwestern impoundment and impacted the crushed tuff beneath the northeastern impoundment. Both inorganic and radioactive indicator contaminants follow the pattern described above, such that, many more locations with relatively higher concentrations are located beneath the northeastern impoundment compared to concentrations beneath the northwestern impoundment. The pattern is illustrated on bubble plots presented in Figures G-1 and G-2. A bubble plot is a graphical representation of contamination where a larger bubble indicates a location with either a higher concentration of contaminant, or a larger number of contaminants with relatively high concentrations. The relatively high concentrations of contaminants in the northwestern impoundment are generally located in the southern area. Chromium and cobalt-60 are the most-often identified indicator contaminants with relatively high concentrations in the northwestern impoundment, while lead , mercury, and sodium-22 are of higher concentrations in the northeastern impoundment. One location in each impoundment shows copper results that exceed the Laboratory background comparison value. One location in the northwestern surface impoundment shows a chromium result greater then its Laboratory background. A lead result exceeds the Laboratory background once and mercury exceeds the Laboratory background once in the northeastern surface impoundment. One location in the northeastern impoundment shows a plutonium-239 result greater than its Laboratory background comparison value.

All frequency and cumulative frequency plots, and the spatial plots showing relatively high concentrations are presented in Figures G-8 to G-18. Table G-1 identifies the level at which concentrations are defined as "relatively high." The summary table also gives the number of relatively high samples and their range, provides the number of results and the range of concentrations greater than the Laboratory background comparison values or respective SALs.

Because the tritium data is in pCi/L and no moisture data is available to convert the units to pCi/g, the only tritium trend that can be determined is that tritium is higher in the tuff than in the two overlying media. In addition, there is relatively more tritium contamination in the northeastern surface impoundment than in the northwestern surface impoundment.

The bubble plots, for classes of organic chemicals, show that with the exception of VOCs, very few detected values occur. Beneath the northwestern impoundment, total VOC spatial concentration patterns appear random. Total VOCs were detected at all, except for three locations in the southern portion of the northeastern impoundment between 0.002 mg/kg to 0.1 mg/kg. Herbicides and pesticides are detected only twice beneath the northwestern impoundment, and along the south and east edges beneath the northeastern impoundment; concentrations range between 0.0007 mg/kg and 0.005 mg/kg. Total SVOCs [only bis (2-ethylhexyl)phthalate] was detected only once beneath the northwestern impoundment and was not detected beneath the northeastern impoundment. None of the detected concentrations of organic classes of chemicals exceed their respective SALs.

Based on a qualitative evaluation of the spatial distribution of indicator contaminants, 20 locations were identified as locations where deeper interval tuff samples should be collected. Four locations in the southern half of the northwestern impoundment, and 13 locations in the northeastern impoundment will be sampled at two additional depth intervals. Three additional sample location were identified between the surface impoundments to bound cobalt-60. Samples will be collected from the 20 locations at the following depths, 60 to 72 in. and 132 to 146 in. Samples will be analyzed for the following analytical suites to determine extent: TAL metals, PCBs, SVOCs, gamma spectroscopy, isotopic plutonium, and tritium.

Once the relatively higher concentrations and locations were identified, those locations where extent has not yet been determined for at least one indicator contaminant was identified. Extent for this process is determined using three criteria:

- The concentration of an indicator contaminant shows a decreasing trend from the sludge, through the liner, and into the tuff;
- the concentration of an indicator contaminant in the tuff is not greater than Laboratory background comparison values; and
- the concentration of an indicator contaminant in the tuff is not greater than its human health risk-based SAL.

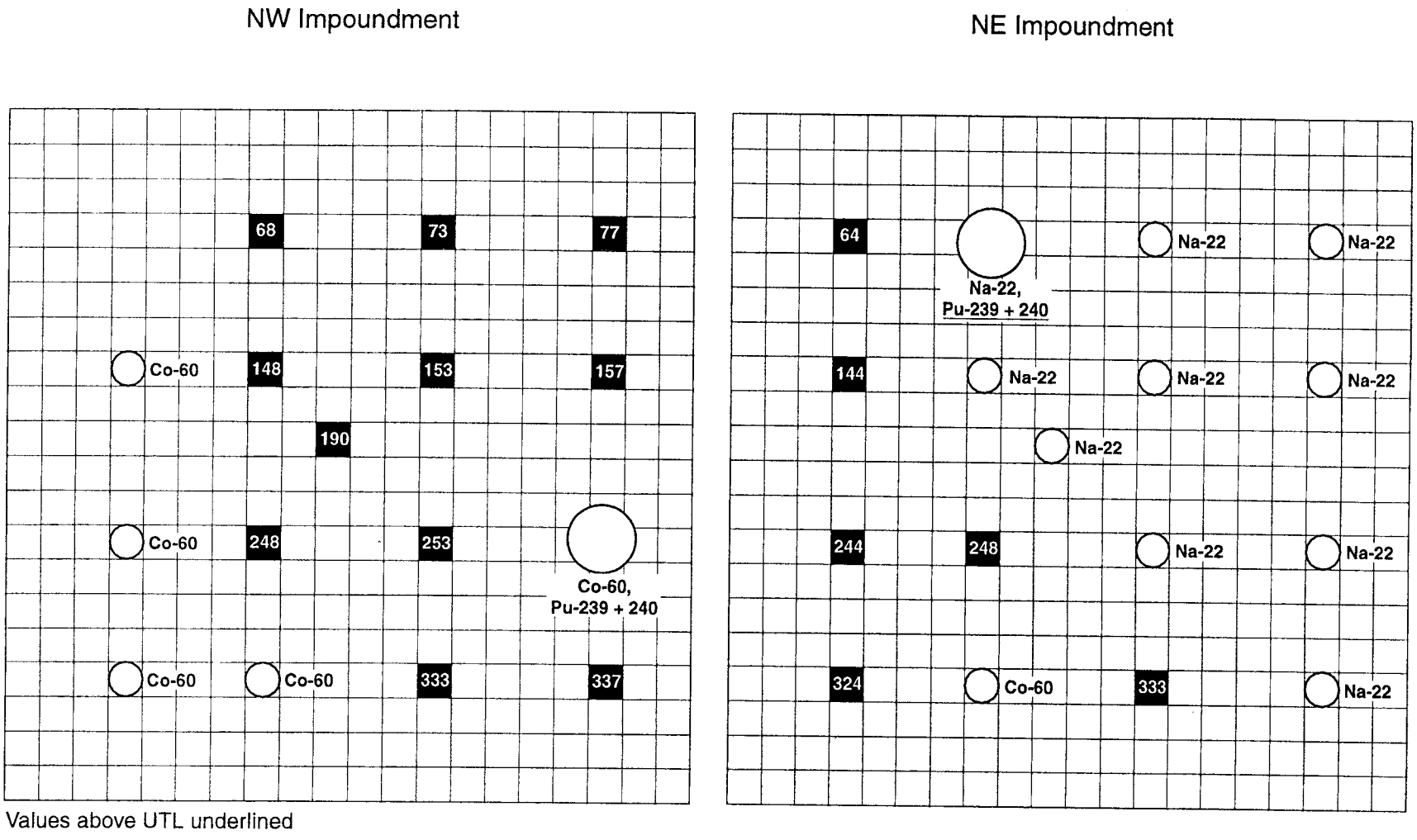
For many analytes, the Laboratory background comparison value represents an upper percentile of the background distribution. Therefore, there is a known, positive probability that one or more observations may exceed the Laboratory background comparison value, while the overall distribution is consistent with the background distribution. Therefore, an exceedance of the background comparison value should not necessarily warrant further sampling. The decision to conduct further sampling in these cases was determined judgmentally by interpreting the combined effects of results for other analytes, the proximity of other sampling locations, and degree to which the background comparison value may be exceeded.

The general areas where vertical extent has yet to be determined include the bermed areas between and below the surface impoundments, the southern portion of the northwestern impoundment, and much of the area beneath the northeastern impoundment.

Chromium levels are higher in the tuff than in the clay liner at four southern locations in the northwestern impoundment, therefore, a decreasing trend has not been established. Other indicator contaminants (arsenic, cadmium, copper, lead, mercury, zinc, cobalt-60, plutonium-239), along with chromium, are present in the southeast corner of the northwestern impoundment at higher concentrations in the tuff than the clay liner (Location ID 53-1013). Of these analytes, the copper and chromium concentrations in tuff exceeds the Laboratory background comparison value of 4.66 mg/kg and 7.14 mg/kg, respectively.

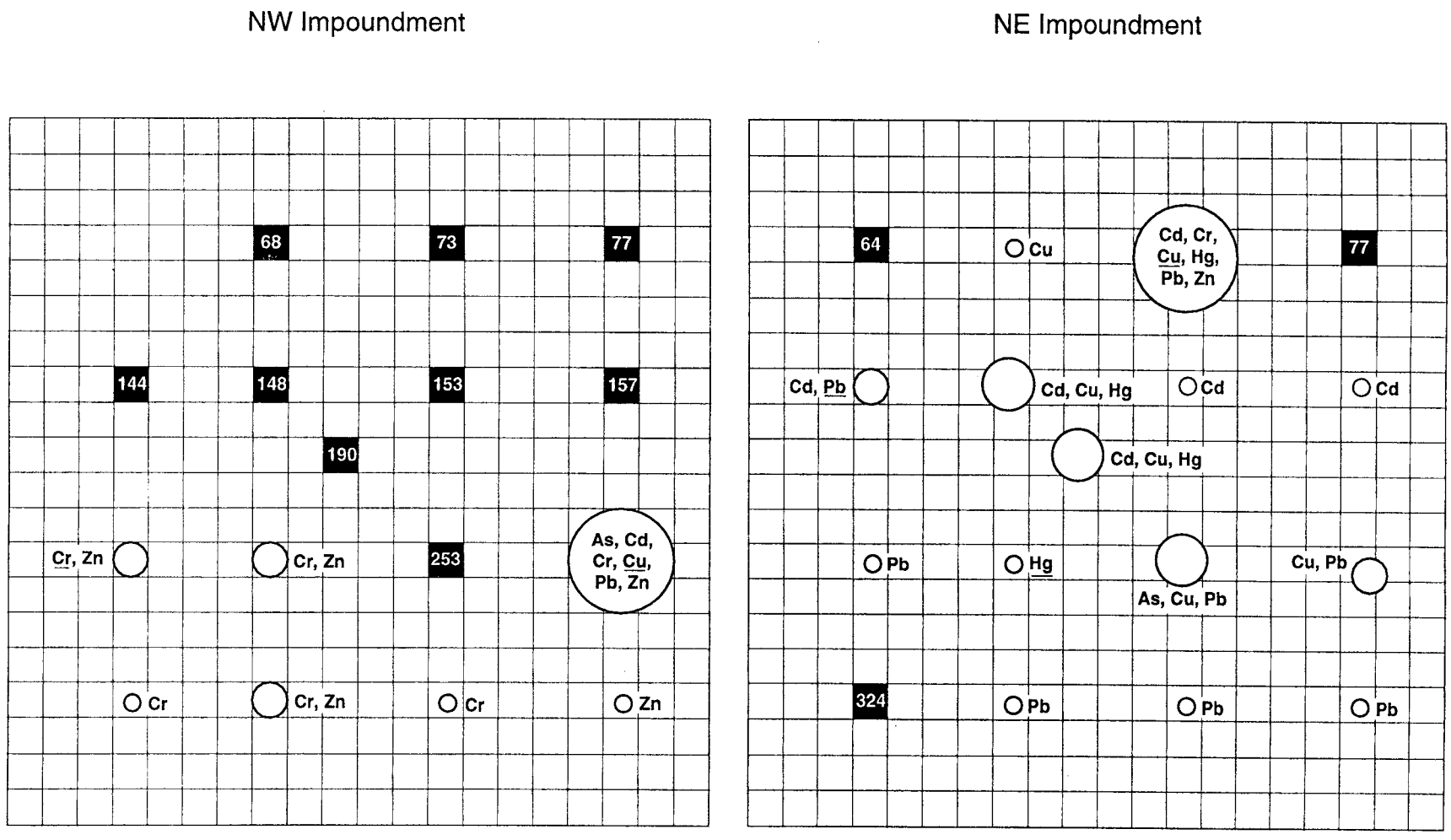
Many inorganic and radiological indicator contaminants show higher levels in the tuff than in the clay liner, and possibly the sludge, at various locations in the northeastern impoundment. In the northern half of the northeastern impoundment, these chemicals include: arsenic, cadmium, chromium, copper, lead, mercury, zinc, cobalt-60, sodium-22, and plutonium-239. Analytes with results that exceed the Laboratory background comparison value in the northern half of the northeastern impoundment include copper and lead. Mercury exceeds the Laboratory background comparison value in the southern half of the northeastern impoundment at one location, and mercury, sodium-22, and plutonium-239 show higher levels in the tuff compared to the clay liner.

Cobalt-60 concentrations exceed the human health risk-based SAL of 1.1 mg/kg in the tuff at several berm sample locations. Most of these locations are concentrated in the area between the Northern surface impoundments; one is located on the west side of the northwestern impoundment (Location ID 53-1291) and one is located on the south side of the northwestern impoundment (Location ID 53-1294). Copper is the only inorganic analyte detected in a berm sample at a level exceeding the Laboratory background comparison value of 4.66 mg/kg (Location ID 53-1321).



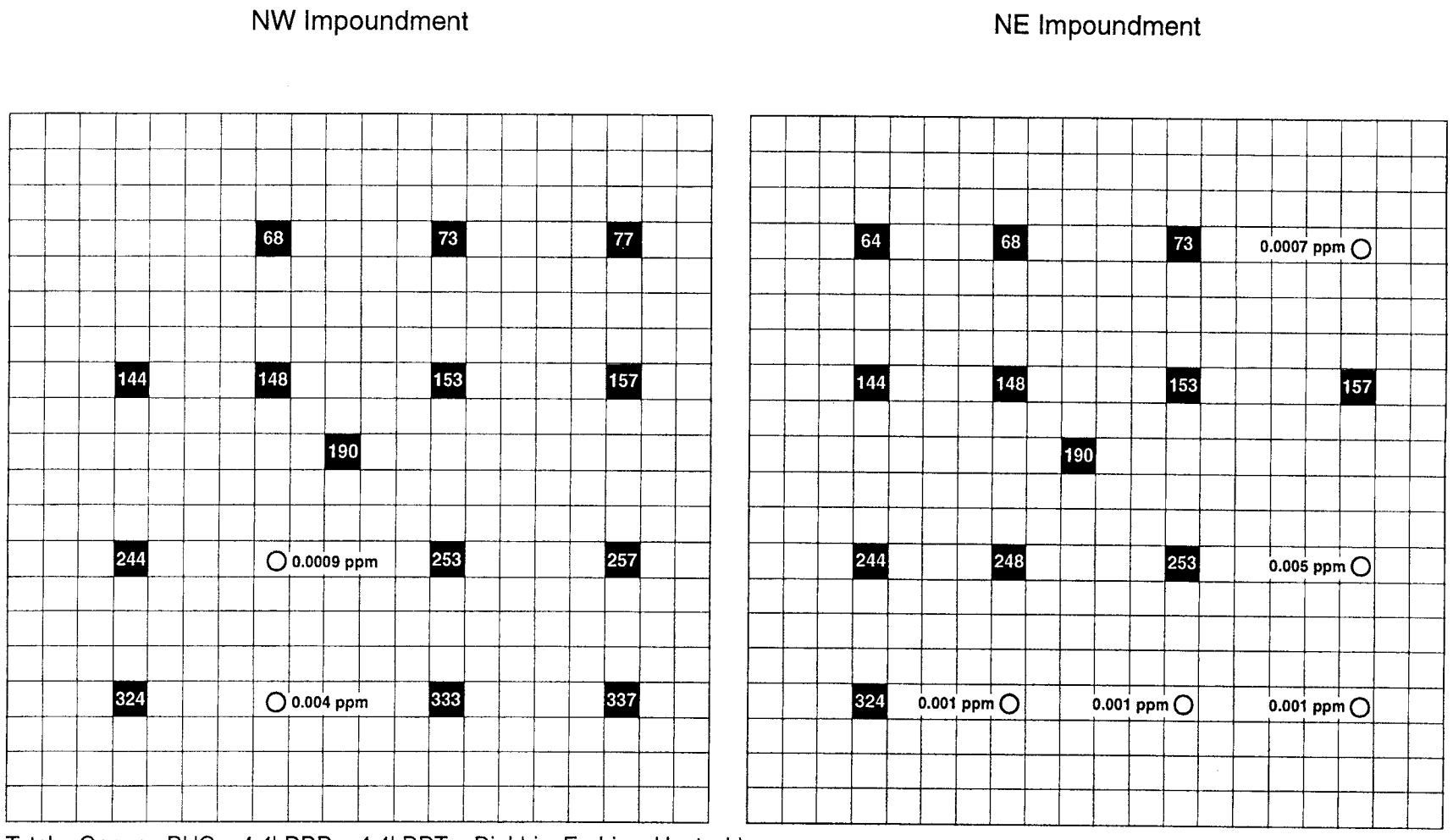
Values above UTL underlined

Figure G-2 Co-location of radiological analytes with relatively high concentrations in tuff



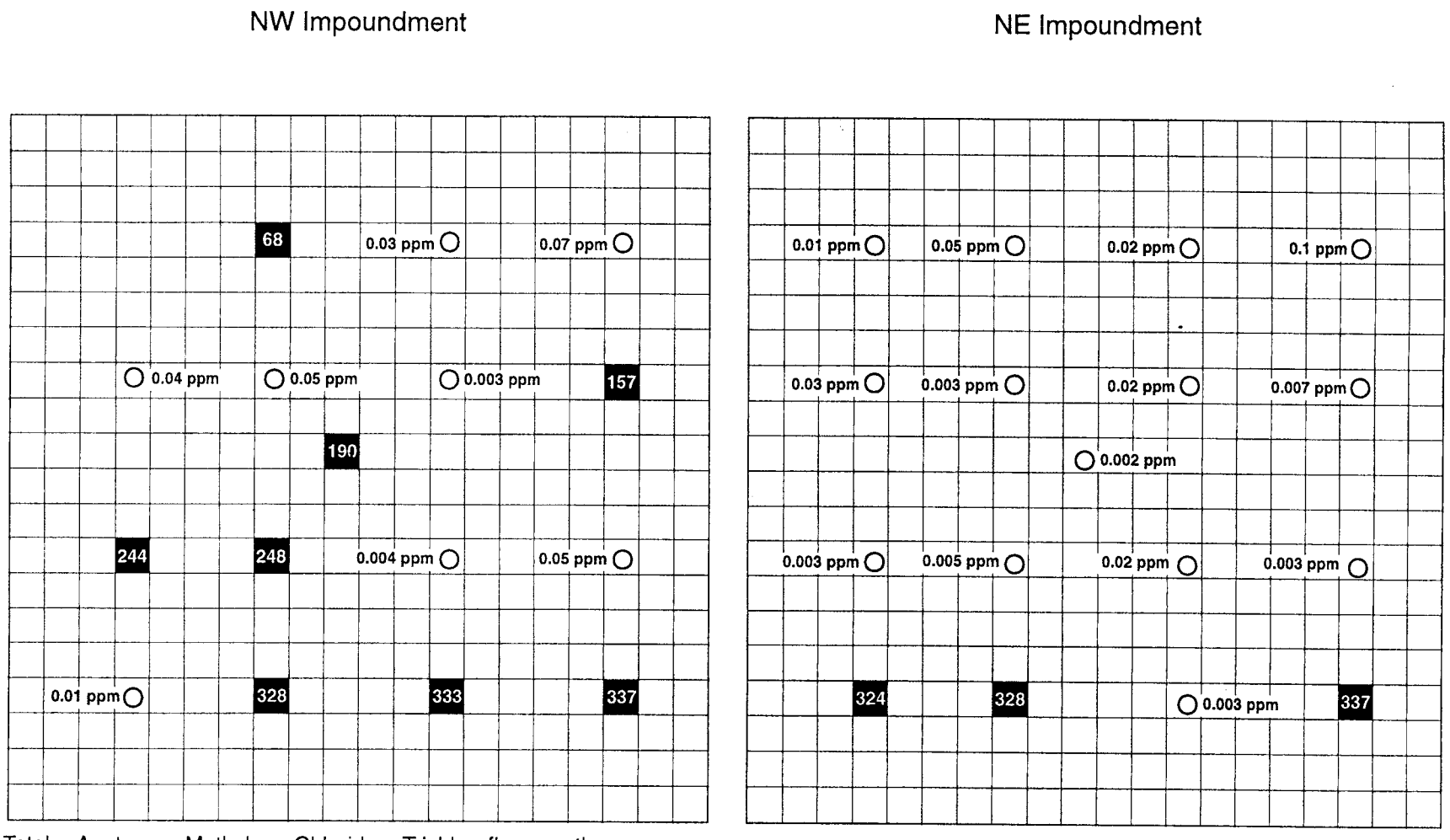
Values above UTL underlined

Figure G-1 Co-location of inorganic analytes with relatively high concentrations in tuff



Total = Gamma-BHC + 4,4'-DDD + 4,4'-DDT + Dieldrin, Endrin + Heptachlor

Figure G-4 Distribution of total detected herbacides and pesticides in tuff



Total = Acetone + Methylene Chloride + Trichlorofluoromethane

Figure G-3 Distribution of total detected VOCs in tuff

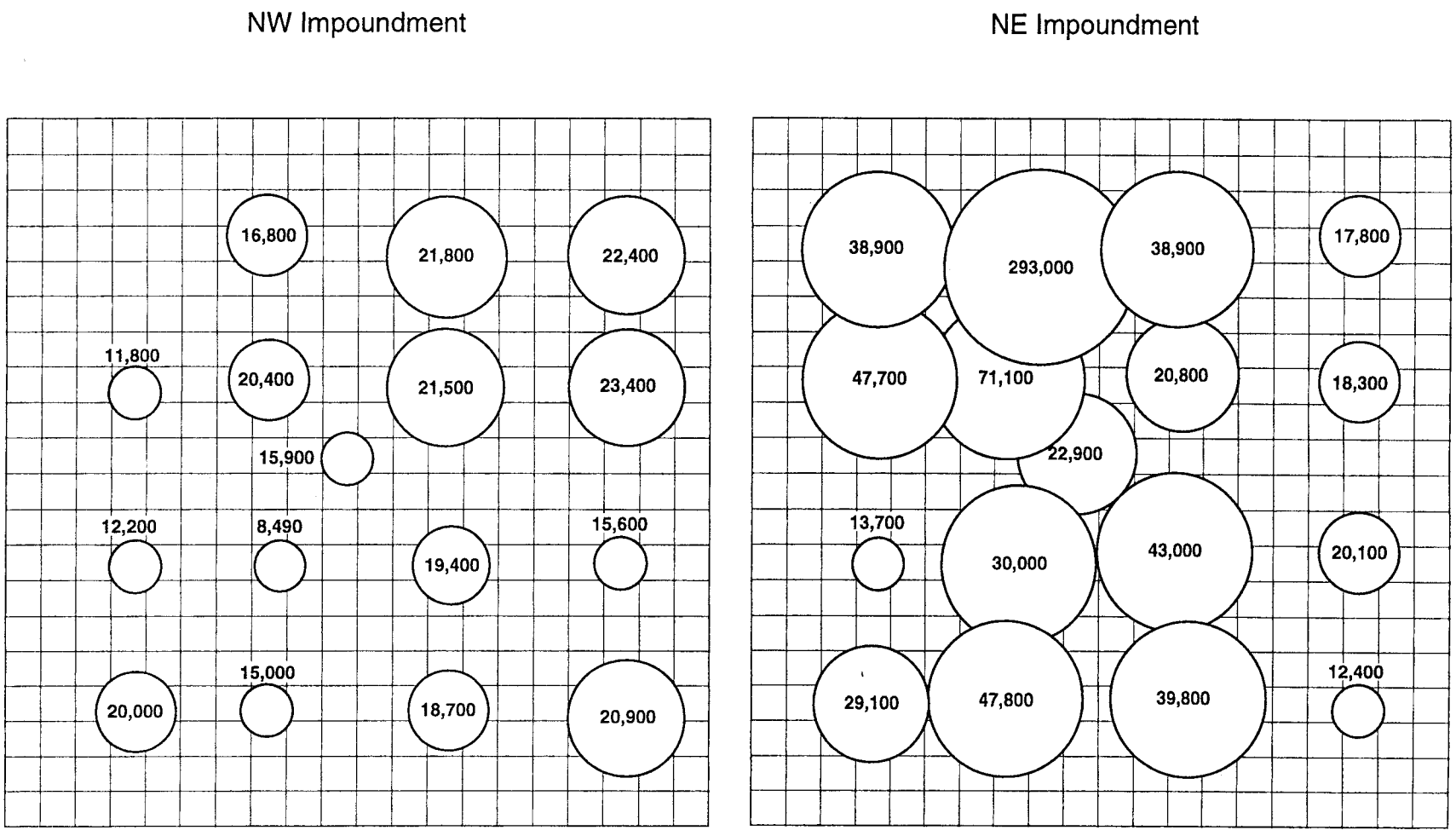
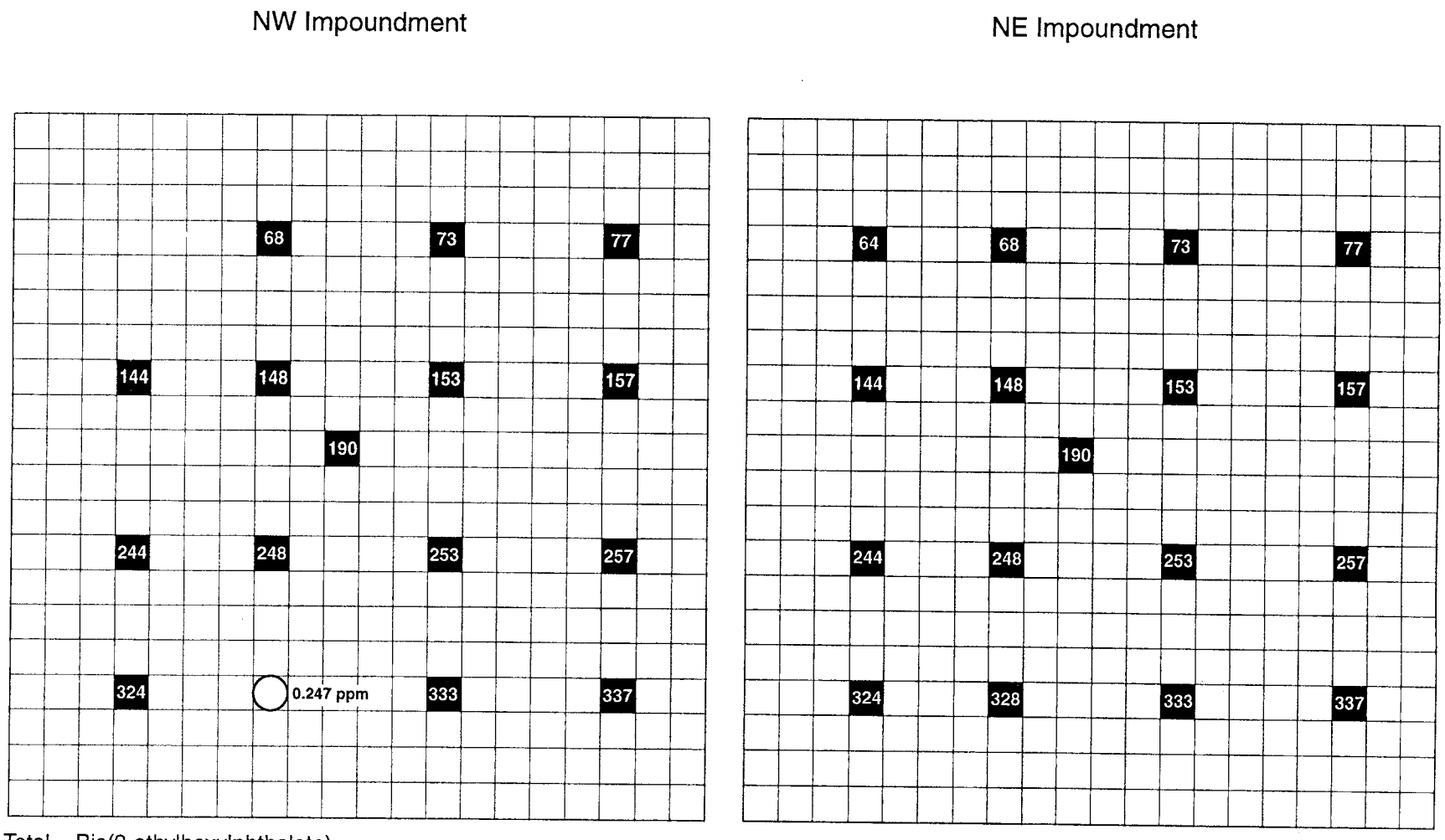


Figure G-6 Tritium concentrations in (pCi/L) in tuff



Total = Bis(2-ethylhexylphthalate)

Figure G-5 Distribution of total SVOCs in tuff

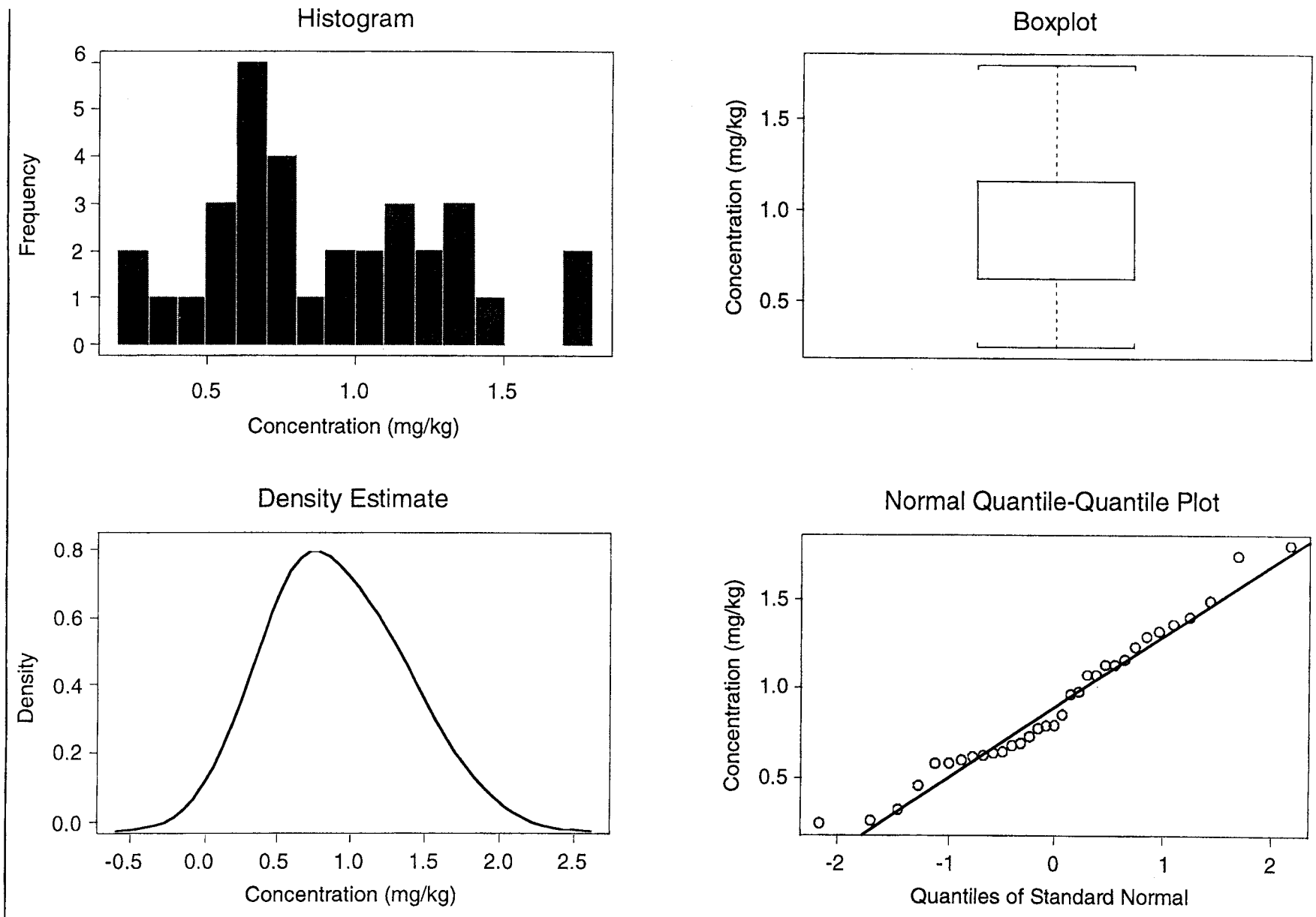


Figure G-8 Summary plots for arsenic data from tuff underlying the northern impoundments

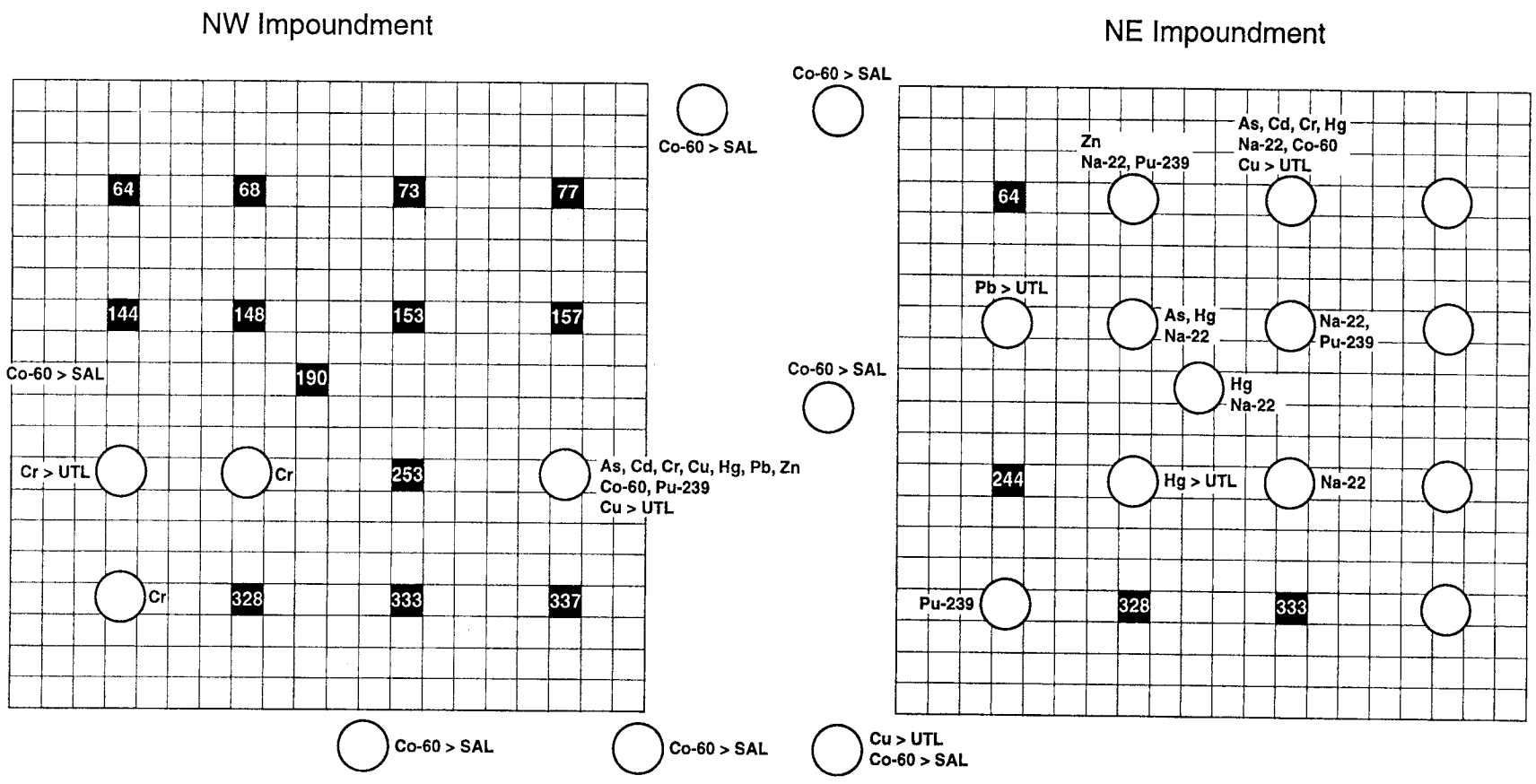


Figure G-7 Sampling results for the northern impoundments

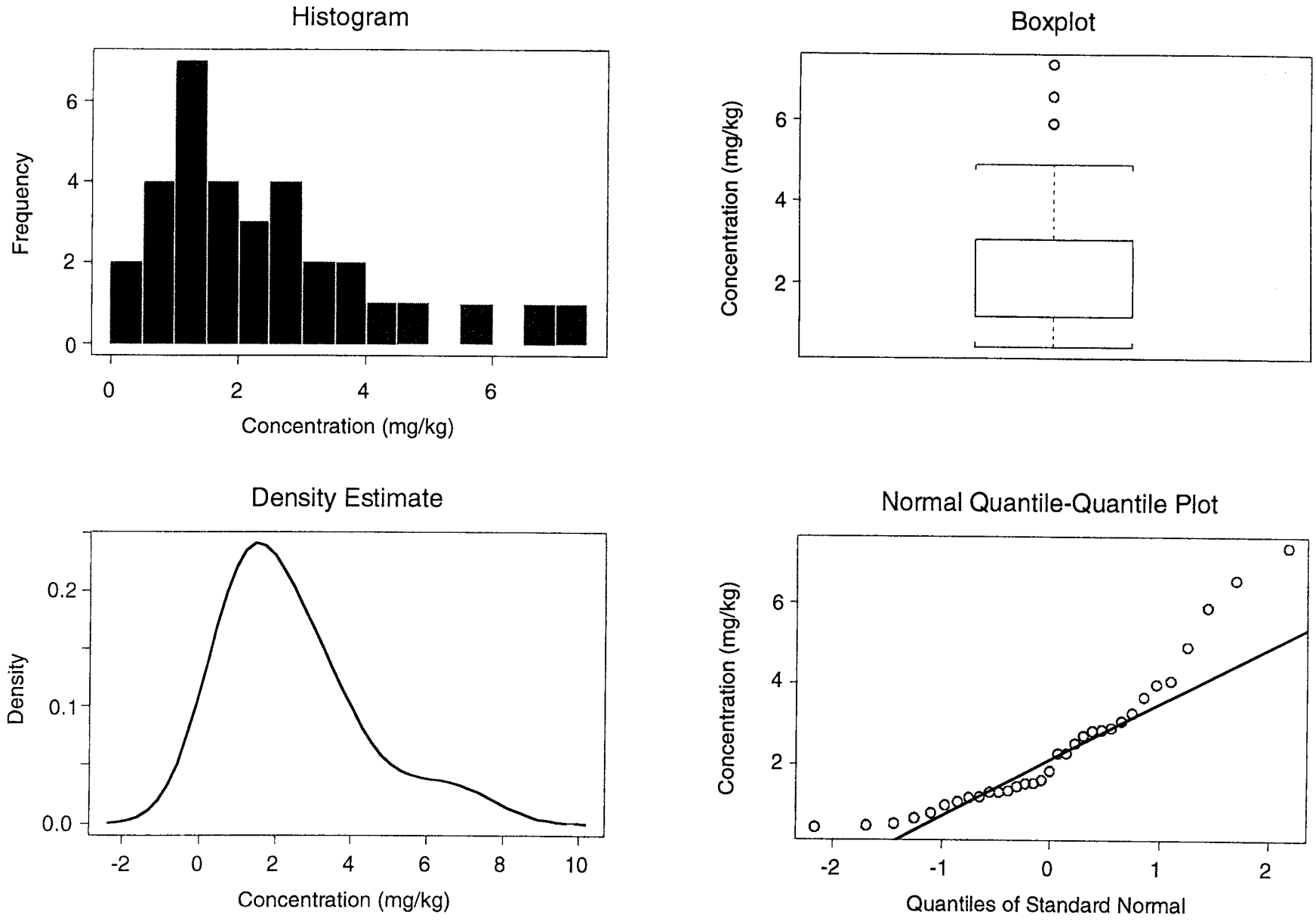


Figure G-10 Summary plots for total chromium data in the tuff underlying the northern impoundments

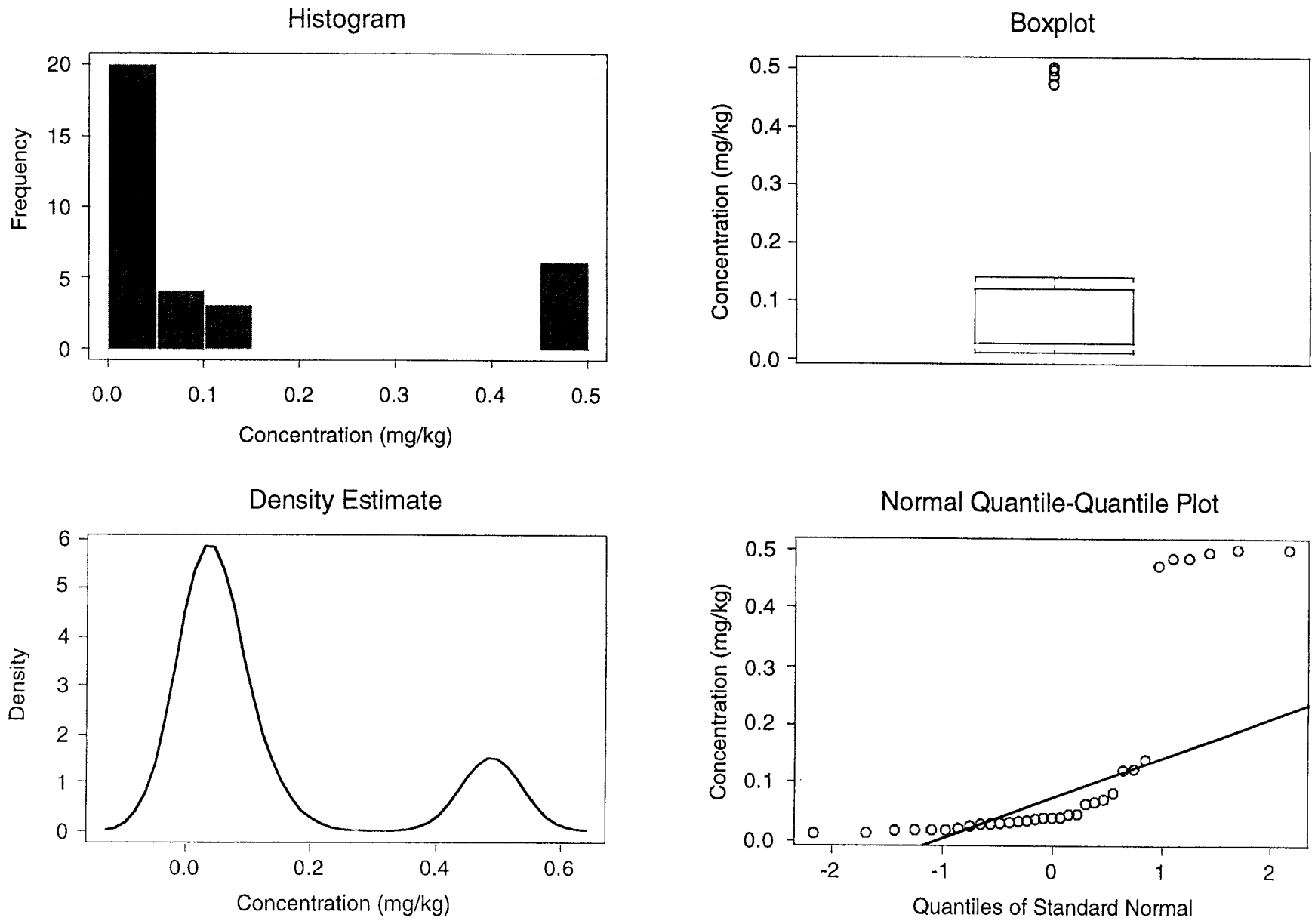


Figure G-9 Summary plots for cadmium data from tuff underlying the northern impoundments

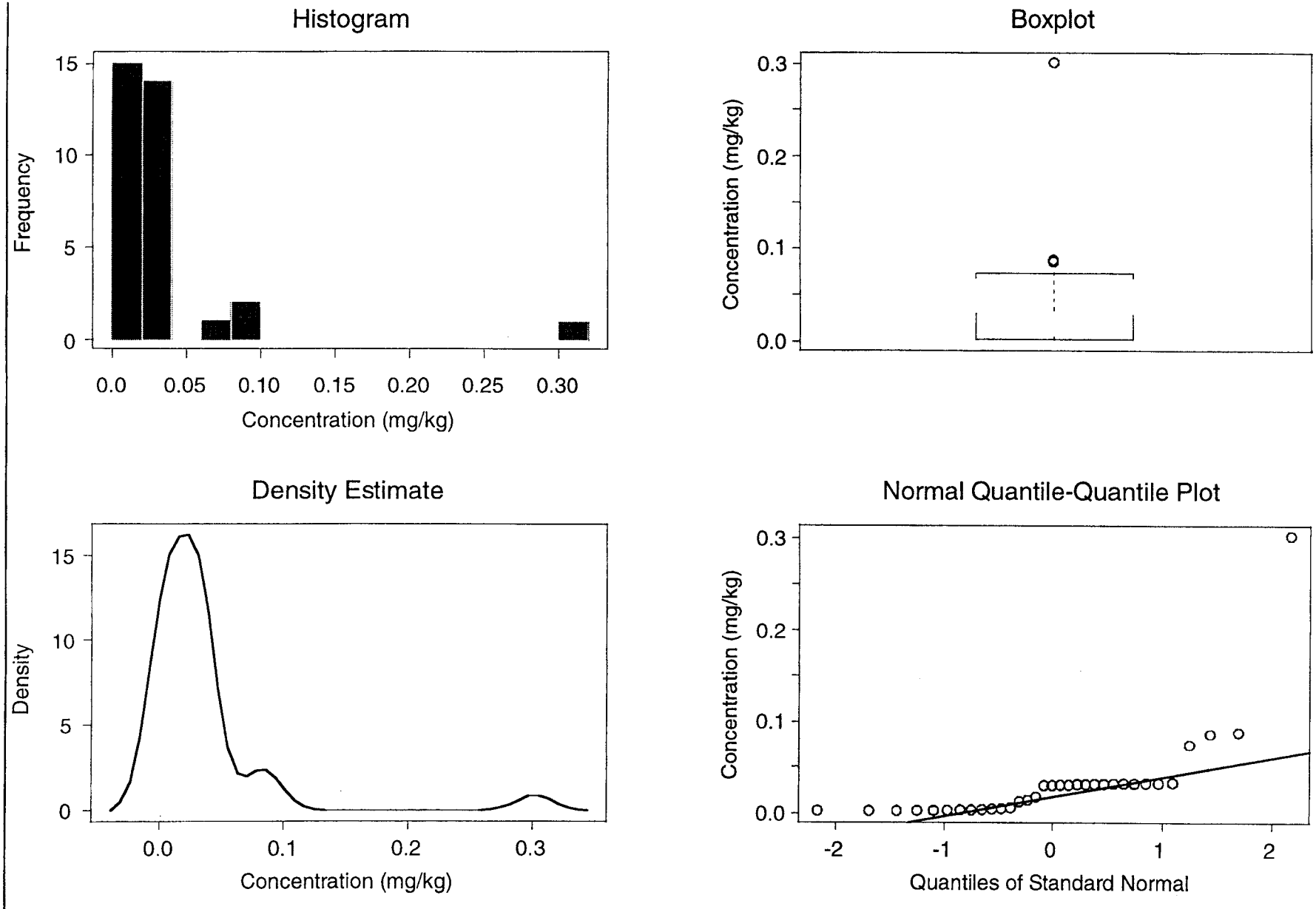


Figure G-12 Summary plots for mercury data from tuff underlying the northern impoundments

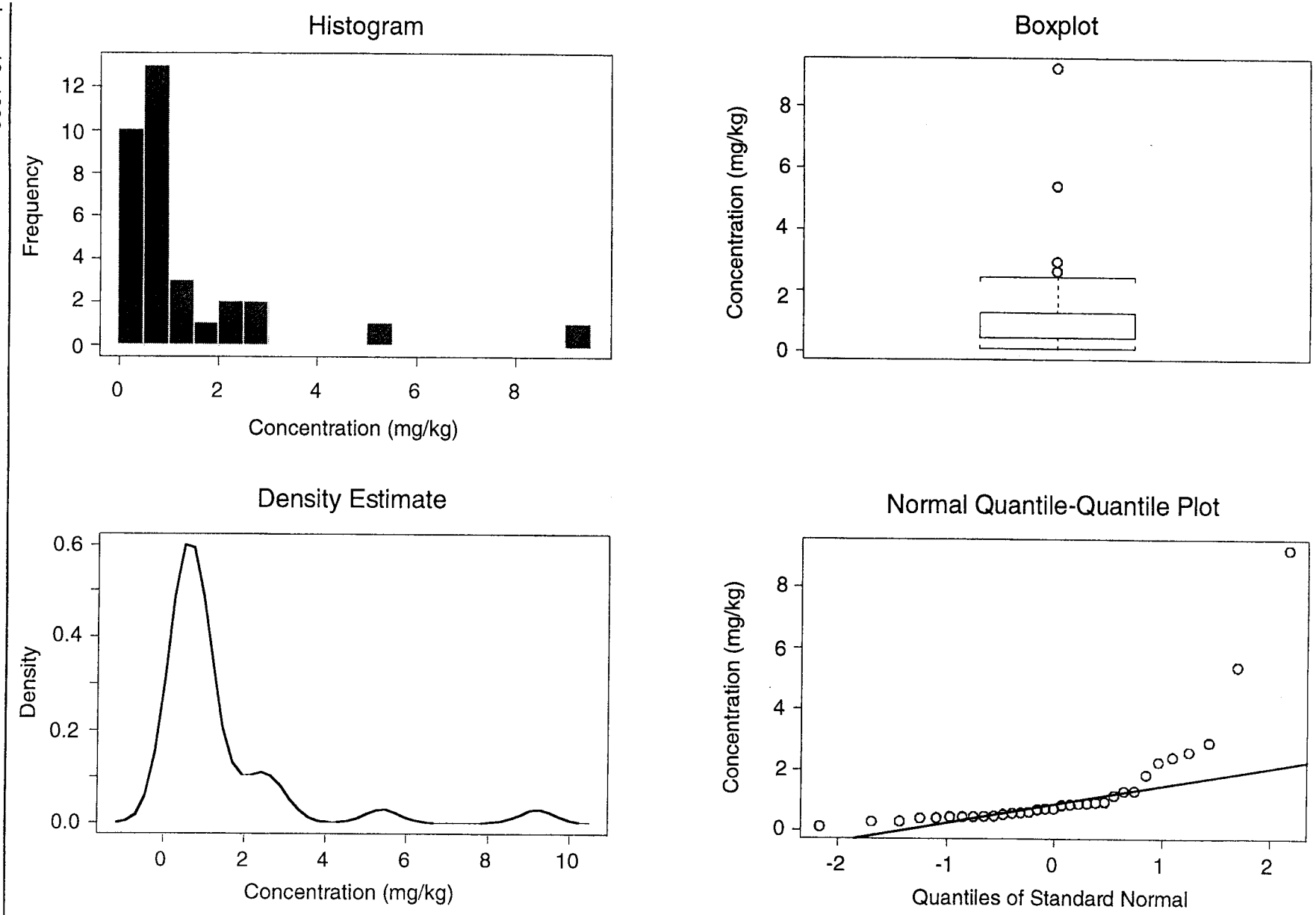


Figure G-11 Summary plots for copper from tuff underlying the northern impoundments

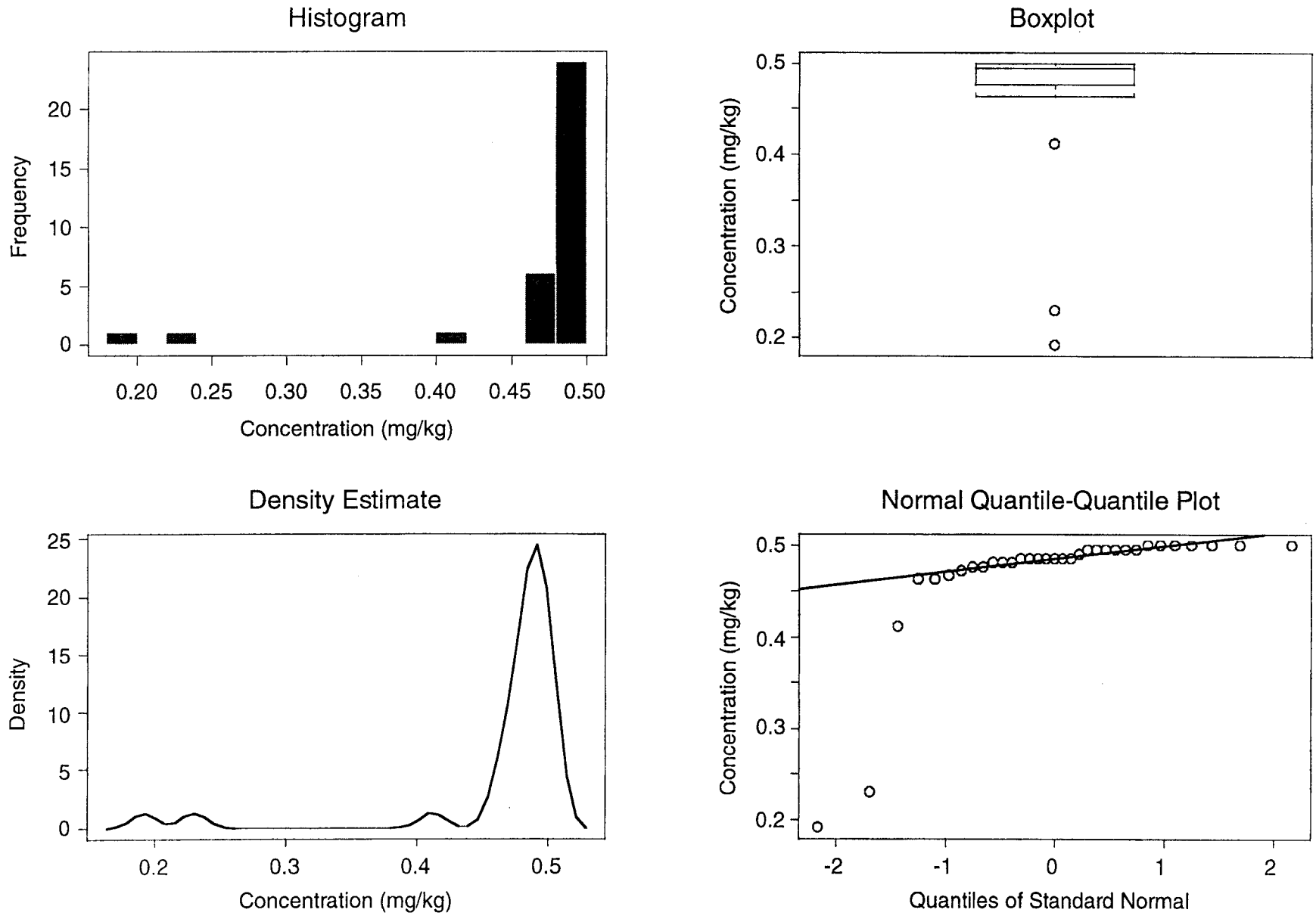


Figure G14 Summary plots for selenium data from tuff underlying northern impoundments

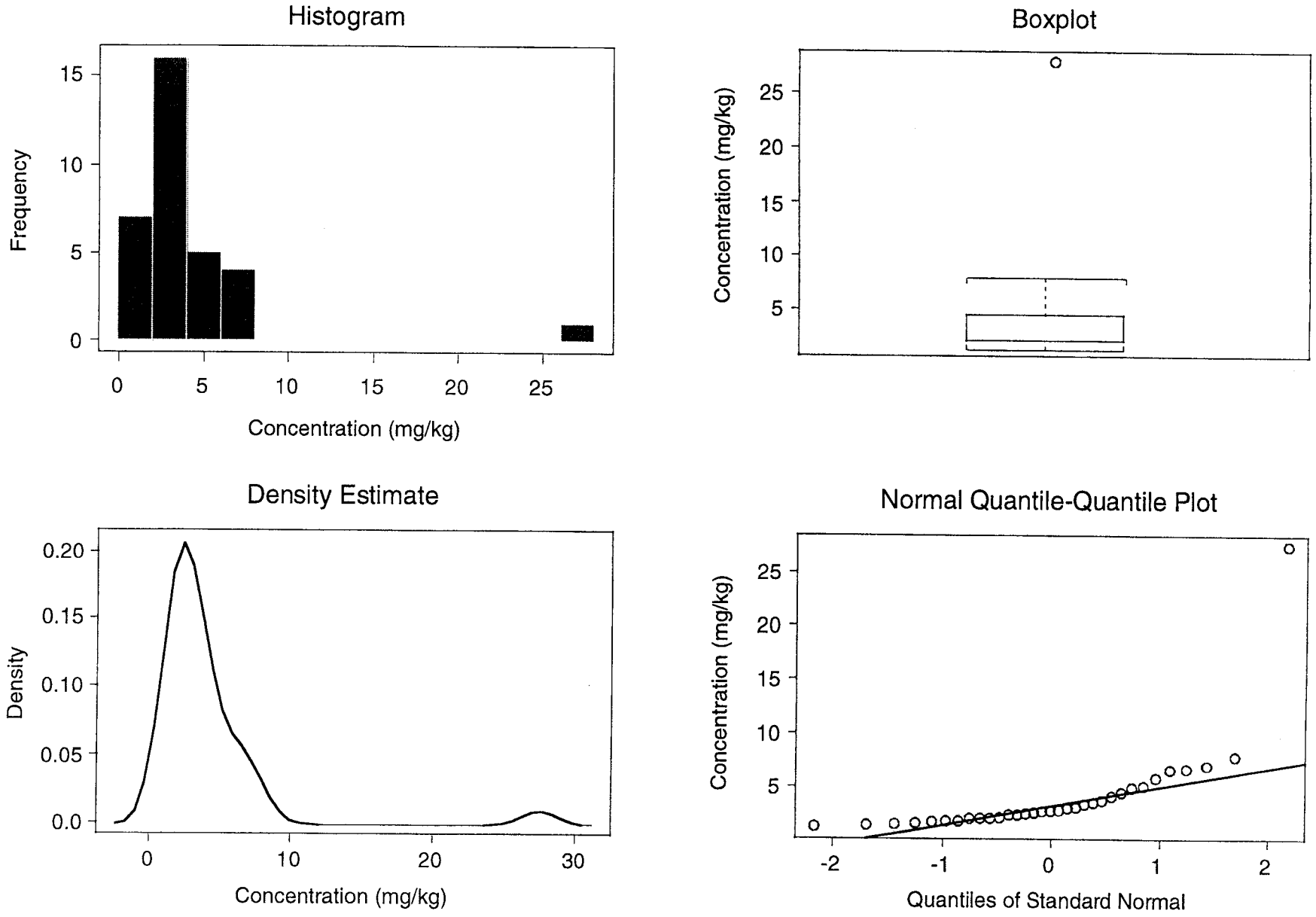


Figure G-13 Summary plots for lead data from tuff underlying northern impoundments

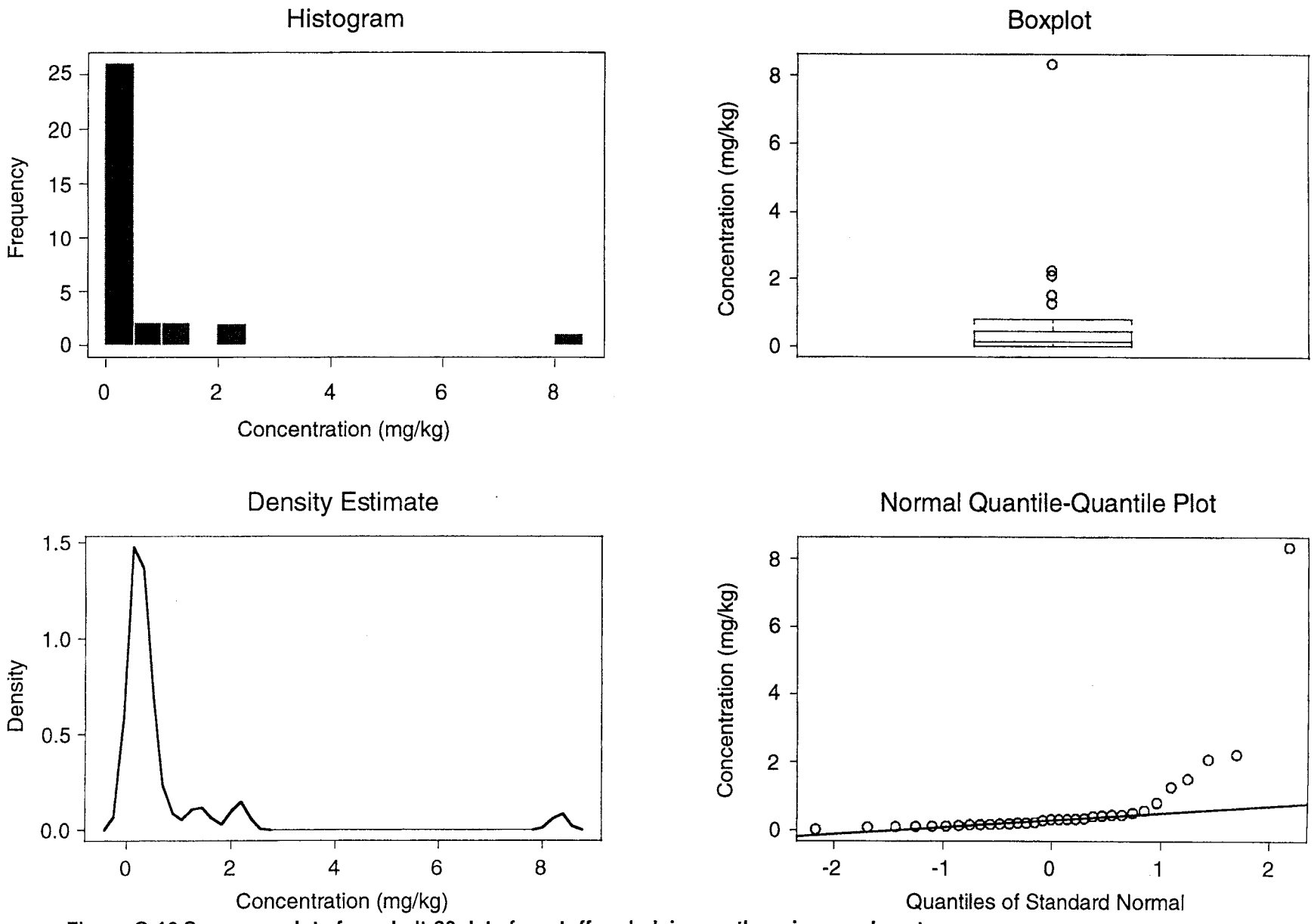


Figure G-16 Summary plots for cobalt-60 data from tuff underlying northern impoundments

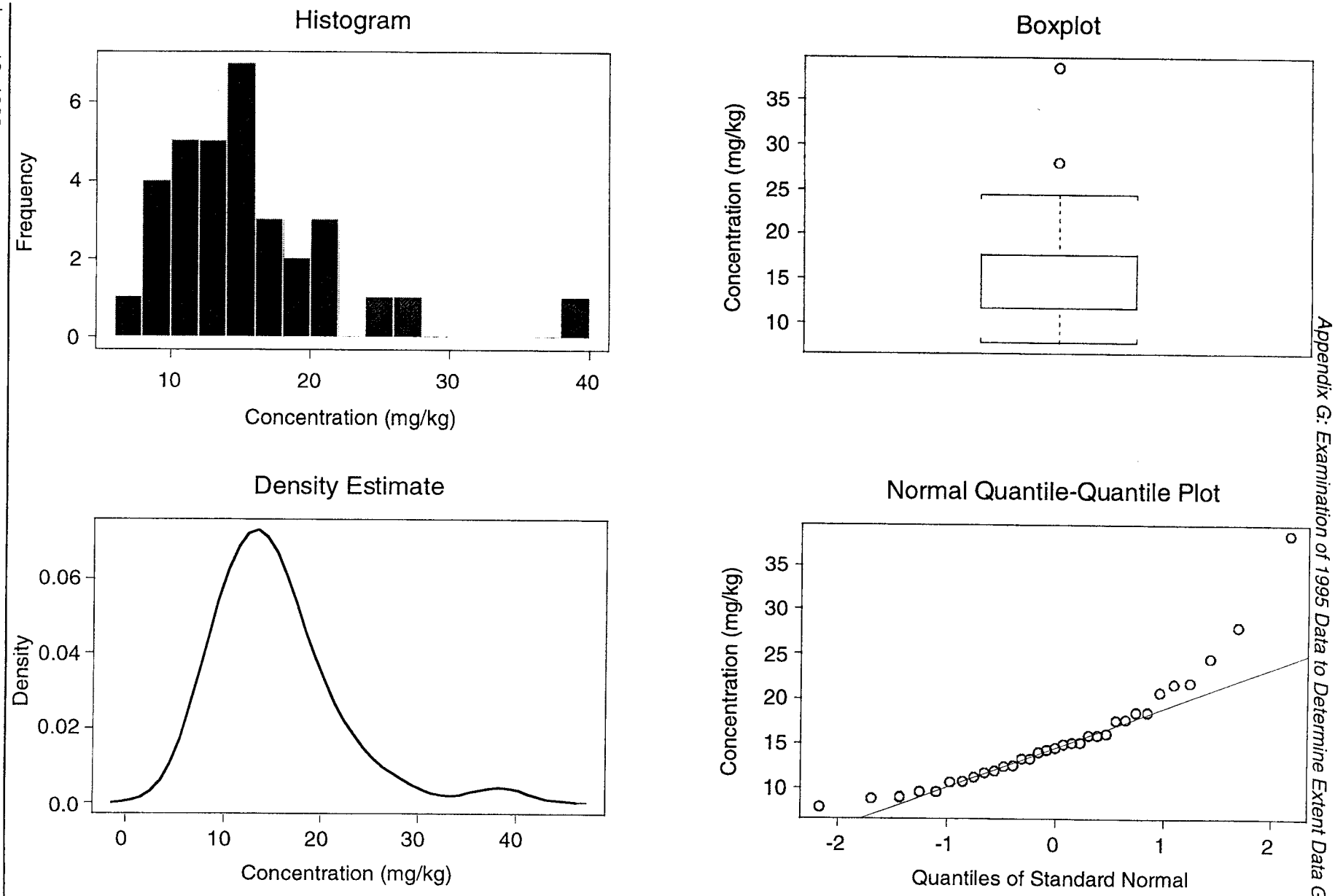


Figure G-15 Summary plots for zinc data from tuff underlying northern impoundments

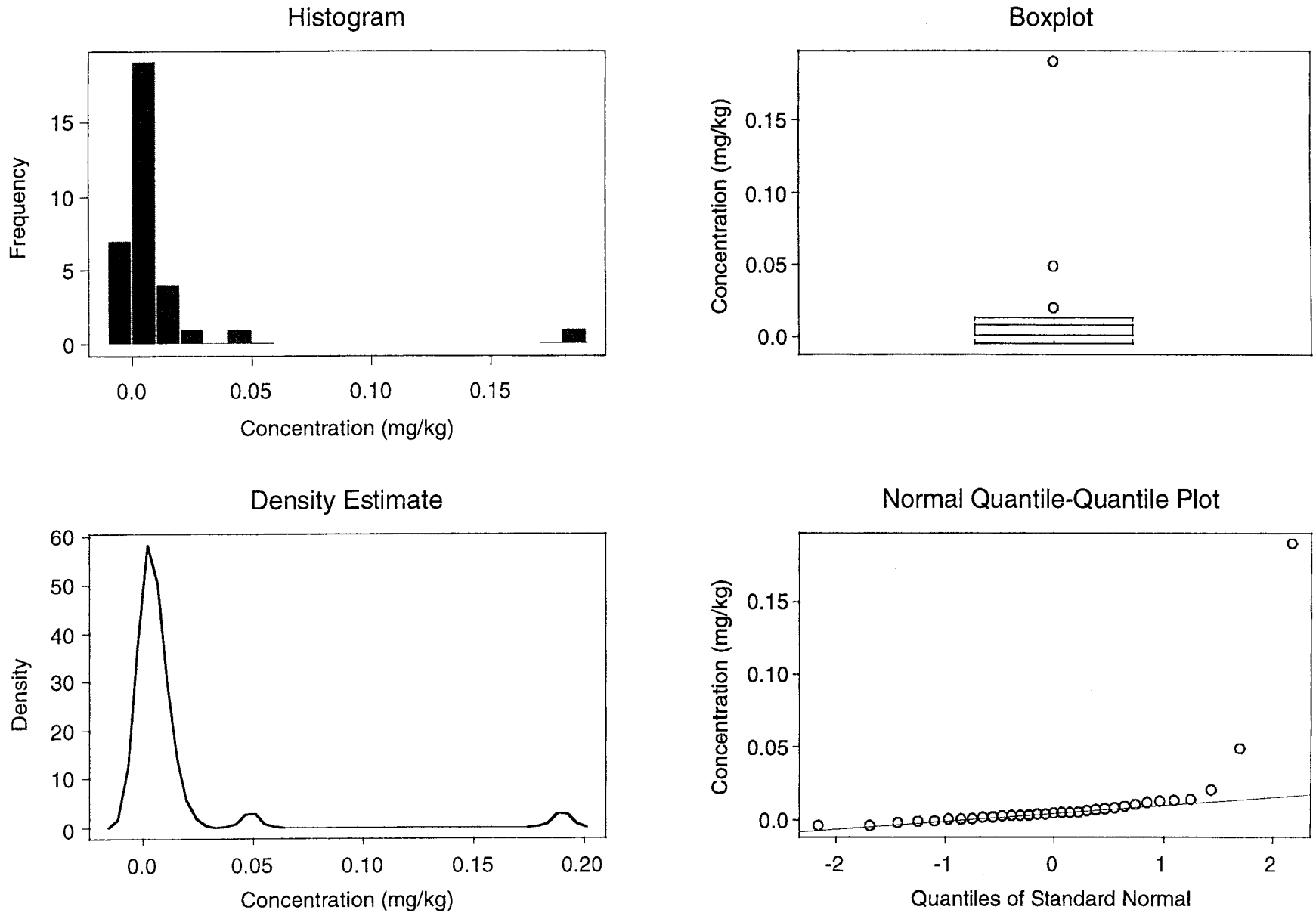


Figure G-18 Summary plots for plutonium-239/240 data from tuff underlying northern impoundments

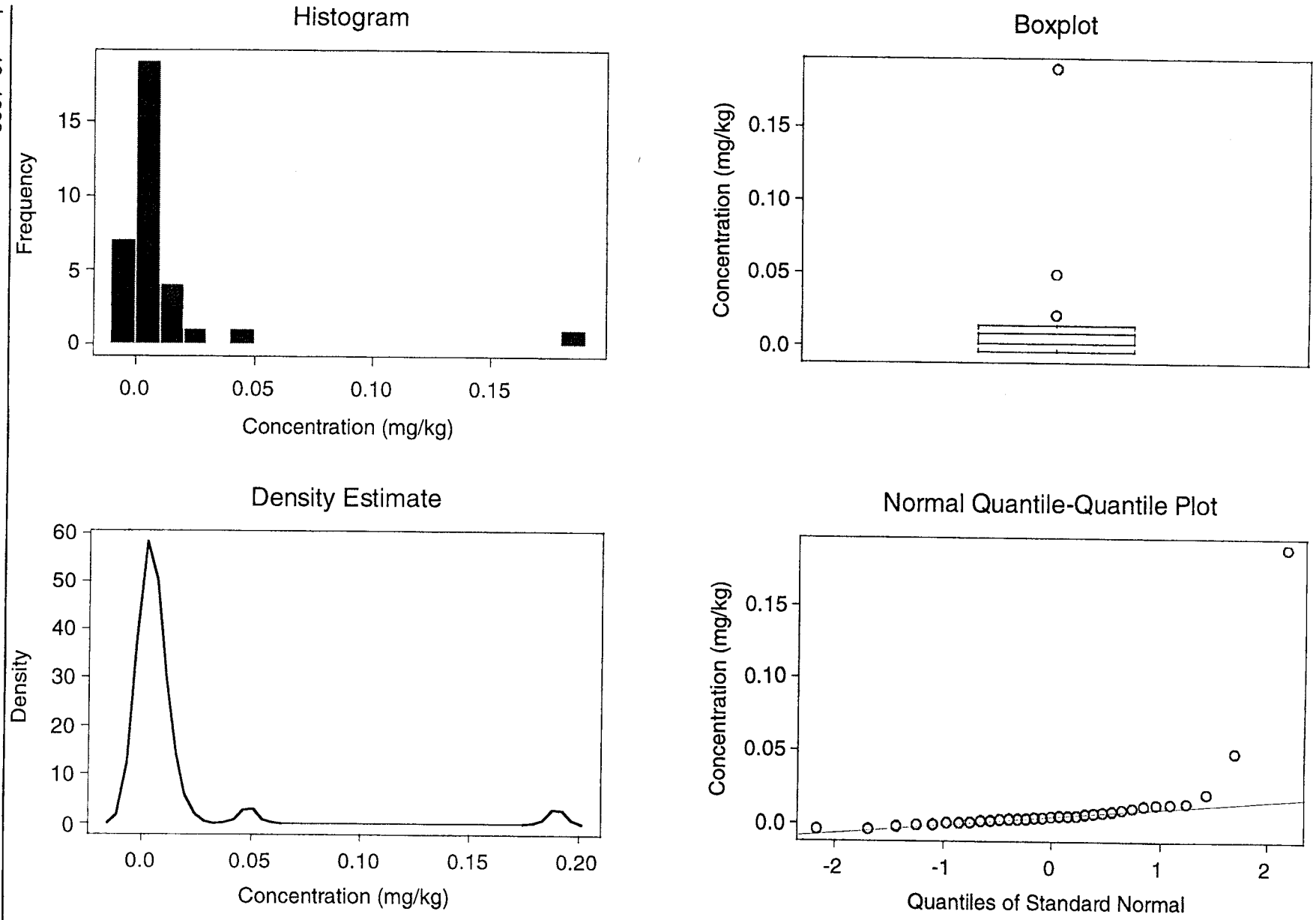
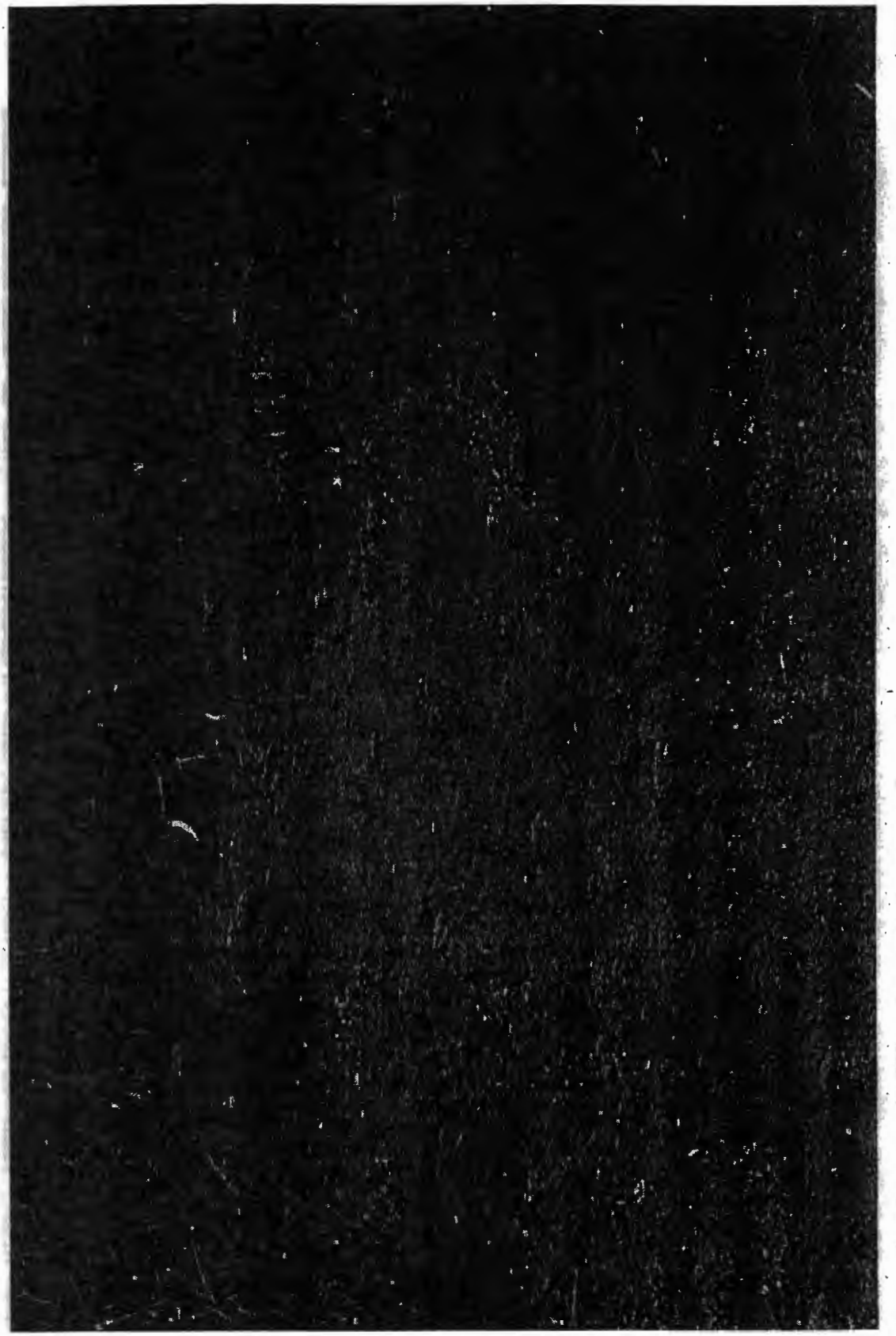


Figure G-17 Summary plots for sodium-22 data from tuff underlying northern impoundments

H-1. Existing area south of SW corner of south impoundment

H-3. Bench below SW corner of south impoundment



H-2. Surface soil SW of south impoundment

H-5. Drainage area across the road from existing weir; straw bales placed as BMP

H-4. Existing weir area on east side of impoundments

H-7. View down Los Alamos Canyon

H-6. Top view of weir and outfall across the road