Los Alamos Environmental Restoration Records Processing Facility

ER Record I.D.# 41928

ENTERED

LOS ALAMOS

LOS ALAMOS NATIONAL LABORATORY
ENVIRONMENTAL RESTORATION
Records Processing Facility
ER Record Index Form
SWMU SCREENING REVIEW

DATE RECEIVED: 11/02/92 PROCESSOR: MRM PAGE COUNT: 51

Part I: Complete all fields; indicate if not applicable or appropriate; please write legibly.

DOCUMENT TO: Dirk Heineman ORGANIZATION: HS-3

ORIGINATOR NAME: ROBERT GONZALES ORGANIZATION: EM-13

SYMBOL: 10 978 DOCUMENT DATE: 10/28/92

SUBJECT: Collection of soil surface and subsurface samples, TA-3, Bldg. 30

RECORD TYPE: SWMU REVIEW

RECORD CATEGORY: PROGRAMMATIC RECORD FILMED (Y/N): YES

MISCELLANEOUS (List other indexing criteria as necessary; please write legible):
ER-RG-1003
Work Order- 10978
Excavation Permit - 6395

Part II: Complete all fields; indicate if not applicable or appropriate; please write legibly. Use *ER Record Index Form Attachment Sheet* if needed.

TECH AREA(S)	ADS NO(S)	STRUCTURE NO(S)/MDA
LIST RELEVANT TECH AREA(S). 3	*LIST RELEVANT ADS NO(S).* —	*LIST RELEVANT STRUCTURE NO(S)/MDA* 3-30

CORRECTION (Y/N): NO
(Is this a correction to a record previously processed?)

CORRECTED #: —
(If answer is Yes, please give ER Record # for corrected record.)

CORRECTION DESCRIPTION (Optional): NONE

SUPERCEDE: NO REPLACE: NO DELETE: NO ADD: NO REVISE: NO

ATTACHMENTS FILMED (Y/N): Y
(Were attachments to this record filmed?)

LOCATION: —
(Indicate location of attachments if not filmed)

33049

ATTACHMENT LIST

A) Form TO: — FROM: Phil Fresquez
SYMBOL: 10978 SUBJECT: HS + EM Facility Review Record
DATED: 10/22/92

B) Form TO: — FROM: —
SYMBOL: — SUBJECT: Excavation Information
DATED: —

C) Drawing TO: — FROM: —
SYMBOL: — SUBJECT: Take Soil Samples 6395
DATED: —

D) Letter TO: — FROM: Philip R. Fresquez
SYMBOL: — SUBJECT: Excavation Permit Request
DATED: 10/22/92

E) Memo TO: Ed Griggs FROM: Phil Fresquez
SYMBOL: — SUBJECT: Collection of Soil Samples at SWMU
DATED: 10/22/92

F) Drawing TO: — FROM: —
SYMBOL: — SUBJECT: Location of Soil and Sediment Sampling Points at SWMU 3-010(a)
DATED: —

G) Report TO: — FROM: —
SYMBOL: — SUBJECT: Sampling and Remediation Plan for Mercury-Contaminated Soils at TA-3-30
DATED: 10/23/92

LANL CONSTRUCTION / MAINTENANCE / SWMU SCREENING REVIEW
FOR INTERNAL EM/HS-INFORMATION ONLY

TO: Dick Heineman, HS-3, MS K489 (51) ER-RG-1003
FROM: Robert Gonzales, EM-13, MS M992

LANL Construction Project No: _____ Project Description: Collection of soil surface and subsurface samples

TA: 3 Bldg: 30 Other location information: _____

PI No.	Service Request	Work Order	Excavation Permit	Submitted Drawings	Siting No.	Construction Design Review	ES&H Order	Contract No.
		10978	0395					

FRIORITY CATEGORY FOR REVIEW: Routine Urgent Extra Urgent xx Other

Package Acceptable for ER Review? No __ Yes xx

IMPACT TO ER PROGRAM? No xx Yes __ (See Comments)

Field Verification Q-clear no
Field Contact Phil Fresquez
Phone 7-0815 Date

Informational copy provided to (cy: if checked):
HS-1___ HS-3___ HS-5___ EM-7___ EM-8___ HS-12___

SPECIAL PROTOCOL FOR SITE VISITS by EM-13 or EM-13 Contractors

Secured Area Yes ___ No xx
Emergency Procedures Yes ___ No xx
Special Health and Safety Considerations Yes ___ No xx
Special TLD Requirements Yes ___ No xx

REFERENCES: xx 11/90 SWMU Report ____ 1989 Site Data Base ____ 1987 CEARP (Phase I)
____ Records Office Other _____

Comments:
The ER Program has received a request for an excavation permit to take environmental samples west of SM-30 at TA-3.

This project is being conducted in support of ER planned activities for Operable Unit #114. ER concurres with the project as outlined. This project should be allowed to proceed without further delay.

Oral approval given to HS-3 at 2:30 p.m. on October 26, 1992

EM-13 PROJECT REVIEW SECTION INFORMATION
Prepared by: J P Langer Date: 10 28 92
(ym)

LANL EM-13 PROJECT LEADER REVIEW By: [signature] Date: 10/28/92

cy: *Phil Fresquez, EM-8, MS K490
Ed Griggs, CLS-DO, MS E525
Don Helmer, EM-13, MS M992
EM-13 RPF, MS M707

xx Approved
___ Approved with comments
___ Disapproved

Received by ER-RPF
NOV 02 1992
YCG

10/26/

X URGENT

HS & EM Facility Review Record

Subject:

Request From: Phil Fresquez Date: 10/22/92

Title: Collection of Soil Surface + Subsurface Samples

TA: 3 BLDG. NO. 30

ID Number 10978 LJ SR SJT (WO) Cont. NO.

Concerning HSE Review for:

[X] Excavation Permit # 6395 [ ] SWMU Review [ ] Siting

[ ] Disposal of Property [ ] Re-Utilization Property

The listed action may involve concerns relating to your field(s) of expertise. Please review and return your comments on this sheet as soon as possible. The document will not be returned to Engineering/Johnson Control Inc. for implementation without your input.
Thanks for your cooperation.

From: HS Facilities Design Review (MS K489)

[ ]	Dick Heineman	5-5444	[X]	Nina Gallegos	5-5363
[ ]	Don Helmer	5-5762	[ ]	Darrin Stafford	104-3096
[ ]	Adan Ortega	104-4032	[ ]	Fred Thomen	104-4028
[ ]	Bob Plale	104-3088			

Distribution: w/attachment Date 10/22/92

[X]	HS-12	K483	G. Neely
[ ]	HS-5 OS	K489	
[X]	HS-5	K494	M. Tillery
[ ]	EM-7	E518	L. Emelity/D. Moss
[X]	EM-8	K490	D. Garvey
[X]	EM-8	K490	[redacted] R. Rangel
[ ]	EM-8	K490	D. McInroy
[X]	EM-13	K481	R. Gonzales
[ ]	Other		

HS & EM Review ___ /__ /92 By: _____

[ ] Approved [ ] Approved with Comments [ ] Disapproved

Comments:

EXCAVATION INFORMATION

STRUCTURE NUMBER: TA-3-30

LOCATION: (RELATION TO BUILDS ETC.)
Behind TA-3-30 / west side / behind fence.
(Please see map)

LOCATION OF TANK/VALVE/PIPE ON OR IN TANK/VALVE/PIPE:

PRIORITY: X - Urgent

REASON FOR URGENT & XURGENT:
EPA and ENMED request clean-up of this contaminated area ASAP.

USAGE OF TANK/VALVE/PIPE/VAULT:

SPECIAL ACCESS REQUIREMENTS:
N/A

WORK REQUIREMENTS:
40 hr. OSHA training

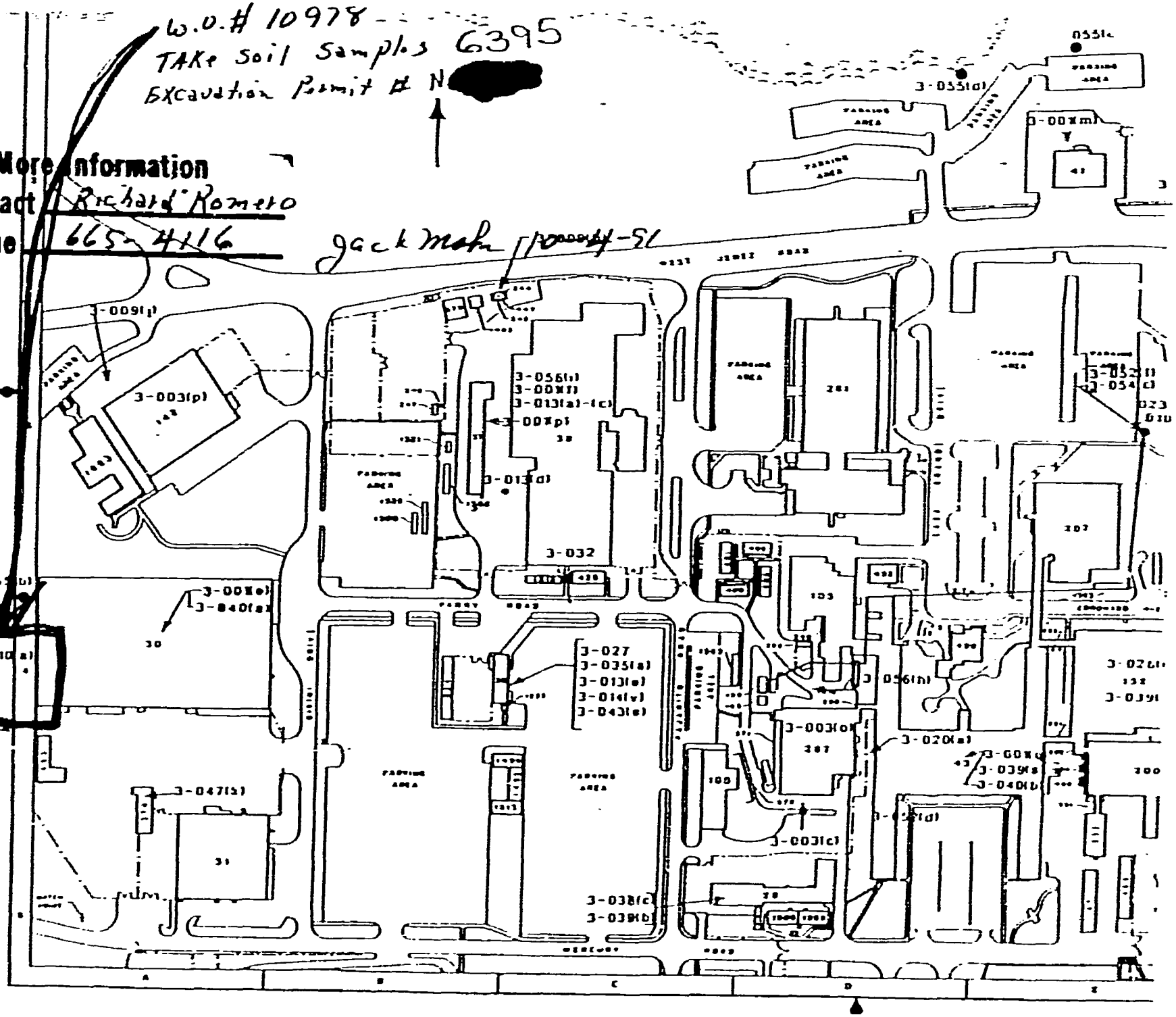
CONTACTS:
Phil Fresquez 667-0815
470-1111

W.O.# 10978 -
TAKE Soil Samples 6395
Excavation Permit # N[redacted]

For More Information
Contact Richard Romero
Phone 665-4116

jack Mahn

work location



October 22, 1992

Subject: **EXCAVATION PERMIT REQUEST**

Nina:

Enclosed you will find a (1) sampling and analysis plan for the collection of soil surface and subsurface samples behind TA-3-30, and (2) results of soil surface samples collected back in August of 1992. Please use this information as my application for an excavation permit, as we are planning to collect more subsurface samples at this site.

We found up to 13,500 ppm Hg, 700 ppm Pb, 35,000 ppm of total petroleum hydrocarbons, ppb levels of VOC's (acetone and 1,1,1-TTE), 1.55 pCi/g Pu-239,240, 0.036 pCi/g Pu-238, 189 pCi/mL of H-3, and 3.7 ug/g total U.

This area has been reported to EPA and NMED, as well as being reported in various newspapers. Therefore, a high priority to clean it up ASAP has been given by the Laboratory. For this reason, please place an X-URGENCY on the excavation process. Thanks!

Philip R. Fresquez, Ph.D.
Environmental Soil Scientist
Environmental Protection Group
667-0815, MS K490

DRAFT

Ed Griggs, CLS-DO, MS E525 October 22, 1992
Ron Conrad, EM-8 K490/7-0815

Phil Fresquez, EM-8 EM-8:92-
COLLECTION OF SOIL SAMPLES AT SWMU 3-010(a)

On August 26, 1992, the Environmental Protection Group (EM-8) collected two soil and three sediment samples from Solid Waste Management Unit (SWMU) 3-010 located directly behind building TA-3-30. Two (soil) samples, collected at the 0 to 3-inch-depth, were located (sample #1) at the top of the slope within an obvious mercury (Hg) contaminated area (i.e., the Hg was visible on the soil surface) two feet away from the western edge of the TA-3 fence line, and (sample #2) approximately 27 feet down gradient of the first sampling point (Figure 1). The other three (sediment) samples were collected at the sediment/tuff interface along the length of a drainage channel down (stream) of the Hg contaminated area; sample #5 was located in the drainage channel directly below the Hg site, and samples #3 and #4 were located in the drainage channel approximately 31 and 63 feet down (stream) from sample location #5, respectively.

All soil/sediment samples were screened for gross alpha, beta and gamma activity before they were submitted under full chain-of-custody documentation to the Environmental Chemistry Group (EM-9). Sample #1, where visible signs of Hg were evident, was submitted for analysis of total Hg and Be, TCLP metals, total U, Pu-238, Pu-239,240, H-3, volatile organic compounds (VOC), total petroleum hydrocarbons (TPH) and polychlorinated biphenyls (PCB's). All other soil/sediment samples were submitted for metal and radiochemical analysis only. All locations of the sample points were surveyed and fixed to FIMAD maps.

Enclosed you will find all of the data. Gross alpha and beta activity for all soil/sediment samples measured <3 pCi/g and <17 pCi/g, respectively. Four soil/sediment samples measured <1.30 pCi/g for gross gamma activity, and one soil sample (sample #2) measured 5.65 pCi/g.

Total Hg levels (as measured with an x-ray fluorescence instrument) measured approximately 13,500 ppm in soil sample #1. Results from EM-9 show total Hg levels in soil samples #1 and #2 at >2000 and 1.7 ppm, respectively. Total Hg levels in the drainage channel measured 1.9 (sample #5), 0.05 (sample #3), and 0.002 ppm (sample #4). Levels of total Be and uranium in all soil/sediment samples were at background levels.

TCLP metals, Ba, Cd, Cr, Pb and Hg, in all soil/sediment samples were below EPA action levels; the highest Hg level was detected in sample #1 at 23.1 ppb. EPA action levels for Hg is 0.2 ppm.

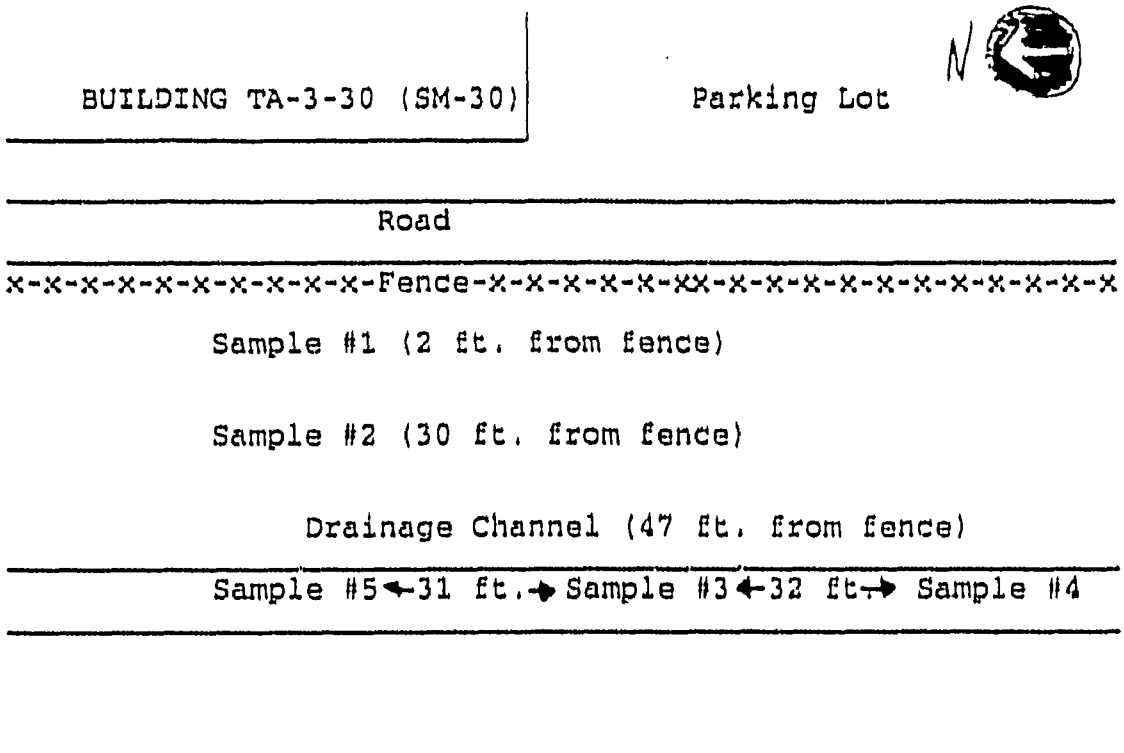
Total petroleum hydrocarbon levels in sample #1 measured 37,000 ppm. No PCB's were measured above detection limits. Two VOC's, acetone (36 ppb) and 1,1,1-trichloroethane (160 ppb), were detected at ppb levels; these levels are far below EPA action levels, however.

Soil samples collected from the hillside (samples #1 and #2), and one sediment sample (#5) had concentrations of H-3, Pu-238, Pu-239,240 above upper limit background levels. Sample #2, for example, contained 189 pCi/mL of H-3, 0.28 pCi/g of Pu-238 and 1.55 pCi/g of Pu-239,240. Upper limit background levels (mean + 2S.D.) for H-3 is 7.2 pCi/mL, for Pu-238 it is 0.005 pCi/g and for Pu-239,240 it is 0.025 pCi/g. The other two sediment samples (#3 and #4) collected in the drainage channel did not contain radiological contaminants above upper limit background concentrations.

PF:RC/gr

Cy: Cal Martell, CLS-1, MS E525
Mike Saladen, EM-8, MS K490
Dave McInroy, EM-13, MS M992
ER Records Processing Facility, MS M707
Circ. File

FIGURE 1. LOCATION OF SOIL AND SEDIMENT SAMPLING POINTS AT SWMU 3-010(a).



SAMPLING AND REMEDIATION PLAN FOR MERCURY-CONTAMINATED SOILS AT TA-3-30.

Prepared for
Los Alamos National Laboratory

by
ICF Kaiser Engineers

Under Contract 9-XS-2-Y5348-1

October 23, 1992

TABLE OF CONTENTS

1.0 Introduction 1

2.0 Background 2

2.1 History of Site 2
2.2 Results of Previous Investigations 4

3.0 Initial Evaluation 4

3.1 Conceptual Site Model 4
3.2 Remedial Objectives 8
3.3 Preliminary Evaluation of Remedial Alternatives . . 9

3.3.1 Description of Chemical Contamination Requiring Treatment 10
3.3.2 Discussion of the No-Action Alternative . 10
3.3.3 Identification of Applicable Technologies 10
3.3.4 Identification of Candidate Remedial Technologies 12
3.3.5 Secondary Screening of Technologies . . . 19

4.0 Sampling Plan 22

4.1 Identification of Data Needs 22
4.2 Sampling Strategy 23
4.3 Analytical Methods 28

5.0 Remediation Plan 30

5.1 Data Evaluation 30
5.2 Evaluation of Alternatives 33
5.3 Implementation 34

- will assume mixed waste
- Phil Fresquez will take samples
- ICF KG will get samples analyzed.

FIGURES

Figure 2-1 Location Map from FIMAD 3
Figure 2-2 Locations of Samples Collected During August 1992 5
Figure 3-1 Conceptual Site Model for TA-3-30 7
Figure 4-1 Locations of Soil Samples 26
Figure 4-2 Locations of Sediment and Water Samples . . . 29

TABLES

Table 3-1 Summary Table of Applicable Remedial Technologies for Removal and Treatment/Disposal 11
Table 3-2 Summary Table of Applicable Remedial Technologies for Isolation 11
Table 3-3 Summary Table of Applicable Remedial Technologies for In-situ Treatment 11
Table 3-4 Summary of Screening of Remedial Technologies . . . 20
Table 4-1 Summary of Data Needs for Remedial Technologies . . 24
Table 4-2 Summary of Samples and Analyses 27
Table 4-3 Summary of Analytical Methods 31

APPENDICES

A. Analytical Results From Previous Sampling 37
B. Standard Operating Procedures 37
C. Quality Assurance Project Plan 37
D. Health and Safety Plan 37
E. Data Management Plan 37

SAMPLING AND REMEDIATION PLAN FOR MERCURY-CONTAMINATED SOILS AT TA-3-30.

1.0 INTRODUCTION

This Sampling and Remediation Plan (SRP) is prepared to address the remediation of contaminated soils found at Building TA-3-30 (SM-30) at Los Alamos National Laboratory (LANL). The current understanding is that mercury is the dominant contaminant of concern at the site. The primary objective of the sampling plan is to determine the vertical and lateral extent of the mercury contamination and provide the data that will be used to select and implement a remedial action at the site.

LANL's objectives are understood to be:

- Determine the extent of the mercury contamination at Solid Waste Management Unit 3-010(a), TA-3-30;
- Evaluate remedial alternatives for cleanup of mercury-contaminated soils and select an alternative for immediate implementation; and
- Verify that there are no releases from the site causing water quality standards to be exceeded at the conclusion of remediation.

This SRP is organized in the following manner. Section 2.0 provides a description of the site, a brief summary of the regulatory issues, and a summary of the results obtained from previous sampling and analysis conducted by LANL at this site. Section 3.0 describes the fate and transport pathways and the remedial objectives that apply to the contamination found at the site. These remedial objectives will quantify the cleanup level at the site. Section 3.0 also presents an evaluation of the remedial alternatives applicable to the site. These remedial alternatives are given a preliminary screening to identify the candidate alternatives. The candidate alternatives are those alternatives having the greatest possibility of successful implementation at the site. Section 4.0 contains the sampling plan with a description of the numbers, locations, types of samples that will be collected, and the analytical procedures that will be used. Section 5.0 describes how the data collected during sampling activities will be used to achieve the Laboratory's objectives. Section 5.0 describes how the alternatives identified in Section 3.0 will be evaluated and analyzed and how the selected alternative will be implemented. The appendices contain the Quality Assurance Project Plan (QAPjP), the Health and Safety Plan (H&SP), the Data Management Plan (DMP), and the Standard Operating Procedures (SOP) that will control site characterization and remediation.

2.0 BACKGROUND

This section provides a brief history of the site and a summary of the results of recent soil and sediment sampling at the site. Section 2.1 summarizes the site history and regulatory involvement while section 2.2 summarizes the results of the previous sampling.

2.1 History of Site

The site, as shown in Figure 2-1, was historically used for disposal of waste vacuum pump oil, some of which was contaminated with mercury. Disposal occurred by dumping the waste oil on the ground surface. Later, oil was pumped from Building TA-3-30 and discharged from a pipe to the ground surface. The disposal area is located at the top of a slope which drains to an ephemeral stream channel flowing to Twomile Canyon. The disposal area appears to be located at the top of a drainage feature leading toward the stream channel, a total area of less than 300 square feet. The site is listed as a Solid Waste Management Unit (SWMU) 3-010(a) under the Resource Conservation and Recovery Act (RCRA) and is being addressed by LANL's Environmental Restoration (ER) Program.

Recent erosion of soil has exposed significant and visible amounts of mercury. The mercury appears as small globules at the soil surface. In response, LANL initiated preliminary remedial actions to control and contain contamination at the site and to prevent any additional exposure of subsurface contaminants. These actions included sampling to define the area of contamination, diversion of runoff away from affected areas, and covering the site with impervious materials to prohibit further erosion of contaminated soil.

Although the site is being addressed by the ER Program under RCRA, the site is also regulated by the New Mexico Water Quality Control Commission (WQCC). WQCC regulation Section 1-203.A requires that as soon as possible after learning of a discharge, the owner/operator of a facility shall take such corrective actions as are necessary or appropriate to contain and remove or mitigate the damage caused by the discharge. Further, the discharger must submit a corrective action report to the New Mexico Environment Department (NMED) after learning of the discharge. The corrective action report will be reviewed for approval by the NMED.

This SRP is being prepared in response to the requirements of the WQCC. Because the site is also a SWMU, actions taken to investigate and remediate the site will also be consistent with the requirements of the ER Program.

Figure 2-1

Location Map from FIMAD

Not available until w/o October 26.

2.2 Results of Previous Investigations

To gain a better understanding of the contamination present at the site, LANL collected soil and sediment samples at five locations on August 26, 1992. The locations of the samples are shown on Figure 2-2. Sample 1 was collected at a depth of 0 to 3 inches in an area of obvious mercury contamination. Sample 2 was collected at a depth of 0 to 3 inches at a location approximately 27 feet downslope of Sample 1. Sample 3 was collected at the sediment/tuff interface in the stream channel downslope of Sample 2. Samples 4 and 5 were collected at the sediment/tuff interface at locations approximately 45 and 63 feet, respectively, downstream from Sample 3.

Sample 1, because of its location in the waste disposal area, was analyzed for a full range of contaminants. This sample was analyzed for total mercury, total beryllium, toxicity characteristic leaching procedure (TCLP) metals, total uranium, isotopic plutonium, tritium, volatile organic compounds, total petroleum hydrocarbons (TPH), and polychlorinated biphenyls (PCBs). The remaining samples were analyzed for heavy metals and radionuclides.

The mercury concentrations in Samples 1 through 5 were 13,500, 1.7, 1.9, 0.05, and 0.002 mg/kg, respectively. TPH was present in Sample 1 at 37,000 mg/kg. Complete analytical results are provided in Appendix A. These results confirm that mercury is the contaminant of principal concern at the site. Radionuclides ~~appear to be at background concentrations~~ and organics and PCBs are below ER Program action levels. Elevated levels of TPH were detected at the disposal area (Sample 1).

[PARAGRAPH DISCUSSING HISTORICAL WATER/SEDIMENT SAMPLING IN PAJARITO CANYON, WETLANDS, ETC?]

3.0 INITIAL EVALUATION

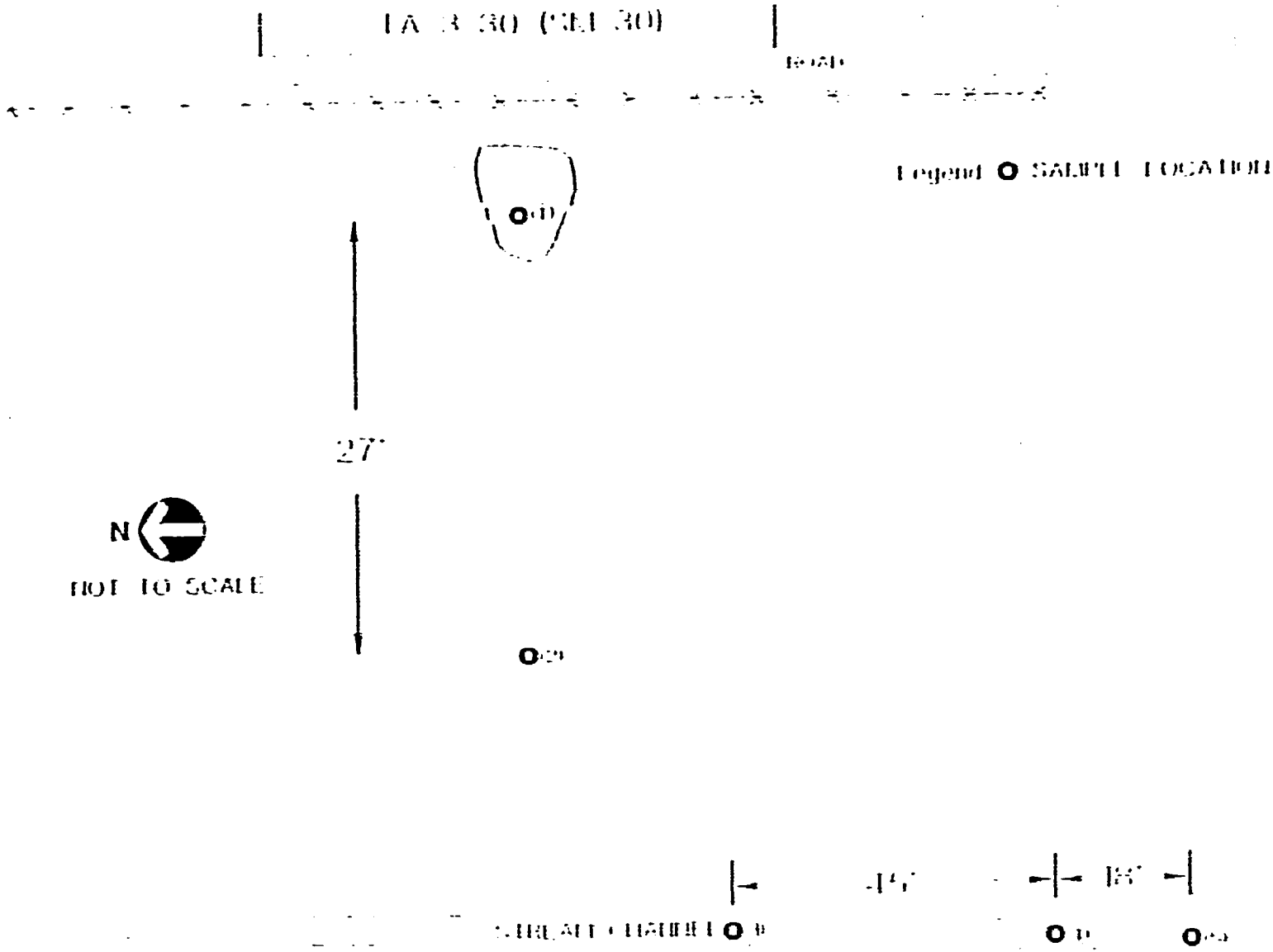
This section discusses the conceptual site model, the remedial objectives and a preliminary evaluation of remedial alternatives. Section 3.1 discusses the conceptual site model and the potential migration and exposure pathways. Section 3.2 presents the remedial objectives that the selected remedial alternative will have to meet. Section 3.3 contains a preliminary evaluation of the remedial alternatives.

3.1 Conceptual Site Model

Conceptual site models describe the potential sources of contamination, potential migration pathways for contaminants released from the source, and subsequent human health and biota

Figure 2-2
Locations of Samples Collected During August 1992

FIGURE 2-2 LOCATION OF [illegible] SALIVES



exposure points and pathways. The conceptual site model serves as a basis for planning the proposed field investigations.

Figure 3-1 presents the conceptual site model and exposure pathways and potential receptors for the contaminants found at TA-3-30. Only a limited number of potential migration and exposure pathways are considered to be significant at the site. The relative significance of each exposure pathway is indicated on the site model. The exposure pathways deemed significant include the dominant scenarios for risk assessment. Accordingly, if acceptable risk levels can be demonstrated for these pathways, then acceptable risk levels will be met for all exposure pathways.

A brief description of each column in Figure 3-1 is provided below.

- The source is the potential mode for release of contamination into the migration pathways.
- The migration pathway is the environmental pathway by which contaminants may move from source to receptors (e.g., mercury may volatilize).
- Exposure is the precise mechanism by which exposure occurs (e.g., ingestion of soil).
- Receptors are human and other receptors that may come in contact with a contaminated environmental medium (e.g., site workers having direct dermal contact with contaminated soil during excavation activities).
- Relative significance is the anticipated importance of the identified exposure pathway relative to other exposure pathways at the site (e.g., the potential significance of exposure to contaminated soil may be high relative to exposure from ingestion of contaminated groundwater).

The dominant exposure pathways are expected to be dermal contact or ingestion of soil material and exposure to volatilized mercury. Mercury has a relatively high vapor pressure (0.0018 mm at 25°C) and volatilized mercury could be inhaled by workers in the vicinity of the site. As an interim measure, volatilization has been reduced by covering the site with plastic. This covering should also serve to reduce volatilization of any organic compounds found at the site. Mercury is a potential health risk through dermal exposure and ingestion. The ingestion pathway will drive a risk-based standard for mercury in soils.

Figure 3-1

Conceptual Site Model for TA-3-30

Source	Pathways	Exposure	Humans: Residents	Humans: Visitors	Biota: Terrestrial	Biota: Aquatic	Relative Significance
Soil	Volitilization/ Wind	Ingestion	•	•	•		Moderate
		Inhalation	•	•	•		
		Dermal	•	•	•		
	Soils/ Sediments	Ingestion	•	•	•		Moderate
		Dermal	•	•	•		
	Surface Water Runoff	Ingestion	•	•	•	•	Low
		Dermal	•	•	•	•	
	Percolation to Water Table	Ingestion	•	•			Low
		Dermal	•	•			

Infiltration to groundwater is not expected to be a major exposure pathway. Elemental mercury is relatively insoluble and has a high surface tension. The high surface tension impedes the mercury from "wetting" the soil surface and migrating through the vadose zone. The high surface tension was evident during the site visit. The mercury was observed as tiny silver droplets in the surface soils. Based on the low solubility and high surface tension it is not anticipated that extensive migration of mercury into the subsurface environment will occur. Further, infiltration at the site is expected to be low and should minimize the potential for vertical migration. If data collected during the sampling activities indicate vertical migration of mercury, the conceptual model will be modified.

The low solubility and high surface tension of mercury also reduce the potential for exposure from surface water runoff. The initial sampling results are consistent with this model. The concentrations of mercury in soil and sediment decrease rapidly with distance from the disposal area. Concentrations in the sediment sample furthest down the stream channel appear to be within the background range for mercury.

3.2 Remedial Objectives

The results of the conceptual model evaluation suggest general objectives that must be addressed at the site. The first is protection of human health from exposure to mercury in contaminated soil. The second is protection of surface water quality downstream of the site. These objectives will be addressed through use of applicable standards for mercury in environmental media.

Mercury levels in soil that are protective of human health can be established through performance of a detailed, site-specific human health risk assessment. Because the site is relatively small and easily accessible for remediation, a conservative cleanup standard can be applied in lieu of performing a quantitative risk assessment. Because this site is a SWMU, the screening action levels (SALs) contained in the Installation Work Plan for Environmental Restoration (IWP) at LANL were considered in selecting a cleanup level. The SAL for mercury in soil in the 1992 IWP is 80 mg/kg. The SALs were developed based on conservative assumptions for human exposure assuming a residential scenario. While this level for cleanup is overly conservative, it will be used for a site of this magnitude and will ensure that the site is remediated to comply with NM Water Quality Control Commission Regulations.

Levels of mercury in water that are protective of the environment are contained in the water quality standards developed by the WQCC. The applicable standard for mercury in water discharged is 2 ug/L (WQCC Regulations, Part 3, August 18, 1991). This water

quality standard cannot be directly related to an equivalent concentration of mercury in soil. As a result, compliance with the water quality standard will be evaluated at conclusion of site remediation by monitoring water quality downstream of the site during periods of runoff rather than by establishing a soil cleanup level.

The New Mexico Water Quality Control Commission Regulations also prohibit disposal of refuse in watercourse (WQCC Regulations, Part 2, August 18, 1991). The remedial objectives for the site will, therefore, address removal of all waste material at the site from the watercourse.

The sampling and analysis strategy described in Section 4.0 proposes analysis for metals other than mercury at highly contaminated areas. If any of these metals are present above their corresponding SAL in the IWP, the cleanup level for each will be established to ensure that the water quality standard for these metals will be met in water downstream of the site.

In summary, the following remedial objectives will apply to this site:

- Prevent human exposure to all soils contaminated with mercury at a level above 80 mg/kg.
- Prevent migration of mercury or other metals from the site at levels that would cause water quality standards to be exceeded downstream of the site.
- Remove waste from watercourses at the site.

3.3 Preliminary Evaluation of Remedial Alternatives

The objective of this section is to provide a preliminary identification of technologies that are applicable and may be implemented at TA-3-30. Screening criteria are used to reduce the applicable remedial technologies to those candidates with the most promise for success at the site. In the following discussion "applicable" is used to refer to the suite of remedial technologies that could be used at the site. "Candidate" is used to refer to the reduced set of promising technologies. "Appropriate" is used to refer to those technologies recommended for further consideration and possible implementation at the site. This preliminary identification of candidate remedial technologies has been developed to determine data needs for the various alternatives. The information is based on past experience that will be specifically referenced when data evaluation is completed.

The appropriate technologies listed in this section are those that are thought most likely to be successful at the site given

the current state of knowledge about the site. The upfront determination of the data needs of the various technologies allows the appropriate data to be collected as the field work is performed; thereby reducing the likelihood of having to return to the field to collect additional data once the final remedial technologies to be employed at the site are known. However, if the field data collected as part of this investigation suggest that alternate technologies may be more promising, additional data needs may be identified.

3.3.1 Description of Chemical Contamination Requiring Treatment

Based on preliminary sampling and site history, mercury is expected to be the contaminant of principal concern at the site. High levels of total petroleum hydrocarbons have also been identified. Additional sampling and analysis will focus on mercury and other inorganic constituents and the total petroleum hydrocarbons. Based on the previous sampling, site history, and site visits, the contamination appears to be restricted to a "hot spot" where direct discharges occurred. These discharges came from a pipe and, prior to the installation of the pipe, from hand disposal.

3.3.2 Discussion of the No-Action Alternative

From an assessment of the types of contamination present at the site, it is concluded that mercury is present at concentrations that could potentially pose a threat to human health or the environment. Mercury levels in the soil are of concern because of their potential for direct contact (ingestion of soil) or volatilization into the air pathway (inhalation). Soil concentrations of mercury are well above the SAL. Therefore, it appears that the no-action alternative would result in unacceptable levels of risk.

3.3.3 Identification of Applicable Technologies

Three general classes of response actions were identified for this site. These classes are removal and treatment/disposal, isolation, and in-situ treatment. Technologies within these classes were reviewed to identify those that were applicable to the contaminants at this site, namely mercury and petroleum hydrocarbons. These technologies and applicable contaminants are identified in Tables 3-1 through 3-3.

Table 3-1

Summary Table of Applicable Remedial Technologies for Removal and Treatment/Disposal

Remedial Technologies	Applicable Contaminants
Excavation and off-site disposal	Mercury/Petroleum Hydrocarbons
Excavation and stabilization	Mercury/Petroleum Hydrocarbons
Excavation and thermal treatment	Mercury/Petroleum Hydrocarbons
Excavation and soil washing	Mercury/Petroleum Hydrocarbons

Table 3-2

Summary Table of Applicable Remedial Technologies for Isolation

Remedial Technologies	Applicable Contaminants
Containment with low permeability walls	Mercury/Petroleum Hydrocarbons
Surface covers	Mercury/Petroleum Hydrocarbons
Bottom sealing through grouting	Mercury/Petroleum Hydrocarbons
Bottom sealing through block displacement	Mercury/Petroleum Hydrocarbons
Ground freezing	Mercury/Petroleum Hydrocarbons

Table 3-3

Summary Table of Applicable Remedial Technologies for In-situ Treatment

Remedial Technologies	Applicable Contaminants
Soil Washing	Mercury/Petroleum Hydrocarbons
Vitrification	Mercury/Petroleum Hydrocarbons
Soil Heating	Mercury/Petroleum Hydrocarbons

Remedial Technologies	Applicable Contaminants
Vapor Extraction	Mercury/Petroleum Hydrocarbons
Electroreclamation	Mercury
Stabilization	Mercury/Petroleum Hydrocarbons

The applicability of an individual remedial technology is determined by the nature of the contamination. Both inorganic and organic contaminants are found at this site. For the purposes of a preliminary identification of remedial alternatives, technologies that address contaminated soils have been identified. The remedial objectives for meeting water quality standards will be met by removal of contamination sources rather than through cleanup of water. Technologies that address contaminated water were, therefore, not addressed.

3.3.4 Identification of Candidate Remedial Technologies

In this section the applicable technologies provided in Tables 3-1 through 3-3 are reduced by the use of screening criteria to provide a list of candidate technologies. This screening is performed to be consistent with the procedures in the IWP. The candidate technologies are further reduced to the technologies deemed most appropriate for the site. These "appropriate" technologies are those technologies judged to have the greatest promise for success at this site. The list of appropriate technologies may change as the field work advances. The technologies are reduced to those thought to have the highest likelihood for use at the site so that the data requirements of these technologies can be satisfied with data generated through implementation of the work plan.

Even a preliminary screening of the many possible response actions requires formulation of remedial action goals and objectives. Remedial objectives were identified in Section 3.2. In addition to these primary goals, there are a number of other goals that must be considered. Generally, these secondary goals address the relative desirability of response alternatives.

After identification of specific goals related to the remedial action, criteria are developed to provide a means of assessing if these goals are being met. This assessment can be made less subjective if the criteria can be expressed in quantitative terms. The screening criteria are: (1) effectiveness, (2) implementability, and (3) cost, as discussed below.

Technical Effectiveness. Technical effectiveness criteria are based on the ability of an alternative to meet remedial action goals. Only technologies capable of meeting the remedial

objectives developed in Section 3.2 with an acceptable level of risk are considered. Therefore, consideration of technical effectiveness is determined by the uncertainty involved in meeting these objectives, i.e., the reliability of a technology.

A general goal should be to select methods that are effective in meeting the remedial objectives with a high degree of certainty. The ability of an alternative to meet the objectives should be assessed by comparison of required performance with typical or expected performance. Assessment of effectiveness is expressed by the following criterion:

> The required technical performance of a remedial action should be within the typical range of operating performance for that alternative.

Implementability. Implementability criteria should address site-specific conditions that may impact implementation of the remedial action. Typically, implementability concerns result from requirements for materials or conditions which may not be present at the site. Remedial alternatives should generally be chosen that do not require materials or conditions not readily available at the site. This goal is reflected in the following criterion:

> The selected remedial technology should not be significantly impacted by site conditions or resources.

Cost Effectiveness. Cost criteria are based on the overall cost of implementing a response action. In general, it is desirable to select the response action with the lowest overall cost. Because other important factors may be overlooked if decisions are based solely on cost, selections should be based on cost-effectiveness. Cost-effectiveness considers cost as well as technical feasibility, reliability, technical performance, and environmental protection.

This section is not meant to be a feasibility study and no detailed cost analyses have been performed. Cost has been taken into consideration only in a general way to arrive at those technologies that have the greatest possibility for use and success at the TA-3-03 site.
30

A goal of response action selection should be to minimize cost while meeting all other goals. This goal is expressed in the following criterion:

> The most cost-effective alternative should be selected for implementation.

The candidate technologies are given below. Candidate technologies were identified through application of the three

immobilization technique that produces quite insignificant mercury emissions to the air. In Japan (**ref.**), stabilization/solidification with sodium sulfide and ferrous chloride has been considered a basic treatment method for soils contaminated with greater than 10 mg/kg of mercury. It is estimated that such technology could cost approximately $150 to $200 per ton for the immobilization of mercury contaminated soils.

Stabilization can occur in place, on site using transportable process equipment, or at a fixed-base disposal facility. Equipment requirements are largely determined by the type of mixing employed. All systems consist of the following steps:

- Mixing the waste with the treatment ingredients;
- Allowing time for the absorption, gelling reaction, or curing to take place; and
- Disposition of the solidified product.

In-situ mixing of reagents and waste has primarily been used for the closure of ponds or lagoons. However, in-situ site closures have been performed on soils. In-situ mixing of reagents with soils has been accomplished using pneumatic vibrating "fingers" which feed and inject the solidifying reagents into the waste. The mixture is allowed to cure and remain in place. An alternative in-situ technique uses a giant auger which mixes soils and reagents. The auguring process is repeated until the entire contaminated volume is treated. In-situ stabilization using the reagents identified as appropriate for mercury is a viable alternative.

If the solidified waste is returned to the excavation site for disposition, increases in waste volume after treatment must be taken into account. Volume increases may vary from 10 to 100 percent.

Excavation/Removal. Excavation and removal of contaminated soils is a well developed and well understood technology. Successful implementation relies on standard excavating equipment, vehicles to transport the excavated soil, and a permitted facility for treatment/disposal.

Excavation and redisposal is not generally a preferred option for cleanups under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (**ref.**). Furthermore, excavation and removal of contaminated waste to a hazardous landfill presents the potential for adverse environmental effects caused by exposure to the excavated material and raises the probability of releases resulting from transportation accidents.

criteria to the list of applicable technologies listed in Section 3.3.3. The list of candidate technologies does not include institutional actions. Institutional actions protect public health and the environment by restricting site access and restricting future use. The data needs required for institutional actions are believed to be encompassed by the data needs of the preferred technologies. The data requirements to evaluate each technology and a summary of the data needs to address all the candidate technologies are discussed in Section 4.1.

Candidate technologies identified as having the greatest potential for application at the site are stabilization, excavation/removal, soil washing, capping, and thermal treatment. These technologies are described below.

Stabilization. Stabilization refers to treatment processes that physically and/or chemically immobilize contaminants in place. Other terms sometimes used interchangeably with stabilization are fixation, solidification, and encapsulation. Selection of materials or reagents for stabilization depends on such factors as the availability of raw materials, cost, the process vendor's proprietary position, and the treatability and compatibility of the waste with the reagents. Reagents that are often used to treat wastes are:

- Portland cement alone;
- Portland cement/fly ash;
- Lime/fly ash; and
- Sodium silicate/portland cement or lime.

These reagents, however, are not appropriate for mercury-contaminated soils. Immobilization of mercury in the soil or waste matrix should generally be considered the last resort option when recovery is either impossible or impractical. However, in the real world, it is often the most preferred alternative from the standpoint of convenience and short-term cost perspective. Several proprietary immobilization and stabilization processes for mercury treatment with demonstrated effectiveness in soils and sludges have been identified by the U.S. EPA (**ref.**). These techniques are generally based on chemical fixation principles and involve mixing of contaminated soils with proprietary chemicals.

The U.S. EPA (**ref.**) has recommended that these processes be employed only when recovery of mercury is impossible or not advisable because of radioactive or other harmful contamination. Absorption technology employing calcium polysulfide with zinc dust and sulfuric acid was found to be an excellent

Excavation, transport, and storage of contaminated waste presents a number of potential problems with respect to implementation. Several additional investigations are needed to address the associated engineering considerations and needs.

Excavation of the contaminated soil presents health and safety concerns. Because of the potential hazard posed by inhalation of contaminated dust, respiratory protection may be required for all site workers. In addition, dust suppression activities would have to be employed to prevent the spread of contaminated dust to surrounding areas.

Transportation and disposal regulations stipulate the absence of free liquids in waste materials. The truck beds on the trucks used to haul material would have to be lined and covered to prevent contaminated soil from escaping during transportation. Trucks would have to be decontaminated after loading and prior to leaving the site. Transportation regulations would dictate the size of trucks and loads that could be used.

Soil Washing. Soil washing is a physical and/or chemical process whereby contaminants are removed from soils. The soils are contacted with liquid reagents to accomplish the washing process. This technique can be carried out in equipment that is designed for contacting excavated soil with the liquid, or the washing can be carried out in-situ by applying or injecting the liquid into the contaminated soil. After contact with the soil, the washing solution is extracted and treated for removal of the contaminants. After the contaminants are removed from the washing solution, the solution is available to wash additional soils. In some cases multiple washings are required to reduce the contaminants to acceptably low levels. In those cases where the soil is excavated prior to washing, the decontaminated soil is redeposited in the excavation area.

An understanding of two basic mechanisms by which contaminants are held within the soil matrix is needed for effective soil washing. First, contaminants can be held on the surfaces of soil particles through adsorption processes. Second, precipitated contaminants can be retained within the interstices of the soil particles. The relative influence of these two mechanisms of contaminant retention may vary considerably from site to site depending on site-specific conditions. Removal of contaminants from the soil matrix is accomplished by physical displacement of loosely held contaminants, by desorption of more tightly retained contaminants and by dissolution of precipitated contaminants.

The most important parameters that influence the effectiveness of soil washing techniques are the organic matter content, initial water content, particle size gradation of the soil, and the contaminant type for a given soil matrix. Organic materials have large surface areas that act as adsorption surfaces. Therefore,

high organic matter content makes it more difficult to remove contaminants from the soil by a washing procedure. Coarse soils (i.e., sandy) facilitate the removal of contaminants through soil washing.

Acid leaching solubilizes low concentrations of mercury in wastes/soils. In certain situations, chemical oxidation is conducted first to release the mercury, followed by sludge dewatering and acid washing to convert all mercury to soluble ionic form in the leachate, which requires treatment by chemical precipitation. This technology has been examined in detail by the U.S. EPA (ref.) and is an appropriate best demonstrated available technology (BDAT) for wastes or contaminated soils containing less than 260 mg/kg mercury. Acid leaching of incineration residues also is an effective method for removing mercury from such residues.

Acid leaching of mercury-contaminated soils will require laboratory- and field-scale testing. Preliminary assessment indicates that the cost of such treatment may range between $200 to $250 per ton, depending on the nature of the required chemical oxidation and precipitation processes (ref.). A more detailed laboratory investigation is needed to analyze the application of this technology.

Extraction of metal contaminants, such as mercury, from soils can be conducted by complexing agents like anhydrous ammonia. Ammonia is an excellent complexing agent for metals in aqueous solution. Its strong tendency to donate a pair of electrons to a central atom (Lewis Basicity) makes ammonia a good ligand for coordination with metal ions. It is also a low-cost extractant ($0.05/pound in fertilizer grade) with low cylinder pressure (115 psig at 22°C) and ample availability.

A recent study (ref.) shows that approximately 26 percent of the spiked mercury could be removed by anhydrous ammonia in batch Soxhlet Extraction tests. The results were verified by the commercially available Supercritical Extraction (SCE) screening system (ref.). The available experimental data clearly indicate the need for investigating potential extraction-enhancing ligands and other extractants to improve the performance of this technology.

The implementability of soil washing as a technique for cleaning contaminated soils depends on the ability to effectively carry out the following steps:

- Contact the soil particles with the washing solution;
- Flush and desorb contaminants from soil;
- Recover wash solution following contact with soil;

- Separate the contaminants from the washing solution;
- Recycle washing solution for additional contaminant removal; and
- Dispose of the concentrated contaminant waste.

In-situ soil washing is often considered more economical than excavation and ex-situ washing because the excavation phase of the soil washing procedure is eliminated. However, the savings in excavation costs may be negated by longer cleanup times and the cost involved in reclaiming injected solutions.

Capping. The purpose of surface covers (caps) is to reduce the percolation of water through the waste unit. The cover also acts as a physical barrier to keep subsurface wastes isolated from the environment thereby preventing fugitive-dust migration. Caps are constructed out of relatively impermeable materials in a single (asphalt) or multiple layer (clay) design. Caps are usually dome shaped and include a capillary transport barrier and provisions for runoff control. Caps often contain features to protect them against erosion or intrusion from deep rooted plants.

A cover reduces the infiltration of precipitation. Preventing water from contacting the contaminated soils will help soil contaminants remain in place. If an extract test, such as the extraction procedure (EP), TCLP, or a water extraction, is the criterion by which the effectiveness of the remedial action is measured, then the cover alternative may not be judged effective for certain areas. The cover material will not change the waste characteristics. Therefore, those contaminated soils that currently have the EP or TCLP characteristic of toxicity will retain that characteristic under a cover. A cover helps preclude the possibility of a storm event providing sufficient moisture to cause contaminant migration. Thus, a cover provides an added measure of assurance over the no-action alternative.

The convex shape of the cover aids in conveying precipitation away from the contaminated zone boundary. Gentle slopes are used to control water runoff velocity and minimize erosion. An outer layer of soil is sometimes used to support the growth of shallow-rooting grasses for wind and water erosion control. An inner compacted clay layer is typically placed to achieve a permeability of 10^{-7} cm/second or less to resist water infiltration from the soil layer. Sand and/or gravel layers or a synthetic drainage net may be placed between the soil and clay layers if the cover is extensive. The sand and/or gravel layers facilitate runoff from the soil layer. If burrowing rodents are a potential problem, a barrier may be incorporated in the cover. A barrier typically consists of a 1.5 to 3.0 foot layer of rip-rap over the compacted clay layer. A flexible membrane liner may

also be included in the cap to further decrease infiltration of surface water.

Thermal treatment. A recent U.S. EPA (ref.) study has determined that retorting or roasting technology can serve as an effective BDAT for high mercury-containing wastes, i.e., more than 260 mg/kg of total mercury. These technologies are employed by the chloralkali industry in the United States, Europe, and Japan. A vertical multistage roasting furnace (Herreshoff Furnace) was used in Japan (ref.) to treat and recover mercury from 3,600 tons/year of contaminated soil. The roasting furnace was equipped with condensers (to recover mercury), flue gas cleaning devices and a chelate resin water treatment system, operated in compliance with environmental standards.

Mercury is a volatile metal, possessing significant vapor pressure below 1000°C. Since emission control is technically difficult and costly, it is not recommended to incinerate wastes with high concentrations of volatile metals. However, for materials containing high concentrations of volatile metals, the recovery by retorting or roasting is considered to be an effective and promising treatment option that is clearly applicable to mercury. Pyrolysis and infrared thermal destruction could, however, reduce the mobility of these metals by binding them into solid residues.

The on-site rotary kiln was considered to be an "immature technology" for controlling gaseous mercury emissions. The U.S. EPA (ref.) has observed that the multiple hearth furnace provides better control over residence time and eliminates short-circuiting; hence, its performance is superior to the rotary kiln. The cost of soil roasting was reported to be approximately $300/ton for a demonstration project in Japan (ref.).

3.3.5 Secondary Screening of Technologies

The five technologies described in Section 3.3.4 were screened with respect to the three screening criteria. The results of this screening are described below and summarized in Table 3-4.

Stabilization. In general, stabilization has been found to be an effective treatment for immobilizing mercury. Stabilization could be implemented in-situ or ex-situ. In-situ application would not meet the remedial objective for removal of wastes from a watercourse. Ex-situ stabilization would be effective in combination with excavation.

Table 3-4

Summary of Screening of Remedial Technologies

Technology	Effectiveness	Implementability	Cost	Conclusion
Stabilization	Effective when combined with excavation.	Could be implemented using commercially available equipment. Effectiveness with site soils must be verified.	Moderate to high	Selected for further consideration with excavated soils.
Excavation/ Removal	Effective in meeting all objectives, but must be combined with treatment and/or disposal.	Readily implementable.	Low	Selected for further consideration in combination with soil treatment or disposal.
Soil Washing	Effective in-situ or ex-situ application. Ex-situ is the more reliable alternative.	Implementable using commercially available equipment. Effectiveness with high mercury levels must be proven.	Moderate to high	Selected for further consideration with excavated soils.
Capping	Not effective in removing waste from watercourse.	Readily implementable.	Low	Do not consider further due to ineffectiveness.
Thermal Treatment	Effective when combined with excavation. BDAT for soils with high concentrations.	Availability of treatment facility must be determined.	High	Selected for further consideration with excavated soils.

Stabilization could be implemented at the site using commercial, transportable treatment equipment. The effectiveness of stabilization with the specific contaminants found at the site would have to be verified.

The cost of soil washing is expected to be moderate to high.

Excavation/Removal. Excavation/removal of contaminated soils would be effective in meeting all of the remedial objectives. Excavation could be implemented at the site using readily available equipment such as a backhoe. Excavation is a low cost technology. Based on this screening, excavation was retained for further consideration.

It is important to note that excavation would have to be combined with treatment and/or disposal. Because of the high levels of mercury present in the excavated material, the materials would have to be managed as hazardous waste and some type of treatment would necessary prior to disposal.

Soil Washing. Soil washing (acid leaching) is a BDAT for mercury contaminated soils with concentrations less than 260 ppm. Soil washing could be implemented in-situ or ex-situ. While both alternatives could be effective in meeting all remedial objectives, ex-situ is preferred because of greater reliability. Ex-situ washing would have to be combined with soil excavation.

Soil washing could be implemented at the site using commercial, transportable treatment equipment. The effectiveness of soil washing with high mercury concentrations, such as are found at the site, has not been demonstrated. However, appropriate chelating and washing agents may be effective in significantly reducing mercury concentrations.

The cost of soil washing is expected to be moderate to high.

Capping. Capping would not be effective in meeting all of the remedial objectives. While capping could prevent exposure, it would cause waste to remain in a watercourse. For this reason, capping was eliminated from further consideration after discussions with NMED. Capping could be readily implemented at the site and would constitute a low cost technology.

Thermal Treatment. As discussed previously, the BDAT for soils with mercury concentrations greater than 260 mg/kg is thermal treatment. Combined with excavation, thermal treatment would be effective in meeting remedial objectives. The use of thermal treatment will depend on finding an acceptable facility within a reasonable distance and the costs associated with this technology. Thermal treatment is generally considered to be more expensive than soil washing or stabilization.

Summary. Based on the screening analysis, excavation of contaminated soils is selected as the only technology that would be effective in meeting all remedial objectives. The three treatment technologies (stabilization, soil washing, thermal treatment) will be considered for treatment of the excavated soils prior to their disposal. mixed wastes

4.0 SAMPLING PLAN

This section presents a .pecific plan for sampling and analysis at SWMU 3-010(a). First, specific data needs that will be met by sampling and analysis are identified. The specific strategy for sampling is then described, followed by identification of analytical methods.

4.1 Identification of Data Needs

The initial evaluation of data presented in Section 3.0 has allowed identification of data needs to be addressed in the sampling plan. Specific data needs are related to refining and confirming the conceptual site model, determining whether remedial objectives will be met, and evaluating remedial alternatives. These data needs are discussed in more detail in the following paragraphs.

The conceptual site model indicates that significant mercury contamination is confined to a limited area, both horizontally and vertically, around the disposal point. Data describing the horizontal and vertical extent of mercury contamination in soil are needed to verify this model. Specific data needs are the concentrations of mercury in soil samples collected around the source. Specific sample locations are described in Section 4.2.

The conceptual model also indicates that mercury has not migrated to any appreciable extent down the channel below the site. Data describing the concentration of mercury in sediment samples downstream of the site are needed to verify this model. Mercury concentrations in sediments upstream of the site are also needed to verify the absence of other sources. Locations of samples in the stream channel are described in Section 4.2.

The remedial objectives described in Section 3.2 are based on the conceptual model and the pathways of concern identified in the model. Verification of the model will serve to verify that these remedial objectives will result in protection of human health and the environment. The data collected to define the concentrations of mercury in soil around the site will indicate the extent of soil contamination that exceeds the levels identified in the remedial objectives.

The remedial objectives also require that water quality standards not be exceeded in surface water downstream of the site. Concentrations of mercury and other identified contaminants in surface water are needed to verify that this objective has been met.

The preliminary evaluation of remedial alternatives identified several technologies that may be implemented. Data needed to evaluate these technologies are summarized in Table 4-1. Some of these data are already available while other data will be collected through the sampling activities.

In general, the area, volume, and depth of soil contaminated above cleanup levels will be needed to evaluate and implement the excavation alternative. Evaluation of all options for treatment of the excavated soil will depend on the levels of contamination found in the soil. Each treatment alternative will also require specific data related to the effectiveness of the alternative. Waste characteristics of interest include TPH and total metals.

These data needs will be met through collection of samples to define the vertical and horizontal extent of mercury contamination in soil. These samples will be analyzed for total metals, including mercury, and TPH.

4.2 Sampling Strategy

As described in Section 4.1, most of the data needs are related to establishing the horizontal and vertical extent of soil contamination. Key elements of the sampling strategy developed to satisfy these data needs include:

- Establishing a grid on the hillside between the fence and the stream channel to collect horizontally distributed samples;
- Collection of samples at discrete depths at selected grid points to determine the vertical contamination profile; and
- Collection of samples at intervals along the stream channel to determine the extent of contaminant migration along the channel.

The sampling strategy includes a combination of discrete samples and composite samples. Discrete samples will be collected at points expected to have high concentrations (i.e., within the area expected to exceed cleanup levels). Discrete samples will also be collected to establish vertical profiles. Composite samples will be collected at other points. Composite samples will provide indication of the areal distribution of

Table 4-1

Summary of Data Needs for Remedial Technologies

Technology	Data Needs
Excavation/Removal	• Moisture content, • Geologic characteristics, • Topography, • Horizontal and vertical extent of contamination, and • Waste characteristics.
Stabilization	• Soil properties - such as particle size and moisture content, and • Waste characteristics - including constituents present and concentrations, pH, TOC, oxidation state of constituents.
Thermal treatment	• Moisture content, • Heat capacity of soil, and • Concentrations of contaminants.
Soil Washing	• Soil texture - includes quantities and types of clays, • Soil permeability, • Soil organic carbon content, • Waste characteristics, and • Soil mineralogy - including iron and manganese content.

contamination while reducing the number of required analyses. Soil sampling locations are shown in Figure 4-1 and described below. Sample locations and analyses are summarized in Table 4-2.

A grid system consisting of ten rows and five columns will be established. The rows start at the visibly contaminated area ("hot spot") and extend down the slope to the intermittent stream channel. The first six rows will be spaced approximately one meter apart and the remaining four approximately two meters apart. The closer spacing is used nearer the source where more rapid changes in concentration with distance are expected. The grid will have five columns, with the center column through the hot spot. The column spacing is approximately one meter, or sufficient to be outside of the hot spot.

Samples will be collected at all of the grid points, with the exception of those located in the hot spot. Samples will not be collected in the hot spot because this area is already known to be highly contaminated. The sample from each grid point will be split into triplicates. One of the triplicates will be used for making a row composite and one for a column composite. The other will be retained for possible subsequent analysis if indicated by the results of the composite analyses.

Composite samples from Rows 1 through 5 will be created by compositing the samples from Columns 1, 2, 4, and 5. The samples from Column 3 will not be included because they will be located in the hot spot or retained for discrete analysis. These composite samples outside the hot spot are intended to be representative of average concentrations outside the zone expected to require cleanup. Concentrations immediately downslope of the source will be assessed through collection of discrete samples along Column 3 at Rows 3, 4, and 5. These samples are located within areas expected to exceed cleanup levels. Composite samples from Rows 6 through 10 will be created by compositing the samples from all five Columns. These samples are intended to be representative of average concentrations along the transcects downslope from the source where minimal migration is expected to have occurred (i.e., areas not expected to require cleanup).

Composite samples from Rows 1 through 5 will be analyzed for total metals and TPH. Composite samples from Rows 6 through 10 will be analyzed for mercury only.

As noted above, discrete samples will be collected from Column 3 immediately downslope from the hot spot (Rows 3, 4, and 5). These samples will not be included in the row and column composites because the concentrations are expected to be much higher than the concentrations along the lateral columns. At the locations defined by Column 3 and Rows 3 and 5, samples will also

Figure 4-1

Locations of Soil Samples

FIGURE A-1 LOCATIONS OF SOIL SAMPLES

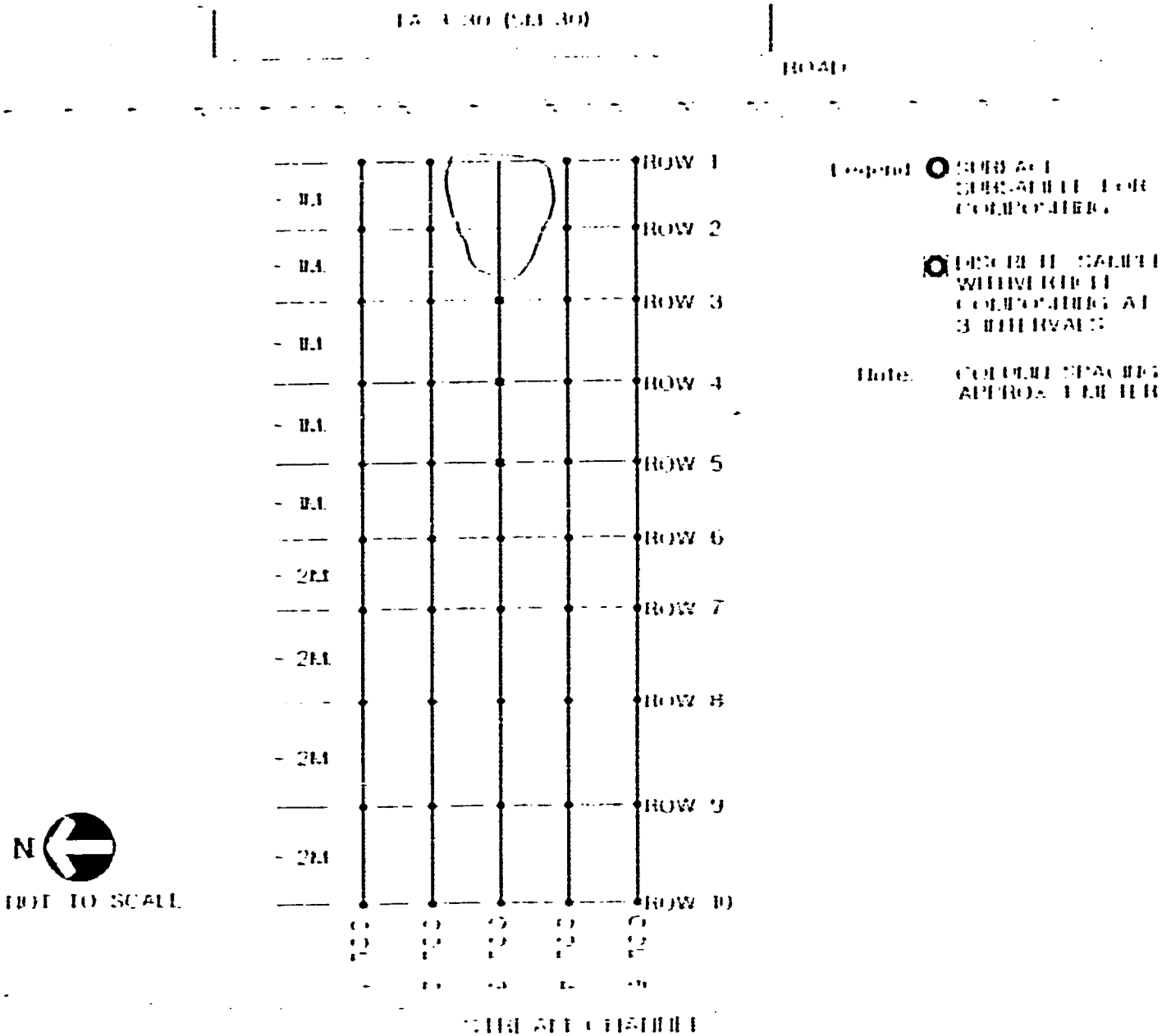


Table 4-2
Summary of Samples and Analyses

Location	Depth	Total Metals	Mercury	TPH
Composite Row 1	Surface	X		X
Composite Row 2	Surface	X		X
Composite Row 3	Surface	X		X
Composite Row 4	Surface	X		X
Composite Row 5	Surface	X		X
Composite Row 6	Surface		X	
Composite Row 7	Surface		X	
Composite Row 8	Surface		X	
Composite Row 9	Surface		X	
Composite Row 10	Surface		X	
Composite Column 1	Surface		X	
Composite Column 2	Surface		X	
Composite Column 3	Surface		X	
Composite Column 4	Surface		X	
Composite Column 5	Surface		X	
Row 3, Column 3	Surface	X		X
Row 3, Column 3	0 - 0.5 m	X		X
Row 3, Column 3	0.5 - 1.0 m	X		X
Row 3, Column 3	1.5 - 2.0 m	X		X
Row 4, Column 3	Surface	X		X
Row 4, Column 3	0 - 0.5 m	X		X
Row 4, Column 3	0.5 - 1.0 m	X		X
Row 4, Column 3	1.5 - 2.0 m	X		X
Row 5, Column 3	Surface	X		X
Row 5, Column 3	0 - 0.5 m	X		X
Row 5, Column 3	0.5 - 1.0 m	X		X
Row 5, Column 3	1.5 - 2.0 m	X		X
Stream Sediment, Upstream	0 - 0.5 m		X	
Stream Sediment, 0 to 40 m Composite	0 - 0.5 m		X	
Stream Sediment, 50 to 90 m Composite	0 - 0.5 m		X	

be collected on a vertical profile. In addition to the surface sample, vertical composite samples will be collected from the depth intervals 0 to 0.5 m, 0.5 to 1.0 m, and 1.5 to 2.0 m. If bedrock is encountered before 2.0 m, the sample will be composited over the interval 0.5 m above bedrock. These samples should be sufficient to establish the vertical extent of contamination for purposes of evaluating remedial actions. These samples will be analyzed for total metals and TPH.

Sediment samples from the stream channel will be collected upstream from the point where runoff from the site reaches the channel and at ten points downstream of the site. These sample locations are shown in Figure 4-2. The upstream sample will be located downstream from where a culvert discharges to the stream. This sample will be used to determine whether there are other upstream sources of contamination. The ten samples along the steam channel will be spaced approximately 10 meters apart. Sample locations will be in catchments whenever possible. Because the concentrations are not expected to vary substantially along the channel, composite sampling will be used. At each location, a vertical composite will be made from interval of the surface to 0.5 m or bedrock, whichever is shallower. The vertical composites from the first five locations will be composited into one sample. Those from the next five locations will also be composited into a single sample. All sediment samples will be analyzed for total mercury.

Surface water samples will be collected at three locations in the stream channel when water is present. Sample locations are shown in Table 4-2. The first location is upstream from the site, at the same location of the upstream sediment sample. The second location is immediately downstream of the gridded area. The third location is downstream of the site, immediately downstream of where the bridge crosses the jogging path. Samples will be collected at three times, corresponding to the first three significant runoff events following completion of the remedial action. All water samples will be analyzed for total and dissolved metals.

Surface and subsurface soil samples and water samples will be collected using the Standard Operating Procedures (SOPs) given in Appendix B. Quality control samples consisting of duplicates and blanks will be collected as described in the Quality Assurance Project Plan (Appendix C). Field activities will be conducted in accordance with the Health and Safety Plan (Appendix D).

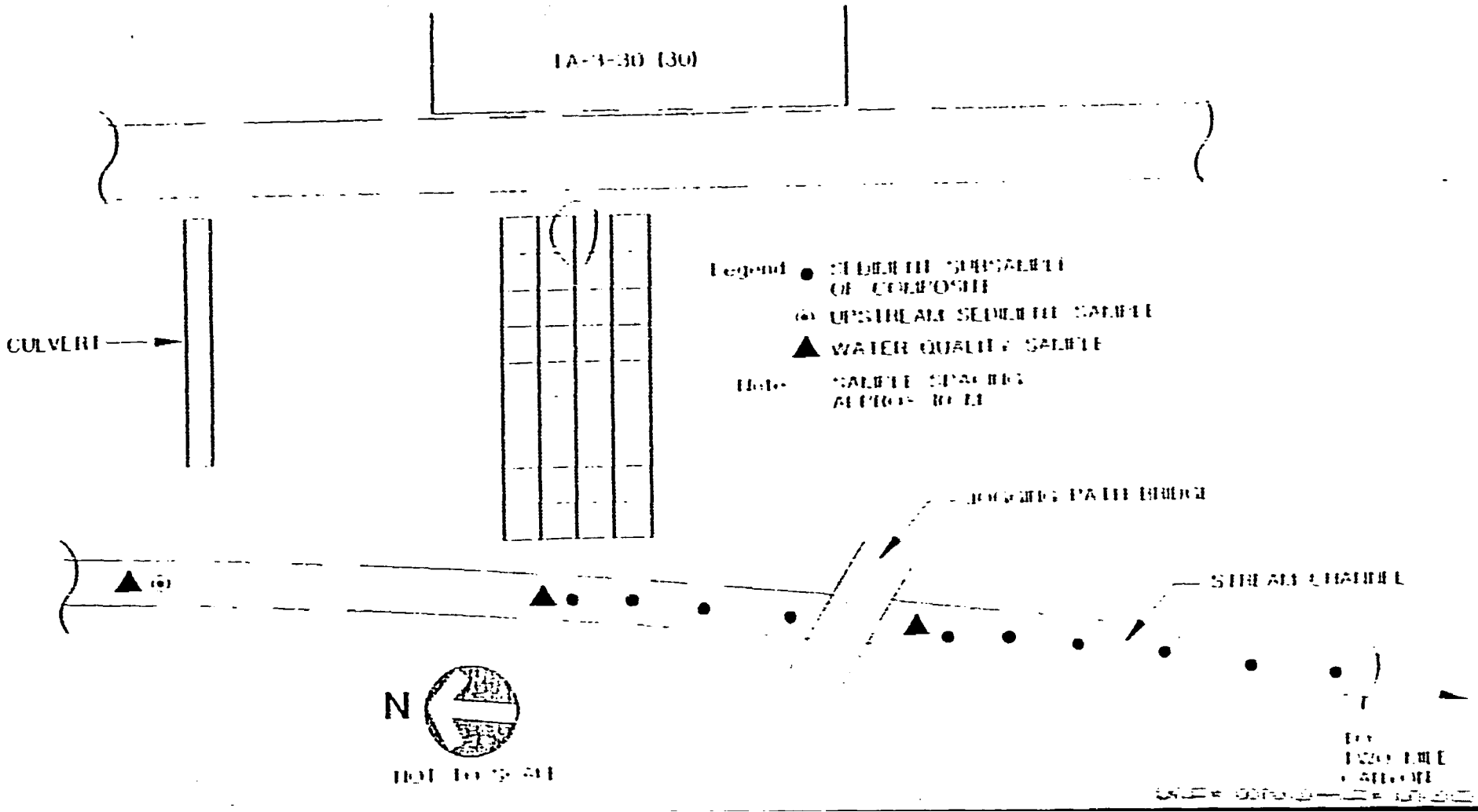
4.3 Analytical Methods

As described in Section 4.1, soil samples will be analyzed for total metals, mercury, and TPH. Total metals analysis will involve analysis for the 23 metals contained in EPA's target

Figure 4-2

Locations of Sediment and Water Samples

FIGURE 4-2. LOCATIONS OF SEDIMENT AND WATER SAMPLES



analyte list (TAL). Analysis for TAL metals will involve a combination of inductively coupled plasma spectroscopy (ICP) and atomic absorption spectroscopy (AA). Mercury analyses will be by cold vapor AA. Samples will be extracted by digestion using EPA SW-846 Method 3050. Samples for TPH analysis will be extracted using EPA SW-846 Method 3550 and the extract analyzed using EPA Method 418.1. Analytes, methods, and estimated detection limits are summarized in Table 4-3.

Water samples will be analyzed for total metals using the same analytical methods as for soils. Water samples will be extracted using EPA SW-846 Method 3005 instead of 3050.

5.0 REMEDIATION PLAN

This section discusses the general actions that will be undertaken as part of the remedial action at the site. These actions include evaluation of the sampling and analysis data, evaluation of alternatives, and implementation of alternatives.

5.1 Data Evaluation

The results from analysis of soil samples for total metals and mercury will be evaluated to determine the area and depth of soil to be excavated. These data will be evaluated as described below.

Results of the row and column composite samples will be reviewed to identify any mercury results above the 80 mg/kg cleanup level. For a row having results of 80 mg/kg or above, the following procedure will be used. If any column composites are 40 mg/kg or above, the reserved triplicate sample for that row and column will be submitted for mercury analysis. If none of the column composites are 40 mg/kg or above, all of the reserved triplicates for that row will be submitted for mercury analysis. Once the results of analysis of the reserved samples is complete, all mercury results will be used to define the area exceeding the 80 mg/kg cleanup level. A similar procedure will be used if there are any other metals present above the SALs given in the 1992 IWP.

If all samples for a row are above the cleanup level, two approaches may be taken. If the results are slightly above the SAL, the existing results may be used to extrapolate the horizontal extent of contamination. If the results are greatly above the cleanup level, additional samples may be taken and analyzed to define the extent of contamination.

The results of the vertical sampling will be evaluated to estimate the vertical extent of soil contaminated above the 80

Table 4-3

Summary of Analytical Methods

Analyte	Method	EPA Method Number	Approximate Detection Limit, mg/kg
Aluminum	ICP	6010	20
Antimony	ICP	6010	6
Arsenic	Graphite Furnace AA	7060	0.5
Barium	ICP	6010	5
Beryllium	ICP	6010	0.5
Cadmium	ICP	6010	0.5
Calcium	ICP	6010	500
Chromium	ICP	6010	1
Cobalt	ICP	6010	4
Copper	ICP	6010	2.5
Iron	ICP	6010	10
Lead	ICP	6010	10
Magnesium	ICP	6010	50
Manganese	ICP	6010	1.5
Mercury	Cold Vapor AA	7470	0.25
Nickel	ICP	6010	4
Potassium	ICP	6010	10
Selenium	Graphite Furnace AA	7740	0.5
Silver	ICP	6010	1
Sodium	ICP	6010	50
Thallium	ICP	6010	10
Vanadium	ICP	6010	4
Zinc	ICP	6010	2
TPH		418.1	30

mg/kg cleanup level. If all results are above the level, soil will be excavated to the top of bedrock.

After evaluation of all data, the volume of soil to be excavated will be plotted on a map of the site.

The results of the metal and TPH analyses will be used to estimate the range of concentrations of mercury, TPH, and any other metals of concern. These results will also be used to estimate the average concentrations of these constituents. The estimated averages should be representative of the bulk concentration of contaminants in the soil after excavation. The range and average concentrations will be needed to determine the applicability and effectiveness of the various treatment alternatives.

5.2 Evaluation of Alternatives

Presently, three alternatives are being considered for treatment of the excavated soil. These alternatives are:

- Stabilization;
- Soil washing; and
- Thermal treatment.

mixed waste treatment

The alternative selected will depend on the concentrations of contaminants present in the soil. General guidelines for selection of the alternatives are described below.

The primary factor governing treatment of the mercury-contaminated soils are the RCRA Land Disposal Restrictions (LDRs) (**ref.**). The LDRs determine the type and extent of treatment that will be required to dispose of the soils. If the average concentration of mercury in the excavated soils is expected to be greater than 260 mg/kg, the LDRs that require thermal treatment be used. Thermal treatment options specified in the LDRs include incineration, or roasting or retorting in a unit capable of recovering volatilized mercury. These types of facilities are not available at LANL and the soil would have to be sent off-site for treatment.

If the soils have a mercury concentration below 260 mg/kg, either stabilization or soil washing could be used. The LDR in this case requires that the treated soil pass the TCLP. That is, the concentration of mercury leached from the treated soil must be less than 0.2 mg/L. The selection of a treatment method will be based on evaluation of the physical and chemical properties of the soil. Examples of important factors are described below.

Concentrations of other leachable metals materials:	The concentrations of other materials that can be leached along with mercury will determine the total amount of metals in the leachate. This in turn will determine the total amount of sludge produced by treatment of the leachate and the amount of secondary waste requiring disposal.
Soil particle size:	In general, soil washing would be given preference for coarse soils and stabilization for fine soils. Soil particles in the clay size range are difficult to separate from the soil washing solution and can contribute to the amount of secondary waste generated.
Soil texture:	The soil texture will affect the ease of mixing for incorporating stabilization chemicals into the soil. If the soils are highly plastic, mixing may be difficult and stabilization may be ineffective.
Concentrations of other metals potentially reacting with stabilization agents:	The stabilization process involves incorporation of chemicals into the soil that will react with mercury to form insoluble sulfides. Other metals may be present in the soil that would undergo similar reactions. The concentration of such metals would affect the amount of stabilization chemicals that would need to be added.

5.3 Implementation

The specific actions to be taken during implementation will be identified after evaluation of the data. In general, remedial action will involve the following major components: excavation, soil management, confirmatory sampling, and backfill. Implementation of these components is described below. Prior to implementing the remedial action, the Health and Safety Plan will be revised to address the additional hazards posed by implementation of the remedial action.

The method of excavation will depend on the area and depth of soil to be excavated. It is currently expected that all of the soil can be excavated from the road behind Building TA-3-30 using a backhoe excavator. The size of excavator used will depend upon the required reach.

Management of the soil after excavation will depend on the treatment to be employed. If off-site treatment will be required, the soil will be loaded directly into lined, covered 20- or 30-cubic yard dump trucks. The soil will be transported

under applicable RCRA and Department of Transportation (DOT) requirements to the treatment facility. If on-site treatment is to be used, soil will be transported in a similar manner to the place of treatment. If necessary, the soil will be stockpiled for treatment by placement on an impervious liner and then covered with an impervious cover. The stockpiled soil will be inspected daily until treatment is complete. Treated soil will be transported to an off-site disposal facility in a similar manner as untreated soil.

A confirmatory sampling program will be used to verify that cleanup levels have been met. A grid composed of five rows and five columns will be established within the area defined by the sides and bottom of the excavation. Triplicate grab surface samples (0 to 3 inches) will be collected at each grid point and used to create composite row and column samples, as described in Section 4.2. These samples will be analyzed for total mercury and any other metal originally present above SALs. One of the triplicate samples from each point will be reserved for further analysis, if needed. The methods for sample collection and analysis will be the same as described in Sections 4.2 and 4.3.

After receipt of analyses confirming that cleanup levels have been met, the excavation will be backfilled using clean soil. The fill will be compacted during placement to prevent subsidence. After backfilling is completed, the site will be revegetated with native vegetation to prevent erosion.

REFERENCES

APPENDICES

A. Analytical Results From Previous Sampling

B. Standard Operating Procedures

C. Quality Assurance Project Plan

D. Health and Safety Plan

E. Data Management Plan