LANL HSWA FA3 TA 10 18

Rec'd 10/11/95

Rec'd 10/11/95

Los Alamos National Laboratory

ENVIRONMENTAL RESTORATION

University of California
Environmental Restoration, MS M992
Los Alamos, New Mexico 87545
505-665-4557
FAX 505-665-4747

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

Date: September 29, 1995
Refer to: EM/ER:95-528

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

SUBJECT: SUBMITTAL OF RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION (RFI) REPORTS FOR SOLID WASTE MANAGEMENT UNITS (SWMUs) 33-002(a-e), 33-003(a), 33-004(a), 33-007(c), 33-009, 33-011(d), 33-013, 33-016, AND 33-017

Dear Mr. Neleigh:

Enclosed are two copies of the Los Alamos National Laboratory's (Laboratory's) RFI Reports concerning SWMUs 33-002(a-e), 33-003(a), 33-004(a), 33-007(c), 33-009, 33-011(d), 33-013, 33-016, and 33-017. The Laboratory also requests revisions to approved sampling plans for potential release sites (PRSs) 33-003(b), 33-004(k), 33-008(a), 33-008(b), C-33-001, and C-33-002. The SWMUs are covered in two separate RFI reports, one describing MDA K [SWMU 33-002(a-e)], and one describing the other PRSs listed above. The reports document the field work performed as detailed in the approved RFI Work Plan for Operable Unit 1122 and the sampling results.

Please ask your office to contact Brad Martin at (505) 667-6080 or Everett Trollinger at (505) 667-5801 if you have any questions.

Sincerely,

Jorg Jansen, Program Manager
Environmental Restoration

Sincerely,

Everett A. Trollinger
for Theodore J. Taylor, Program Manager
Los Alamos Area Office

JJ/TT/gmb

Environmental Restoration

4723

Enclosure: RFI Reports for SWMUs 33-002(a-e), 33-003(a), 33-004(a), 33-007(c), 33-009, 33-011(d), 33-013, 33-016, and 33-017.
Revisions to PRSs 33-003(b), 33-004(k), 33-008(a), 33-008(b), C-33-001 and C-33-002

Cy (w/enc.):
B. Garcia, NMED-HRMB
D. Griswold, ERD, AL, MS A906
J. Harry, EM/ER, MS M992
B. Martin, CST-18, MS E525
E. Merrill, EM-453, DOE-HQ
T. Taylor, LAAO, MS A316
E. Trollinger, LAAO, MS A316
N. Weber, Bureau Chief, NMED-AIP
J. White, ESH-19, MS K498
S. Yanicak, NMED-AIP
EM/ER File, MS M992
RPF, MS M707

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

CERTIFICATION

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

Document Title: **Resource Conservation and Recovery Act Facility Investigation Report for Solid Waste Management Units 33-002(a-e), 33-003(a), 33-004(a), 33-007(c), 33-009, 33-011(d), 33-013, 33-016, and 33-017**

Name: _____ Date: 9-28-95

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

or

Tom Baca, Program Director
Environmental Management
Los Alamos National Laboratory

Name: _____ Date: 10-2-95

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

or

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

LA-UR-95-3624

RFI Report for MDA K

PRSs 33-002(a,b,c,d,e)

Field Unit 3

Environmental Restoration Project

Los Alamos
National Laboratory

A Department of Energy

Environmental Cleanup Project

September 29, 1995

CONTENTS

EXECUTIVE SUMMARY ix

1.0 INTRODUCTION 1

1.1 Site History 1

1.2 RFI Overview 1

1.2.1 RFI Objectives 4

1.3 Field Activities 4

1.3.1 Field Surveys 4

1.3.2 Field Sampling 5

1.3.3 Deep Borehole Sampling 7

1.3.4 Samples not Collected 8

2.0 ENVIRONMENTAL SETTING 9

2.1 Climate 9

2.2 Geology 9

2.2.1 Geologic Setting 10

2.2.2 Soils 10

2.3 Hydrology 10

2.4 Biological and Cultural Surveys 10

3.0 APPROACH TO DATA ASSESSMENT AND ANALYSIS 11

3.1 Summary of Quality Assurance/Quality Control Activities 11

3.1.1 Inorganic Analyses 12

3.1.2 Organic Analyses 12

3.1.3 Radiochemistry Analyses 12

3.1.4 High Explosives Analyses 12

3.2 Screening Assessment 13

3.2.1 Background Comparison 13

3.2.2 Screening Action Levels Comparison 14

3.2.3 Ecological Screening Assessment Methodology 14

3.3 Risk Assessment Methodology 15

3.4 Development of Conclusions and Recommendations 15

4.0 SITE-SPECIFIC RESULTS, CONCLUSIONS, AND RECOMMENDATIONS 15

4.1 SWMU 33-002(a) TA-33-86 Septic System and MDA K Surface Tritium 16

4.1.1 Previous Investigation 18

4.1.2 Field Investigation 18

4.1.2.1 Results of Field Surveys 20

4.1.2.2 Results of Field Screening 20

4.1.3 Screening Assessment 22

4.1.3.1 Comparison to Background/SALs 22

4.1.3.1.1 Septic Tank and Shallow Borehole Results 22

4.1.3.1.2 Surface Tritium Results 22

4.1.3.1.3 Deep Borehole Results 26

4.1.3.2 Data Interpretation 28

4.1.3.2.1 Borehole Observations 28

4.1.3.2.2 Borehole Interpretations 35

4.1.3.3 Risk Assessment for MDA K 36

4.1.3.4 Ecotoxicological Screening Assessment 37

4.1.4 Conclusions and Recommendations 38

4.1.4.1 Surface Tritium 38

4.1.4.2 Subsurface Tritium 39

4.1.4.3 Septic Tank 40

4.2 SWMU 33-002(b) Sump TA-33-134 40

4.2.1 Previous Investigations 40

4.2.2 Field Investigation 41

4.2.2.1 Results of Field Surveys 41

4.2.2.2 Results of Field Screening 41

4.2.3 Screening Assessment 41

4.2.3.1 Comparison to Background/SALs 41

4.2.3.2 Data Interpretation 42

4.2.3.3 Risk Assessment 42

4.2.3.4 Ecotoxicological Screening Assessment 44

4.2.4 Conclusion and Recommendation 44

4.3 SWMU 33-002(c) Sump TA-33-133 45

4.3.1 Previous Investigations 45

4.3.2 Field Investigation 45

4.3.2.1 Results of Field Surveys 46

4.3.2.2 Results of Field Screening 46

4.3.3 Screening Assessment 46

4.3.3.1 Comparison to Background/SALs 46

4.3.3.2 Data Interpretation 48

4.3.3.3 Risk Assessment 48

4.3.3.4 Ecotoxicological Screening Assessment 48

4.3.4 Conclusion and Recommendation 48

4.4 SWMU 33-002(d) Noncontact Cooling Water Outfall 48

4.4.1 Previous Investigations 49

4.4.2 Field Investigation 49

4.4.2.1 Results of Field Surveys 50

4.4.2.2 Results of Field Screening 50

4.4.3 Screening Assessment 50

4.4.3.1 Comparison to Background/SALs 50

4.4.3.2 Data Interpretation 53

4.4.3.3 Risk Assessment 53

4.4.3.4 Ecotoxicological Screening Assessment 55

4.4.4 Conclusion and Recommendation 55

4.5 SWMU 33-002(e) TA-33-86 Roof Drain 56

4.5.1 Previous Investigations 56

4.5.2 Field Investigation 56

4.5.2.1 Results of Field Surveys 57

4.5.2.2 Results of Field Screening 57

4.5.3 Screening Assessment 57

4.5.3.1 Comparison to Background/SALs 57

4.5.3.2 Data Interpretation 57

4.5.3.3 Risk Assessment 57

4.5.3.4 Ecotoxicological Screening Assessment 57

4.5.4 Conclusion and Recommendation 60

5.0 REFERENCES 61

APPENDIX A RAW DATA A-1

APPENDIX B PHASE II SAMPLING AND ANALYSIS PLANS FOR PRS 33-002(a,b,c) B-1

1.0 FURTHER INVESTIGATIONS OF SWMU 33-002(a) MDA K SEPTIC SYSTEM AND BOREHOLES B-1

1.1 Phase II Sampling Objectives B-1

1.2 Sampling and Analysis B-2

2.0 FURTHER INVESTIGATION OF SWMU 33-002(b) SUMP 33-134 ..... B-5

2.1 Phase II Sampling Objectives B-5

2.2 Sampling and Analysis at SWMU 33-002(b) Sump TA-33-134 ..... B-6

3.0 FURTHER INVESTIGATIONS OF SWMU 33-002(c) SUMP TA-33-133 ..... B-7

3.1 Phase II Sampling Objectives B-7

3.2 Sampling and Analysis for SWMU 33-002(c) Sump TA-33-133 ..... B-8

APPENDIX C CALCULATIONS FOR ECOTOXICOLOGICAL SCREENING ASSESSMENT C-1

APPENDIX D RESIDUAL RADIO ACTIVE MATERIAL RISK ASSESSMENT CALCULATIONS D-1

LIST OF TABLES

Table ES-1 Potential Release Sites at MDA-K ix

Table ES-2 RFI Work Plan Sampling Not Conducted x

Table 1-1 RFI Work Plan Sampling Not Conducted 9

Table 3-1 Range (Excluding Outliers) and Upper Tolerance Limits for Inorganics in Soil Samples 13

Table 3-2 Range (Excluding Outliers) and Upper Tolerance Limits for Radionuclides in Soil Samples 14

Table 4-1 PRSs at MDA K 16

Table 4-2 Inorganic and Radionuclide Analytes Found in the Tank and Shallow Boreholes at SWMU 33-002(a) With Concentrations Greater Than LANL or TA-33 Background Surface UTLs 22

Table 4-3 Organic Analytes Found Above Detection Limits at SWMU 33-002(a) 23

Table 4-4 Surface Tritium Activities Greater Than TA-33 Background UTL 24

Table 4-5 Analyte Concentrations Above LANL and TA-33 UTLs For Boreholes at MDA K, Excluding Tritium 26

Table 4-6 Soil Tritium Activities in Boreholes 33-1230, 33-1231, and 33-1232 27

Table 4-7 Tritium Activities Detected in Chaquehui Canyon (1991-1994) 33

Table 4-8 Surface Soil Samples With Tritium Activities Exceeding SAL 36

Table 4-9 Parameters Used in RESRAD Model for MDA K 37

Table 4-10 Inorganic and Radionuclide Analytes Found at SWMU 33-002(b) With Values Greater Than LANL and TA-33 Background UTLs 42

Table 4-11 Parameters Used in RESRAD Model for Sump TA-33-134 44

Table 4-12 Radionuclide Analytes Found at SWMU 33-002(c) With Values Greater Than LANL or TA-33 Background UTLs 46

Table 4-13 Weston Surface Sampling Results Above Background 49

Table 4-14 Tritium Found at SWMU 33-002(d) With Value Greater Than TA-33 Background Upper Tolerance Limit 50

Table 4-15 Inorganic and Radionuclide Analytes Found at SWMU 33-002(d) With Values Greater Than LANL AND TA-33 Background Upper Tolerance Limits 51

Table 4-16 Multiple Constituent Analysis for Sample AAA1942 51

Table 4-17 Organic Analytes Above Detection Limit at SWMU 33-002(d) 52

Table 4-18 Comparison of Tritium Activities in May 1993 and December 1994 53

Table 4-19 Comparison of Tritium Parameters in May 1993 and December 1994 55

Table 4-20 Organic Analytes Detected in Surface Samples at SWMU 33-002(e) 58

Table C-1 SWMU 33-002(a): Septic System, TA-33-86 ..... C-1

Table C-2 MDA K Sumps and Outfalls C-2

Table C-3 Middle (Tritiated) Borehole 33-1231 ..... C-3

Table C-4 North (Cattail) Borehole 33-1230 ..... C-3

Table C-5 South Borehole 33-1232 ..... C-3

Table D-1 Tritium Surface and Subsurface Contamination D-1

Table D-2 Tritium in Sump TA-33-134, 3 Meter Depth D-2

Table D-3 Tritium in Sump TA-33-134, 27 Meter Depth D-3

LIST OF FIGURES

Fig. 1-1. Location of TA-33. 2

Fig. 1-2. Location of MDA K at Main Site. 3

Fig. 4-1. PRS locations at MDA K. 17

Fig. 4-2. Tritium in soil moisture at MDA K. 19

Fig. 4-3. SWMU 33-002(a) septic systems and boreholes locations. 21

Fig. 4-4. Sampling locations with surface tritium above TA-33 background UTLs. 25

Fig. 4-5. Borehole 33-1231 tritium comparisons. 29

Fig. 4-6. Percent soil moisture in Borehole 33-1231. 31

Fig. 4-7. Lithologic log. 32

Fig. 4-8. Chaquehui Canyon sampling. 34

Fig. 4-9. SWMU 33-002(b) sump TA-33-134. 43

Fig. 4-10. SWMU 33-002(c) sump TA-33-133. 47

Fig. 4-11. SWMU 33-002(d) cooling water outfall. 54

Fig. 4-12. SWMU 33-002(e) roof drain outfall. 59

Fig. B-1. Results of resistivity survey and Phase II borehole locations at MDA K. B-3

EXECUTIVE SUMMARY

Material disposal area K (MDA K) is the effluent area for the High Pressure Tritium Facility (TA-33-86) which was operated at Technical Area 33 (TA-33) by Los Alamos National Laboratory (LANL) between 1955 and 1990.

In accordance with the Resource Recovery and Conservation Act (RCRA) Facility Investigation (RFI) Work Plan for Operable Unit 1122, LA-UR 92-925, Phase I sampling and analysis (including deep drilling) was performed between May and November 1993 to determine contamination, primarily by tritium, at the five potential release sites (PRSs) located at Material Disposal Area (MDA) K (LANL 1992, 0784). This RFI report documents results of Phase I sampling and analysis at the five PRSs. The presence of a subsurface tritium plume was confirmed and surface tritium was found above the screening action level (SAL) within the MDA. As listed in Table ES-1, this report recommends Phase II sampling at three PRSs. Two of the five PRSs are proposed for no further action (NFA). The rationale for a recommendation of NFA at these PRSs is based on the LANL Environmental Restoration Project No Futher Action Criteria Policy (Environmental Restoration Project 1995, 1173).

TABLE ES-1

POTENTIAL RELEASE SITES AT MDA K

PRS ID	HSWA[a]	PRS TYPE	ACTION	NFA[b] CRITERION	RATIONALE
33-002(a)	1990	Septic system TA-33-93	Phase II	NA[c]	Define tritium plume
33-002(b)	1990	Sump TA-33-134	Phase II	NA	Define tritium plume
33-002(c)	1990	Sump TA-33-133	Phase II	NA	Complete investigation
33-002(d)	1994	Outfall EPA 04A147	NFA	4	No RCRA contaminants above SAL[d]
33-002(e)	1994	Roof drain from TA-33-86	NFA	1	PAHs[e] not from a waste stream

[a] HSWA = Hazardous and Solid Waste Act Amendments.
[b] NFA = No further action.
[c] NA = Not applicable.
[d] SAL = Screening action level.
[e] PAHs = Polycyclic aromatic hydrocarbons.

Sampling and analyses were performed as specified in the work plan except in cases where the medium to be sampled was not present. Deviations from the approved work plan are listed in Table ES-2.

TABLE ES-2

RFI WORK PLAN SAMPLING NOT CONDUCTED

PRS ID	SAMPLES NOT TAKEN	REASON SAMPLING WAS NOT CONDUCTED
33-002(b)	2 Fluid	Fluid not present in sump. Fluid samples not collected.
33-002(b)	2 Subsurface	Soil too shallow for specified number of subsurface samples.
33-002(c)	2 Fluid	Fluid not present in sump. Fluid samples not collected.
33-002(c)	2 Subsurface	Soil too shallow for specified number of subsurface samples.
33-002(d)	3 Fluid	Surface water not present at outfall. Fluid samples not collected.

The following is a summary of each PRS addressed in this RFI report. When referring to a specific PRS, the site is called a solid waste management unit (SWMU) in accordance with RCRA terminology.

- **SWMU 33-002(a), Septic system and the surface component of MDA K.** Samples from the tank and drain field consisting of fluid, sludge, surface soil, and subsurface soil were collected for laboratory analysis. Tritium was detected in the fluid and sludge samples. Tritium below SAL was detected in the remaining samples. Inorganics and organics, primarily volatile organic compounds, were found in the sludge. A risk assessment performed for surface and subsurface tritium indicated that radiation exposure is below Department of Energy (DOE) guidelines. Because water is supplied to the tritium facility, the septic system is considered active.

  Three boreholes were drilled at the lower edge of the drain field to depths exceeding 200 ft. Samples were taken approximately every 10 ft. Elevated levels of tritium were observed at depths of 80 to 150 ft in one hole. Source of the plume was not determined from Phase I sampling. A Phase II sampling and analysis plan is proposed for SWMU 33-002(a). Following the sampling, a plan will be written proposing removal of hazardous waste from the tank and in-place stabilization of the tritium plume. This latter action will allow tritium to decay to background levels.

- **SWMU 33-002(b), Sump TA-33-134.** Three samples were taken from one borehole adjacent to the sump and a sample was collected from the bottom of the sump. Tritium was detected in all samples. Activities were above SAL in two of the samples. Other contamination detected was below SALs. Because of questions regarding the sampling location within the sump, a Phase II plan is presented for further investigation. The sump has been posted for subsurface tritium in accordance with the LANL Radiological Control (RADCON) Manual (LANL 1994, 1235).

- **SWMU 33-002(c), Sump TA-33-133.** Two samples were taken from a borehole adjacent to the sump and a sample was collected at 4 ft below the surface of the sump. Tritium was detected in all samples at activities below SAL. Other contamination detected was below SALs. Because of questions regarding the sampling location within the sump, a Phase II plan is presented for further investigation.

- **SWMU 33-002(d), Outfall NPDES EPA 04A147.** Five surface samples were collected. Tritium was detected in all samples. Levels exceeded SAL in three samples. Tritium activities in the samples were considered in the MDA K risk assessment which indicated maximum dose well below DOE guidelines. The outfall is recommended for NFA. The unit will be included in the posting of MDA K in accordance with LANL RADCON manual (LANL 1994, 1235).

- **SWMU 33-002(e), Roof drain from TA-33-86.** Five surface samples were collected and analyzed only for tritium and semivolatile organic compounds (SVOCs). Tritium levels were within local background range. SVOCs, primarily polycyclic aromatic hydrocarbons (PAHs), were found in the outfall sample and its two duplicate samples. Several PAHs were detected above SALs. These contaminants are constituents of the asphalt roof and are not part of a waste stream; therefore, this SWMU is proposed for NFA.

THIS PAGE LEFT INTENTIONALLY BLANK

1.0 INTRODUCTION

1.1 Site History

Technical Area (TA)-33 is located in the southeastern section of Los Alamos National Laboratory (LANL) (Fig. 1-1). Material disposal area (MDA) K is the liquid effluent area for the high-pressure tritium facility, TA-33-86, that operated from 1955 until 1990. TA-33-86 housed equipment used to transfer tritium from large transportation tanks to smaller vessels for use at various LANL locations. The building was occasionally used for other activities; for example, a uranium fluidized bed assembly was set up there in the 1960s (Ahlquist 1983, 02-006). After operations ceased in 1990, all equipment was removed from the building.

The TA-33-86 complex is located at Main Site, occupying the southern third of the developed area (Fig. 1-2). The area surrounding the building is level and fenced. Most of the fenced area is paved with asphalt. MDA K lies beyond the fence approximately 100 ft east of the building. The MDA is unfenced and unpaved and retains the natural contour of the land, sloping to the shallow drainage on the northeast. It is served by an unimproved road blocked with a locked chain. Five potential release sites (PRSs) were identified at MDA K: the septic system, two sumps, and two outfalls. All received liquid discharges from TA-33-86.

1.2 RFI Overview

The TA-33 Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) work plan was submitted to the Environmental Protection Agency (EPA) Region 6 in May 1992 and was approved with minor modifications by EPA in July 1993 (EPA 1993, 02-090). EPA modified the MDA K sampling plan to include additional analyses in the first 30 ft of borehole samples at three locations targeted for deep drilling. This modification was implemented during sampling. The technical approach of the plan specified that two types of samples be collected: biased samples from locations most likely to be contaminated, and random samples to provide data required for a baseline risk assessment, if needed. This technical approach was designed to ensure that waste streams associated with LANL activities were discovered and investigated in compliance with LANL's Module VIII of the Hazardous and Solid Waste Amendments (HSWA) LANL Facility Permit (EPA 1990, 0306).

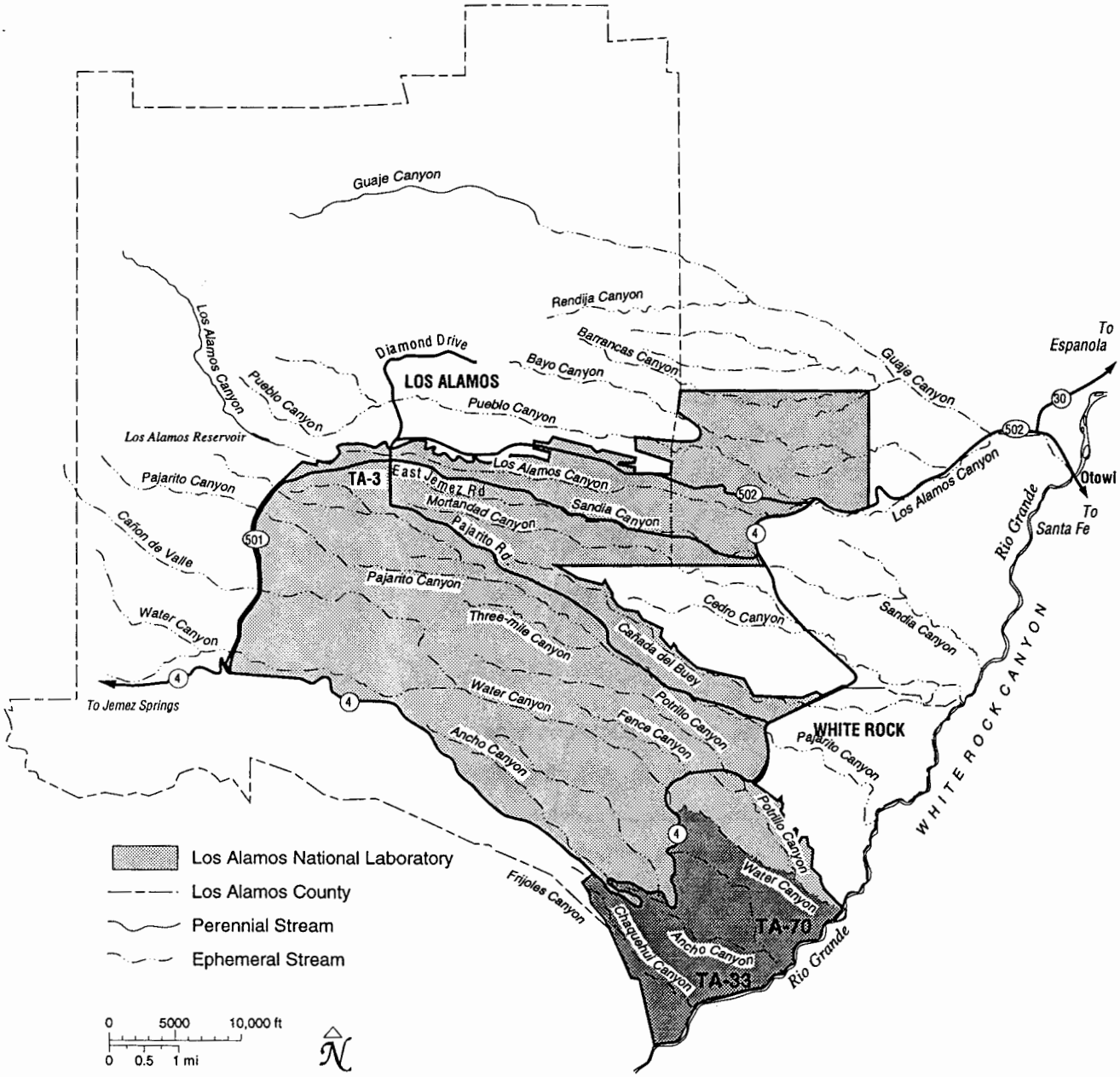

Fig. 1-1. Location of TA-33.

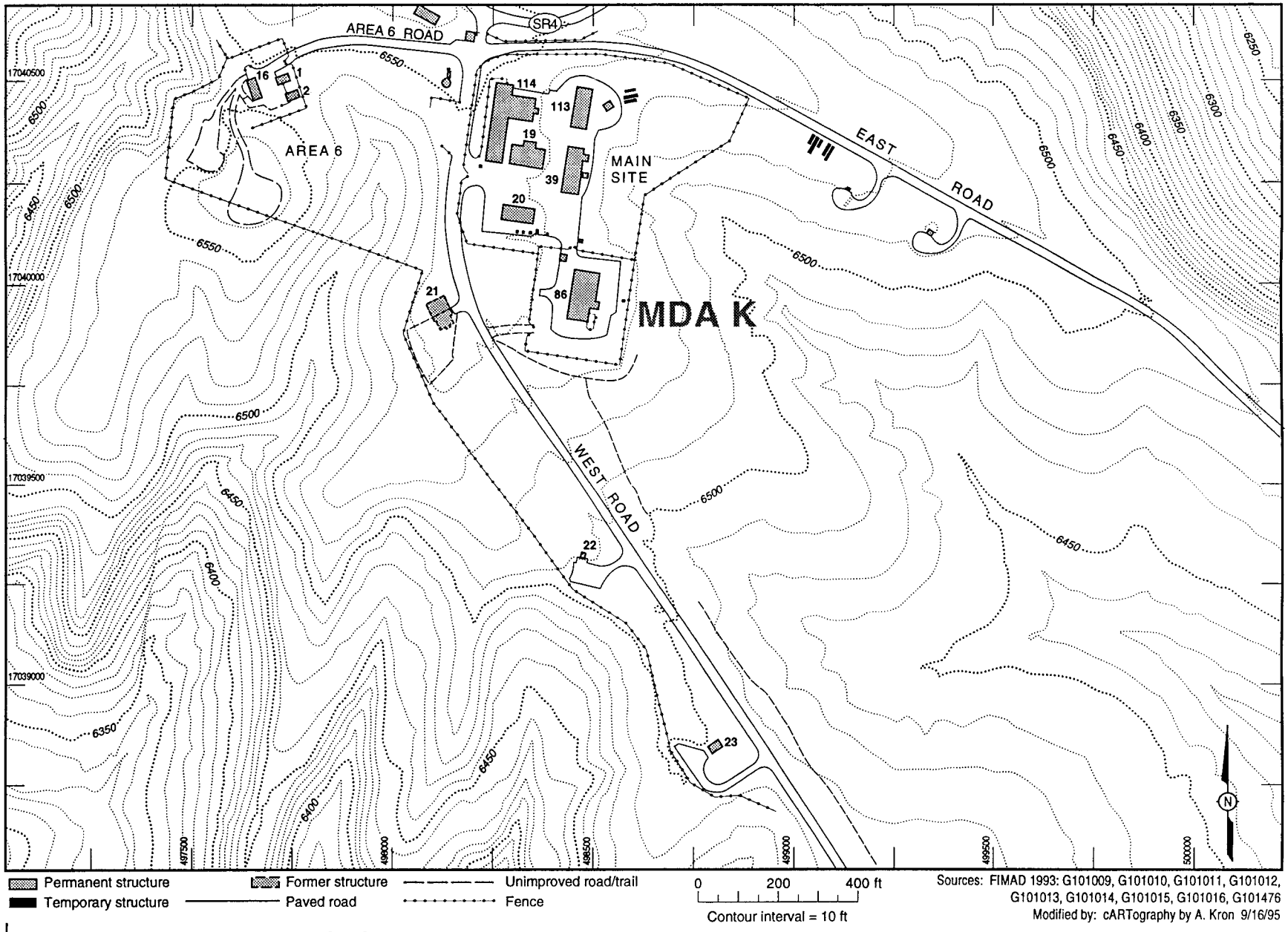

Fig. 1-2. Location of MDA K at main site.

1.2.1 RFI Objectives

Because tritium contamination was previously documented at MDA K, the objective of the RFI Phase I sampling plan was to verify presence of tritium, determine the concentration and extent of tritium contamination, and determine if other contaminants are present. RFI sampling plans were devised to support preliminary risk assessments, should analyses indicate that contamination is present above risk-based screening action levels (SALs). In the work plan, conceptual exposure models were developed for current use, recreational use, and construction scenarios. No conceptual exposure model was developed specifically for MDA K.

For the PRSs at MDA K, this RFI report concludes Phase I of the RFI work plan. Appendix A indicates that raw data are available in the Environmental Restoration (ER) Project Facility for Information Management, Analysis and Display (FIMAD). Phase II sampling and analysis plans for SWMUs 33-002(a,b,c) are given in Appendix B.

1.3 Field Activities

Field activities at MDA K were conducted by ICF Kaiser Engineers (ICF KE) personnel from May to November 1993 (ICF Kaiser 1994, 02-095). Three follow-up samples were collected at the SWMU 33-002(d) outfall in December 1994.

1.3.1 Field Surveys

Field surveys included land surveys and geophysical surveys. The land survey established geodetic control points, coordinates for all sample locations, and grids for geophysics surveys. The land survey was conducted by Santiago Romero, Jr., and Associates during February, March, and April 1993. The survey established geodetic control points at MDA K from LANL primary survey points. Sample locations for the May 1993 sampling activities were surveyed by Romero or by ICF KE personnel. Locations for three boreholes were surveyed jointly by Romero and ICF KE personnel.

Geophysical surveys were conducted at MDA K by ICF KE personnel. The stated objectives of the survey were to delineate drain fields and drain lines and to define saturated areas. To achieve these objectives, the electromagnetic (EM) method was used to search for shallow geophysical anomalies (e.g., septic tanks and drain fields); the magnetic (MAG) method was used to locate shallow, buried, metallic objects; and the resistivity method (Schlumberger rectangle of resistivity) was used to assess deeper geophysical anomalies. The EM instrumentation consisted of a Geonics EM31-DL™ ground conductivity meter and an Omnidata data logger. The MAG instrumentation consisted of a GEM GSM-19™ proton precession

magnetometer/gradiometer. The resistivity instrumentation consisted of an Abem Terrameter SAS 3000™ with a high-power booster. Data from the resistivity survey were compared with data from a geophysical investigation conducted in the area by Roy F. Weston, Inc. personnel in 1989. Both studies identified an anomalous low-resistivity zone downgradient of the septic drain field. The resistivity geophysical survey identified another zone of low resistivity approximately 40 ft south of Weston borehole LAN-0019. These results were interpreted to indicate a possible subsurface crack or void.

1.3.2 Field Sampling

Field sampling activities included surface soil and sediment sampling, structure sampling (e.g., septic tanks, sumps), shallow subsurface soil sampling using hand augers and a hollow-stem auger drill rig, and deep subsurface soil sampling using an air-rotary drill rig. Sample locations were selected using the criteria outlined in the RFI Work Plan for OU 1122 (LANL 1992, 0784). The RFI work plan identifies the criteria for selecting reconnaissance (biased) sample locations, characterization (random) sample locations, and collocated or neighbor sample locations.

- Reconnaissance sample locations were selected specifically to maximize the likelihood of detecting contamination that might be present within the PRS of interest.

- Characterization samples were selected within the PRS of interest without regard to specific site characteristics. Freedom from judgmental influences when selecting sample locations was achieved by the use of a grid-based randomization protocol and an area-based randomization protocol.

- Collocated and neighbor samples were collected in the field to provide data for estimating spatial variability of contaminants in the surface and subsurface soils and sediments. The locations of the collocated samples were established one foot north of their respective grid-based sample locations.

Before each sample was taken, a health physics technician and a field team member surveyed the undisturbed sample location for the presence of above-background levels of radioactivity using a hand-held beta-gamma detector. Field surveys for volatile organic compounds (VOCs) were performed with a photoionization detector (PID). No VOCs or elevated levels of radioactivity were detected for any sample taken at MDA K. The samplers collected the sample, documented weather and site conditions, took photos where appropriate, and documented the field sample. All samples were cooled with ice packs in portable ice chests as soon as possible after sample

collection. Samples collected in the morning and mid-afternoon were submitted to LANL's mobile radiation laboratory on the day of collection. Samples collected in the late afternoon were maintained in coolers at the site and submitted to the mobile radiation laboratory on the following morning.

LANL Project standard operating procedures (SOPs) were used for all field documentation and sampling activities (LANL 1992, 0875). Field documentation was carried out conforming to LANL-ER-SOP-1.04, Sample Control and Field Documentation. Documentation provides the necessary evidence to ensure and defend the quality of data derived from the field samples. This documentation includes field notes, sample collection logs, and chain-of-custody forms. Chain-of- Custody/Request for Analysis forms were completed at the time of sampling to identify and document personnel responsible for safeguarding sample integrity. These forms provide a record of sample collection and transfer between field personnel and personnel at LANL's mobile radiation laboratory.

Surface sample collection activities conformed to LANL-ER-SOP-06.09, Spade and Scoop Method for Collection of Soil Samples. Surface soil samples are defined in the RFI work plan as samples taken from the surface to a depth of 6 in. Surface soil samples were taken to this depth and within a diameter of approximately 6 to 8 in. Soil was collected from each sample location using a dedicated (single use) stainless steel spoon. The soil was placed in a dedicated stainless steel bowl and homogenized by mixing with the spoon.

All fluid and sludge sample collection activities at the Main Site during 1993 conformed to LANL-ER-SOP-06.15, Coliwasa Sampler for Liquids and Slurries. A HAZCO™ Teflon mucksucker sampler was used to collect fluid and sludge samples from septic tanks and sumps. This translucent plastic sampler consists of sampling tube, stop-cock, and closure system. The mucksucker was inserted into the tank, then the fluid or sludge was drawn up and transferred directly to the appropriate sample containers.

All shallow hand auger sample collection activities conformed to the procedures described in LANL-ER-SOP-06.10, Hand Auger and Thin-Wall Tube Sampler. Subsurface locations were sampled in the drain field and at the MDA K sumps from depths up to 10 ft using a stainless steel hand-held auger that was manually driven into the soil. The soil or sediment was removed from the auger, placed into a stainless steel bowl, and homogenized with a stainless steel spoon.

All shallow borehole drilling activities at MDA K conformed to LANL-ER-SOP-04.01, Drilling Methods and Drill Site Management. A hollow-stem auger rig was used to drill boreholes at locations where sample depths or subsurface obstacles precluded the use of the hand auger. Shallow borehole drilling was performed by Rodgers Environmental Services, Inc. with the following equipment.

- C.M.E. 75™ Auger Rig
- 3.75-in.-inner-diameter (I.D.) heavy-duty augers and bit
- stainless steel split-spoon samplers, 2-ft by 3-in.

Samples were collected from the borehole using a stainless steel split-spoon sampler according to LANL-ER-SOP-06.24, Sample Collection from Split-Spoon Samplers and Shelby Tube Samplers. The split-spoon samplers were monitored for radiation and VOCs immediately after opening. The core material was then removed from the split-spoon sampler and placed into a stainless steel bowl. Samples that were to be analyzed for VOCs were immediately placed into 40-ml sample containers. The remaining material was broken up, homogenized using a stainless steel spoon, and placed into appropriate sample containers.

1.3.3 Deep Borehole Sampling

Deep drilling was conducted at MDA K from August 14 through October 25, 1993. Borehole locations were determined on the basis of geophysical resistivity measurements as described in Subsection 1.3.1. Objectives for the deep-drilling activities were to determine the following:

- the lateral and vertical extent of the tritium plume,
- if contaminants other than tritium are present, and
- if a perched aquifer exists

In preparation for the deep-drilling activities, a drilling package was prepared conforming to LANL-ER-SOP-12.01, Field Logging, Handling and Documentation of Borehole Materials. The drilling package consisted of:

- a drilling plan,
- a curation plan for cores,

- drilling specifications, and
- a borehole geophysics plan.

The drilling specifications and the borehole geophysical plan were prepared by LANL's Geoengineering Group (EES-4). All drilling activities conformed to LANL-ER-SOP-04.01 Drilling Methods and Drilling Site Management. Core handling and logging procedures conformed with LANL-ER-SOP-12.01, Field Logging, Handling, and Documentation of Borehole Materials. As the drilling plan specified, each of the three boreholes was drilled with a hollow-stem auger drilling rig to a depth of 30 ft and cased. The purpose of this casing was to provide a means for attaching a vacuum system to collect dust associated with the air-rotary drill rig. These boreholes were then cased with 5-in. diameter steel casing and sealed with a cement/bentonite mixture. Deep drilling then proceeded with an air-rotary drilling rig to depths specified in the drilling plan for each borehole.

All sampling during the MDA K drilling activities conformed to LANL-ER-SOP-06.24, Sample Collection from Split-Spoon Samplers and Shelby Tube Samplers. Continuous cores were collected from stainless steel split-tube samplers. Core material was monitored for radiation using a Ludlum 2221™ radiation instrument with a Ludlum 44-9™ pancake probe. All core samples were analyzed for tritium and moisture at both the on-site mobile radiation laboratory and off-site laboratories. In addition, 25% of the samples submitted to off-site laboratories were analyzed for the full suite of contaminants, including VOCs, semivolatile organic compounds (SVOCs), inorganics, uranium, cesium, and plutonium. The RFI work plan required additional samples be submitted for off-site laboratory analyses if field screening for radioactivity or VOCs revealed contamination in the cores. However, these additional samples were not generated because radiation or VOCs were not detected at above-background concentrations.

1.3.4 Samples not Collected

Eleven samples called for in the work plan were not collected. Seven samples were specified as fluid samples; at the time of sampling, no fluid was present at the sample location. Four subsurface samples were specified to be taken from two shallow boreholes. However, soil depths were too shallow to take more than a surface and a soil/tuff interface sample at two locations. Deviations from the approved work plan are listed in Table 1-1.

TABLE 1-1

RFI WORK PLAN SAMPLING NOT CONDUCTED

PRS ID	NUMBER OF SAMPLES NOT TAKEN	REASON SAMPLES WERE NOT COLLECTED
33-002(b)	2 Fluid	Fluid not present in sump. Fluid samples not collected.
33-002(c)	2 Fluid	Fluid not present in sump. Fluid samples not collected.
33-002(b)	2 Subsurface	Soil too shallow for specified number of subsurface samples.
33-002(c)	2 Subsurface	Soil too shallow for specified number of subsurface samples.
33-002(d)	3 Fluid	Surface water not present at outfall. Fluid samples not collected.

2.0 Environmental Setting

2.1 Climate

Weather at TA-33 is similar to that of LANL as described in Subsection 2.5.3 of the LANL ER Installation Work Plan (IWP): a semiarid, temperate, mountain climate (LANL 1993, 1017). TA-33 is at LANL's lowest elevations; summers are hotter and winter snow cover of shorter duration than at the majority of LANL technical areas. Spring winds and summer rains are as severe as at other areas of LANL.

2.2 Geology

In autumn 1993, the ER Project drilled three deep boreholes at MDA K. Core logging indicates similar stratigraphy (within 5 ft) beneath the three locations. Logs reveal that soils at the drilling sites range from 0.2 to 1.3 ft deep and are underlain by weathered tuff. At the location of the middle borehole, Unit 3 of the Tshirege Member of Bandelier Tuff which consists of pumice and non-welded tuff, extends from near-surface to 10 ft. Unit 2, consists of non-welded to slightly or moderately welded tuff with pumice, extends to 73 ft. Unit 1v extends from 73 ft to 170 ft; it consists of moderately welded tuff with pumice. The vapor-phase notch is at 170 ft. Below the vapor phase notch is Unit 1g of the Tshirege Member. It consists of non-welded tuff with phenocrysts, lithics, and glassy pumice extending to 216 ft. Here is the base of the ash flow Bandelier Tuffs, with 6 ft of fallout/surge reworked glassy tuffs, pumice, and sand crystals. Below the tuffs are sediments of the Puye Formation, extending from 222 ft to 268 ft, and containing abundant basaltic cinders. The Cerros del Rio basalts are encountered at 268 ft below the surface. Drilling stopped in basalt at 315 ft (Stimac 1995, 02-102). Reneau et al. provides a detailed description of geology and geomorphology at TA-33 (al 1995, 02-092).

2.2.1 Geologic Setting

MDA K is located on the mesa top at Main Site. The land slopes gently eastward from the level, fenced complex at TA-33-86. At the eastern edge of MDA-K, drainage channels up to 10 ft deep have formed, leading to a tributary of Chaquehui Canyon.

2.2.2 Soils

Soil at Main Site and the surrounding mesa top is classified as Hackroy-Rock Complex (Nyhan et al. 1978, 0161). Field logs indicate that soils at MDA K range from 0- to 8-ft deep. Soils may be sandy and contain many pumice pebbles ranging in size to 0.5 in. Clay lenses may be intermixed with pulverized tuff. Soils in the drainages are sandy with some clay and many small pebbles. Bedrock is exposed at many areas on the lower (eastern) part of the site, including the drainage channels east of the septic system.

2.3 Hydrology

There is no perennial surface water at MDA K. Since the tritium facility shut down in 1990 cattails and chamisa show signs of stress due to diminished water flow from the cooling water outfall and drain field. Ephemeral surface-water flow occurs during the spring snowmelt and summer thunderstorm seasons in the shallow drainages at MDA K. Groundwater is expected to be at a considerable depth below the mesa tops. Deep drilling conducted on the mesa (elevation 6 530 ft) in the autumn of 1993 reached a depth of 315 ft (elevation 6 215 ft) without encountering perched water. The depth to groundwater appears to lie between 315 and 830 ft (corresponding to the elevation of Ancho Spring, elevation 5 700 ft). There are no data available concerning water transport through fissures and fractures of bedrock at TA-33.

2.4 Biological and Cultural Surveys

Biological and cultural surveys were performed at TA-33 prior to sampling. No sensitive habitats were identified at MDA K (LANL 1992, 0784). A clump of cattails supported by effluent from the cooling water outfall died when the water was cut off in December 1990. The area of the drain field is covered with a stand of chamisa, showing stress from lack of water as building use at TA-33-86 declined. The remainder of the site is typical pinyon-juniper woodland.

Cultural surveys documented three sites near the tritium facility, and listed them as being located in potentially contaminated areas (LANL 1994, 02-103). The report is in error; these sites are not within the boundaries of any PRS, nor were they affected by sampling activities. A houseblock ruin near MDA K, Laboratory of Anthropology No. 4636, was cordoned off during drilling activities.

3.0 Approach to Data Assessment and Analysis

3.1 Summary of Quality Assurance/Quality Control Activities

Results received from analytical laboratories were processed through the ER Project's data verification/validation system. A detailed quality assurance/quality control (QA/QC) assessment from the 1993 sampling season at TA-33 is presented in RFI Report LA-UR-95-882 (Environmental Restoration Project 1995, 1212), submitted to EPA in January 1995. Inspection of QA/QC documentation indicates that all holding times were met. No anomalies were sufficient to question use of these data to make recommendations for PRSs in this report.

Field QA/QC samples were collected during 1993 field sampling to provide the means of assessing the quality of the data that resulted from field sampling. Field quality-control samples were collected during the investigation as specified and defined in the ER Generic Quality Assurance Project Plan (QAPjP) for RCRA Facility Investigations (LANL 1991, 0412). All quality control samples were collected at a minimum frequency of 1 per 20 samples (the frequency was higher if fewer than 20 samples were collected per sampling period). Field quality-control samples include field blanks, rinsate blanks, and field duplicates.

Field Blanks Field blanks collected before October 1993 were taken from "Clean" soil collected from a site near Bandelier National Monument. Samples were collected using the same methods and under the same conditions as the field samples. Field blanks collected after October 1993 were taken from distilled and deionized water supplied by LANL's sample management operations. These samples were also collected under the same conditions as the field samples. The discrepancy in types of material submitted as field blanks was a result of different interpretations of LANL's QAPjP requirements.

Rinsate blanks Rinsate samples assess possible cross-contamination of samples from ineffective decontamination procedures. Following decontamination of nondedicated equipment, the equipment was rinsed again with commercially packaged distilled water. This rinsate was collected in dedicated stainless steel bowls. Rinsate blank samples were collected from this water under the same conditions as the field samples.

Field duplicate Duplicate samples are analyzed to check for both sampling and laboratory analytical reproducibility. The collection procedure for duplicate samples varied slightly from the field sample procedure in that more material was placed into the stainless steel sampling bowl before homogenizing the material. This practice ensured that enough homogenized

material was available for both samples before the samples were removed from the sampling bowl. The off-site and the mobile radiation laboratories were not told which samples were duplicates.

3.1.1 Inorganic Analyses

Two blanks were contaminated with low levels of inorganic analytes; corresponding field samples were not affected. Arsenic and selenium in QC samples were frequently out of control. Silver recovery was poor in several blind controls, attributed to possible loss of silver from blind standard solution.

3.1.2 Organic Analyses

Low levels of blank contamination were reported for several requests. However, because the corresponding samples indicated results for those compounds greater than five times the blank levels, the results were considered valid. Surrogate recoveries were low in many analyses. However, with very few exceptions, all compounds were detected. Overall, QA validation reviewers accept organic results with no qualifications that affect usefulness of results in making decisions.

3.1.3 Radiochemistry Analyses

Plutonium and uranium QC standards were in control in all cases. Cesium-137 recoveries were erratic in one case. Tritium recoveries were high in several cases, possibly due to crossover from high tritium in samples. One tritium sample, AAA3900, was sent for fixed laboratory analysis, but was not analyzed; no reason was provided by the laboratory. The result used in decision making was analyzed in the mobile radiation laboratory and did not receive QA/QC validation. This sample is discussed in Subsection 4.2 of this RFI report.

3.1.4 High Explosives Analyses

No samples from MDA K were analyzed for high explosives.

3.2 Screening Assessment

3.2.1 Background Comparison

During the 1993 sampling campaign at Main Site and Area 6, samples were collected to calculate local background ranges of inorganics and radionuclides. RFI Report LA-UR-95-882 contains a detailed derivation of local background upper tolerance limits (99%, 0.95 UTLs) for TA-33 (Environmental Restoration Project 1995, 1212). Both local and LANL background upper tolerance limits (UTLs) were compared with results of analyses at individual PRSs to identify areas that may have received releases from past LANL activities at TA-33.

Table 3-1 presents a comparison of local background concentrations with the LANL-wide framework studies concentrations (Longmire et al. in preparation, 1142). Results are compared both with respect to the data ranges (minimum and maximum observations), and with respect to estimated background UTLs. As indicated in the third column of Table 3-1, calculations were performed on the logarithms of the data for several analytes.

TABLE 3-1

RANGE (EXCLUDING OUTLIERS) AND UPPER TOLERANCE LIMITS FOR INORGANICS IN SOIL SAMPLES

			FRAMEWORK DATA[a]			TA-33 LOCAL BACKGROUND		
ANALYTE	UNITS	LOG?[b]	MIN	MAX	(99%,0.95) UTL[c]	MIN	MAX	(99%,0.95) UTL
Antimony	mg/kg	NA[d]	<5	2.5	2.5(Max.)	<0.02	0.27	NA[d]
Arsenic	mg/kg	No	0.7	11.2	11.6	1	3.6	4.36
Barium	mg/kg	Yes	27	730	1 140	31	260	268
Beryllium	mg/kg	No	0.31	4	3.31	0.31	1.4	1.51
Cadmium	mg/kg	NA[d]	<0.4	2.7	2.7 (Max.)	<0.4	2.7	NA[d]
Chromium	mg/kg	Yes	1.9	37	34.2	3.4	19	20.7
Lead	mg/kg	No	<4	38	39.0	7	28	39[e]
Nickel	mg/kg	No	<2	19	26.7	<2	32	17.0
Selenium	mg/kg	NA[d]	<0.6	1.7	1.7 (Max.)	<0.6	1.39	NA[d]
Uranium	mg/kg	Yes	<0.2	2.4	2.82	1.8	5	4.84
Zinc	mg/kg	No	14	120	101	16	76	62.3

[a] Longmire et al. in preparation, 1142.
[b] LOG = Were calculations performed on the logarithms of the data?
[c] UTL = Upper tolerance limit.
[d] These data sets have too many below-detection-level observations to calculate UTLs.
[e] The distribution of lead on the grid was too nonnormal to obtain a reliable UTL. However, the upper tail of the local background data (excluding outliers) is similar to that of the framework studies data, so the Framework UTL of 39 mg/kg may be used.

Table 3-2 presents a comparison of radionuclide data from the TA-33 grid (Environmental Restoration Project 1995, 1212) with the surveillance data from perimeter stations around LANL (Longmire et al in preparation 1142). Results are compared both with respect to the data ranges (minimum and maximum observations), and with respect to estimated upper tolerance limits.

TABLE 3-2

RANGE (EXCLUDING OUTLIERS) AND UPPER TOLERANCE LIMITS FOR RADIONUCLIDES IN SOIL SAMPLES

			SURVEILLANCE DATA[a]			TA-33 GRID DATA		
ANALYTE	UNITS	LOG?[b]	MIN	MAX	(99%,0.95) UTL[c]	MIN	MAX	(99%,0.95) UTL
Cesium-137	pCi/g	No	<0.01	1.4	1.5	<1	2.61	2.75
Plutonium-238	pCi/g	No	<0.001	0.140	NA[d]	0.001	0.008	0.0074
Plutonium-239	pCi/g	No	<0.001	0.052	0.025	0.003	0.174	0.058
Tritium	pCi/g	Yes	NA[e]	NA	NA	0.08	43.6	23.2

[a] Longmire et al. in preparation, 1142.
[b] LOG = Were calculations performed on the logarithms of the data?
[c] UTL = Upper tolerance limit.
[d] Plutonium-238 was below detection levels in a larger proportion of the surveillance samples than of the TA-33 samples, but the ranges of the observations are similar.
[e] Tritium is not available in pCi/g in the surveillance data (only pCi/ml are given). In terms of pCi/ml, about half of the TA-33 grid observations are above the surveillance maximum of 13 pCi/ml.

3.2.2 Screening Action Levels Comparison

Concentrations of all analytes detected within each PRS were compared to their respective background UTLs and to SALs. All PRSs with measured concentrations of contaminants of potential concern (COPCs) in excess of background UTLs and SALs received further evaluation by the Field Unit 3 assessment team. Consensus by the team led to a recommendation of no further action (NFA), Phase II sampling to determine extent of contamination, or voluntary corrective action (VCA). Preliminary risk assessments were performed for tritium exposures at MDA K. PRSs with more than one constituent above background but below SALs were subject to multiple constituent analyses. A detailed discussion of the use of screening methods is found in Subsection 4.1 of the 1993 IWP (LANL 1993, 1017).

3.2.3 Ecological Screening Assessment Methodology

Ecological risk assessment is a method of determining effects of hazardous activities on the environment. Several legislative acts provide directives for including ecological risk assessment in estimating environmental impacts of a number of practices, including releases of hazardous

wastes. As a result of environmental legislation, the EPA developed guidelines for ecological risk assessment (EPA 1992, 0989). The methods for ecological risk assessment are presently evolving.

An ecological risk assessment was performed for tritium at MDA K. Results are presented in Subsection 4.1.3.4. Calculations are given in Appendix C of this RFI report.

3.3 Risk Assessment Methodology

The first step to risk assessment methodology is hazard identification. Other steps include assessing the potential for human exposure to contamination, assessing the toxicity of contaminants of concern, and, finally, characterizing the risk to human health. A complete discussion of risk assessment is described in Appendix K of the 1993 IWP (LANL 1993, 1017).

3.4 Development of Conclusions and Recommendations

The RFI work plan specified a phased effort using reconnaissance sampling to detect contamination. Conclusions and recommendations in this RFI report are based on sampling and analytical results as specified in the RFI work plan, with modifications described in Subsection 1.3.4 listing samples not taken. The Field Unit 3 assessments team consisted of a statistician, hydrologist, human and ecological risk assessment specialists, geological and analytical chemists, and the field project leader. The contractor (ICF Kaiser) field manager served as consultant. After all results were assembled for a PRS, the Field Unit 3 assessments team reexamined each sampling point for appropriateness for making decisions. Analytical results were compared to TA-33 and LANL background UTLs and to SALs. Both human health risks and ecological risks were assessed based on results from all sampling points in the MDA. Recommendations were developed following the decision process described in the 1993 IWP, Appendix I (LANL 1993, 1017). The rationale for a recommendation of NFA at two PRSs is based on the LANL ER Project's, Nor Further Action Criteria (LANL Enviromental Restoration Project 1995, 1173).

4.0 Site-Specific Results, Conclusions, and Recommendations

The PRSs addressed in this section are listed in Table 4-1. Figure 4-1 shows the locations of the five PRSs at MDA K. Surface tritium results from all of TA-33 and a risk assessment for all of MDA K are included in the discussion for SWMU 33-002(a). Phase II sampling and analysis plans for PRSs 33-002(a,b,c) are given in Appendix B of this RFI report.

TABLE 4-1

PRSs AT MDA K

PRS[a] ID	HSWA[b]	PRS TYPE	RECOMMENDATION
33-002(a)	1990	Septic system TA -33-93	Divert outflow; remove sludge. Phase II
33-002(a)	1990	MDA K tritium	Stabilize tritium plume. Phase II
33-002(b)	1990	Sump TA-33-134	Phase II
33-002(c)	1990	Sump TA-33-133	Phase II
33-002(d)	1994	Outfall NPDES EPA 04A147	NFA[c]
33-002(e)	1994	Roof drain from TA-33-86	NFA

[a] PRS = Potential release site.
[b] HSWA = Hazard and Solid Waste Amendment.
[c] NFA = No further action.

4.1 SWMU 33-002(a) TA-33-86 Septic System and MDA K Surface Tritium

SWMU 33-002(a) is listed as the MDA K septic system. In this discussion the SWMU has been expanded to include the surface component of MDA K. SWMU 33-002(a) is discussed in the RFI Work Plan for OU 1122 Subsections 3.2.2.1, 4.1.4, and 4.2.3.1. Based on sampling data collected in May and June and August through November 1993, a tritium plume is proposed for long-term stabilization; the septic tank is proposed for expedited cleanup (EC). A Phase II plan is proposed for the subsurface on Appendix B. The MDA will be posted for radioactivity in accordance with the LANL RADCON manual (LANL 1994, 1235).

SWMU 33-002(a) is the septic system established when tritium facility TA-33-86 was built in 1954. The system consists of 1 860-gal. tank TA-33-93 and a tiled drain field approximately 50 ft x 100 ft. The system serves three floor drains, three sinks, and two bathrooms—both with toilet, sink, and shower facilities. The building was removed from service in 1990. No personnel are stationed in the building and all equipment has been removed. Because building TA-33-86 has a water supply, the septic system is considered active.

The tank is located about 100 ft east of the tritium facility (Fig. 4-1). The drain field is east and downslope of the tank. The ground level slopes gently east about 350 ft to a drainage channel. The soil is a sandy loam with inclusions of pumice. The eastern end has sections of exposed bedrock. The surface of the drain field supported a thick, almost impenetrable, growth of chamisa, now showing signs of stress due to lack of water. The lower section of the drain field has been disturbed by drilling activities. The remainder of the site is typical pinyon-juniper woodland.

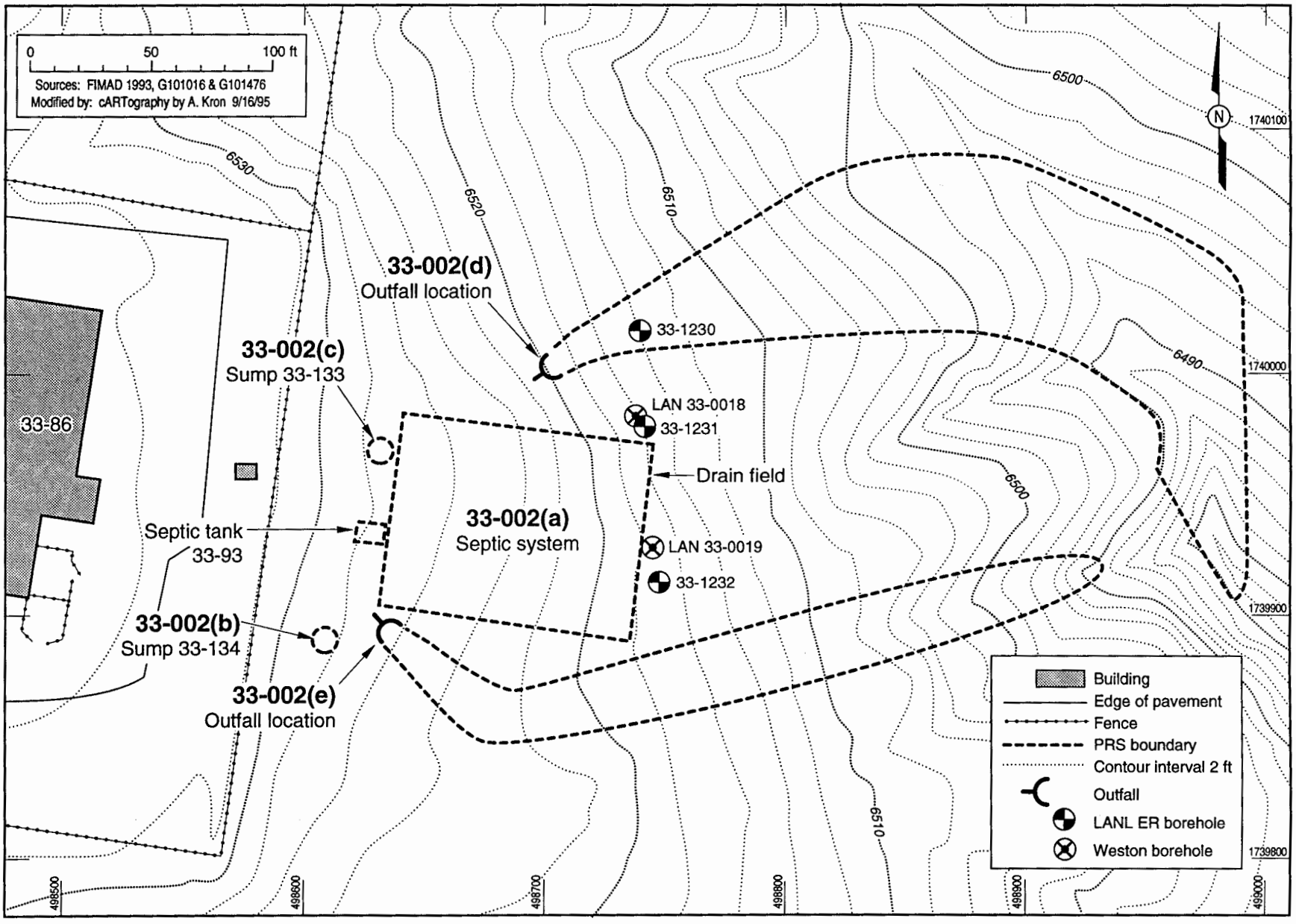

Fig. 4-1. PRS locations at MDA K.

4.1.1 Previous Investigation

Surface monitoring conducted by the LANL Environmental Surveillance Program in 1986 is discussed in detail in Subsection 3.2.4 of the work plan (LANL 1992, 0784). Elevated levels of tritium were detected at MDA K. Figure 4-2 shows the 1986 distribution of surface tritium.

In 1989 personnel from Weston sampled at MDA K. Samples were collected from surface locations, sumps, and three boreholes drilled at the lower boundary of the drain field. Weston data are discussed in conjunction with LANL ER activities in the following assessments, as appropriate. In Subsection 4.1.3.2.1, Weston borehole analytical results are compared to LANL ER borehole results in 1993.

4.1.2 Field Investigation

As specified in the sampling and analysis field plan for SWMU 33-002(a) one liquid sample and one sludge sample were taken from the tank. Duplicates of the fluid/sludge samples were not taken. Four samples, including one duplicate, were taken from a borehole adjacent to the tank. Two boreholes were drilled into the drain field with samples taken at 5 and 10 ft in each location. Two surface samples, one in duplicate and one in triplicate, were also taken in the drain field.

All samples were analyzed for uranium, tritium, plutonium, gamma emitters, inorganics, and SVOCs. Nine subsurface samples were analyzed for VOCs. The surface sample and its duplicate from the borehole adjacent to the tank were analyzed for pesticides and herbicides.

In autumn of 1993, three deep boreholes were drilled in an attempt to further characterize a tritium plume discovered by the Weston investigation in 1989 (LANL 1992, 0784). The northernmost borehole was drilled in the cattail bed formed when the cooling water outfall was active. The middle borehole was drilled near the Weston borehole at the northeast corner of the drain field where geophysical studies indicated that a subsurface anomaly existed. The third borehole was drilled at the southeast corner of the drain field (Fig. 4-3). Samples were taken at approximately 5-ft intervals along the length of each borehole and all samples were analyzed for tritium. In the first 30 ft of each borhole all samples were also analyzed for inorganics and SVOCs. Subsurface samples were analyzed for VOCs. Six additional samples in the three boreholes were analyzed for inorganics, SVOCs, and VOCs.

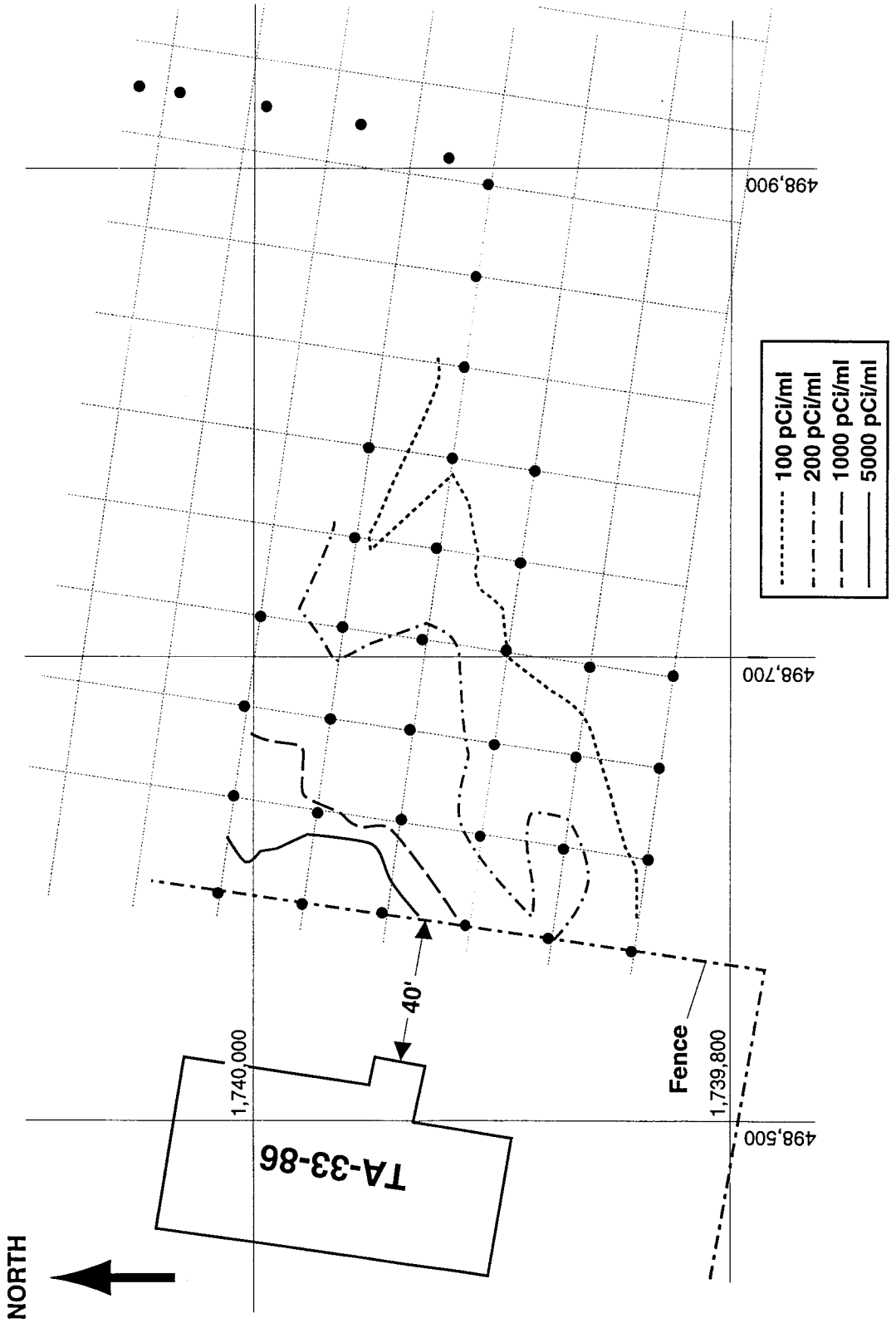

Fig. 4-2. Tritium in surface soil moisture at MDA K (1986 survey).

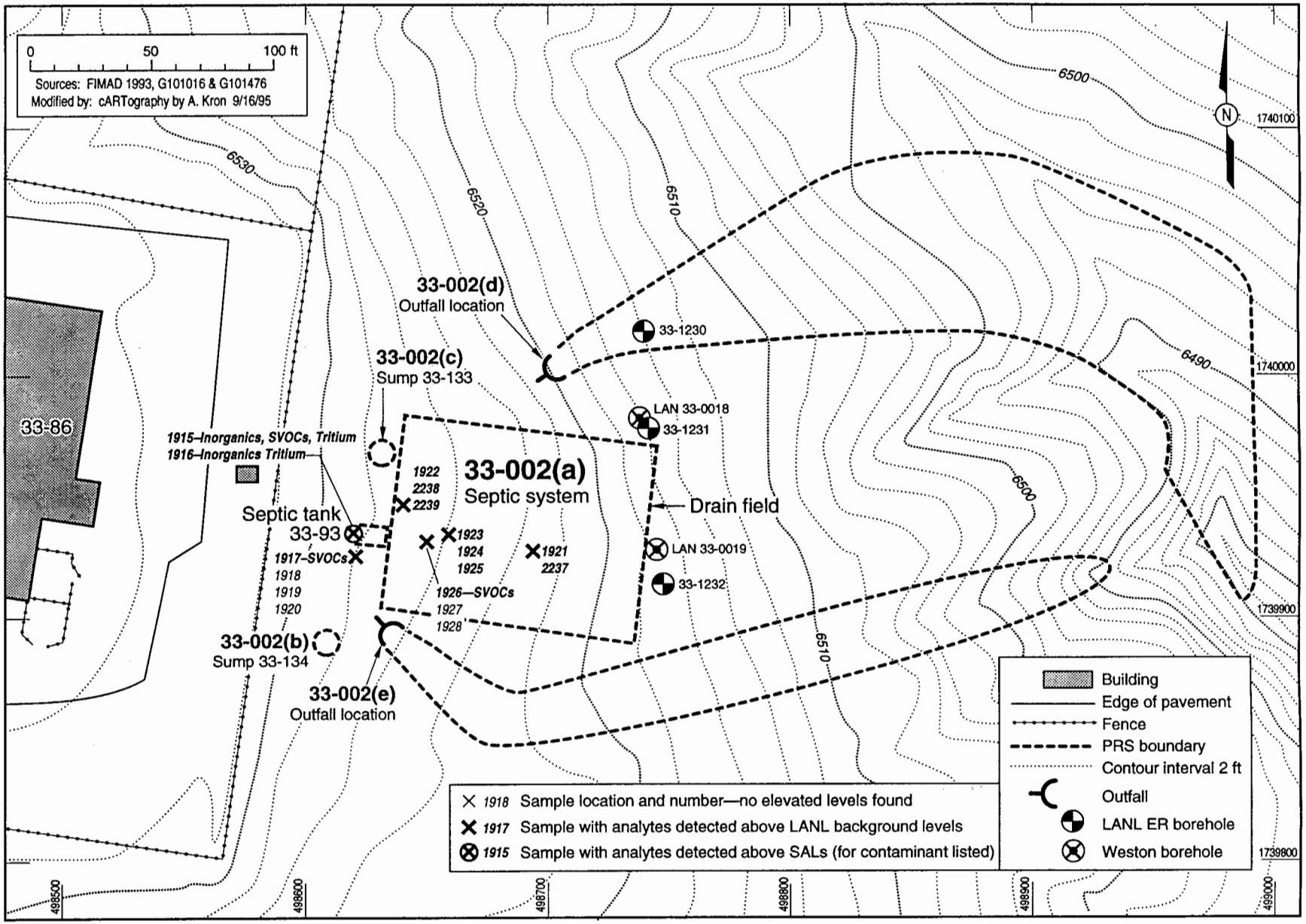

Fig. 4-3. SWMU 33-002(a) septic systems and boreholes locations.

4.1.2.1 Results of Field Surveys

All sampling points were surveyed.

The 1993 electromagnetic survey method used at MDA K detected anomalies that were interpreted to represent structures and drain lines associated with the septic system and drain field. These anomalies coincide with the locations of drain field structures on existing as-built construction maps of MDA K. Sample locations were selected within these areas.

Data from the resistivity survey were compared with data from a geophysical investigation conducted at the lower edge of the drain field by Weston personnel in 1989. These two studies were similar in that anomalous low-resistivity zones occurred in the same region. The resistivity geophysical survey identified another zone of low resistivity approximately 40 ft south of Weston borehole LAN 33-0018. Models created from soundings near the Weston borehole indicated layers with generally low resistivities. These low resistivities may indicate the presence of water or conductive materials such as clay. The borehole log from the Weston drilling indicated strata composed mainly of tuff with clay-lined fractures.

Results of the ER resistivity geophysical survey were used to select the deep borehole biased sample locations at MDA K. The middle borehole, site ID 1231, was positioned at the point of greatest resistivity change. This point was near Weston borehole LAN 33-0018. The south borehole, site ID 1232, was positioned at a location where the subsurface material exhibited high resistivity, indicating unaltered or unsaturated conditions. The north borehole, site ID 1230, was positioned in the surface drainage of the cooling water outfall, SWMU 33-002(d) (Fig. 4-3).

4.1.2.2 Results of Field Screening

SWMU 33-002(a) was included in the grid radiation surveys conducted at Main Site in the spring of 1992. No radiation was detected during the grid survey or during routine field screening. During drilling, tritium "sniffers" were set up in work areas; no tritium was detected (ICF Kaiser 1994, 02-095).

4.1.3 Screening Assessment

4.1.3.1 Comparison to Background/SALs

4.1.3.1.1 Septic Tank and Shallow Borehole Results

Table 4-2 lists inorganic and radionuclide analytes found above LANL and TA-33 background UTLs at SWMU 33-002(a). No screening parameters for liquid or sludge from septic tanks have been developed. Drinking water and soil background UTLs and SALs are listed here merely as reference. Sampling points were shown in Fig. 4-3.

TABLE 4-2

INORGANIC AND RADIONUCLIDE ANALYTES FOUND IN THE TANK AND SHALLOW BOREHOLES AT SWMU 33-002(a) WITH CONCENTRATIONS GREATER THAN LANL OR TA-33 BACKGROUND SURFACE UTLs

ANALYTE	SAMPLE ID	RESULTS	LANL UTL[a]	TA-33 UTL	SAL[b]	DEPTH
Arsenic	AAA1916	**29.8 mg/kg**	11.6 mg/kg	4.36 mg/kg	None	Sludge[c]
Cadmium	AAA1915	**9.2 µg/L**	None	None	5 µg/L	Liquid
Lead	AAA1916	**922 mg/kg**	39 mg/kg	39 mg/kg	400 mg/kg	Sludge[c]
Plutonium-239	AAA1923	0.147 pCi/g	0.025 pCi/g	0.058 pCi/g	24 pCi/g	0-6 in.
Tritium	AAA1915	**136 210 pCi/L**	None	None	20 000 pCi/L	Liquid
	AAA1916	**35 903.5 pCi/g**	None	23.2 pCi/g	810 pCi/g	Sludge[c]
	AAA1924	37.8 pCi/g	NA	23.2 pCi/g	810 pCi/g	60 in.
Uranium	AAA1916	27.8 mg/kg	2.82 mg/kg	4.84 mg/kg	95 mg/kg	Sludge[c]

[a] UTL = Upper tolerance limit.
[b] SAL = Screening action level.
[c] Soil SALs are based on a residential exposure to contaminated soils. No SALs exist for the exposure to contaminated tank sludges.

Analyses were performed for a total of 1 979 organic analytes at SWMU 33-002(a). Table 4-3 lists those concentrations of organic compounds found above their respective detection limits.

4.1.3.1.2 Surface Tritium Results

A source of surface tritium at MDA K is most likely stack releases from the tritium facility. SWMU 33-017, discussed in a separate RFI report, was intended to address stack releases. However, surface tritium contamination at the whole of Main Site is discussed in this RFI report in order to comprehensively in deal with tritium. Table 4-4 lists all sample locations at TA-33 with tritium activity above the TA-33 background UTL of 23.2 pCi/g. Figure 4-4 shows the location of each sampling point.

TABLE 4-3

ORGANIC ANALYTES FOUND ABOVE DETECTION LIMITS AT SWMU 33-002(a)

ANALYTE	SAMPLE ID	CONCENTRATION (mg/kg)	EQL[a] (mg/kg)	SAL[b] (mg/kg)	DEPTH (in.)	MEDIUM
Acetone	AAA1916	0.51	0.01	8 000	In tank	Sludge
Benzo[a]anthracene	AAA1917	0.49	0.33	1	0-6	Soil
Benzo[a]anthracene	AAA1926	0.47	0.33	1	0-6	Soil
Benzo[a]pyrene	AAA1917	0.49	0.33	0.1	0-6	Soil
Benzo[a]pyrene	AAA1926	0.44	0.33	0.1	0-6	Soil
Benzo[b]fluoranthene	AAA1917	0.37	0.33	1	0-6	Soil
Benzo[g,h,i]perylene	AAA1917	0.38	0.33	NC[c]	0-6	Soil
Benzo[k]fluoranthene	AAA1917	0.51	0.33	1	0-6	Soil
Benzo[k]fluoranthene	AAA1926	0.4	0.33	1	0-6	Soil
Bis(2-ethylhexyl)phthalate	AAA1915	75 µg/L	0.33 µg/L	6 µg/L	In tank	Septic liquid
Bis(2-ethylhexyl)phthalate	AAA1916	4.4	0.33	50	In tank	Sludge
Butylbenzene [sec-]	AAA1916	0.32	NL[d]	NC	In tank	Sludge
Butylbenzene [tert-]	AAA1916	0.19	NL	NC	In tank	Sludge
Carbon disulfide	AAA1916	0.075	0.01	7.4	In tank	Sludge
Chlorobenzene	AAA1916	0.72	0.01	67	In tank	Sludge
Chrysene	AAA1917	0.52	0.33	96	0-6	Soil
Chrysene	AAA1926	0.48	0.33	96	0-6	Soil
Di-n-butyl phthalate	AAA1925	0.47	0.33	8 000	120	Soil
Dichlorobenzene (1,4) [p-]	AAA1916	1.4	0.33	29	In tank	Sludge
Dichloroethane [1,1-]	AAA1916	0.054	0.01	410	In tank	Sludge
Ethylbenzene	AAA1916	0.15	0.01	3 100	In tank	Sludge
Fluoranthene	AAA1917	1.4	0.33	3 200	0-6	Soil
Fluoranthene	AAA1923	0.49	0.33	3 200	120	Soil
Fluoranthene	AAA1926	1.2	0.33	3 200	0-0.5	Soil
Fluoranthene	AAA2239	0.38	0.33	3 200	0-0.5	Soil
Indeno[1,2,3-cd]pyrene	AAA1917	0.38	0.33	1	0-0.5	Soil
Isopropylbenzene	AAA1916	0.45	NL	3 200	In tank	Sludge
Isopropyltoluene [4-]	AAA1916	0.32	NL	NC	In tank	Sludge
Phenanthrene	AAA1917	1.1	0.33	NC	0-6	Soil
Phenanthrene	AAA1926	1.1	0.33	NC	0-6	Soil
Propylbenzene	AAA1916	0.59	NL	NC	In tank	Sludge
Pyrene	AAA1917	0.97	0.33	2 400	0-6	Soil
Pyrene	AAA1926	0.76	0.33	2 400	0-6	Soil
Toluene	AAA1916	0.16	0.01	910	In tank	Sludge
Trimethylbenzene [1,2,4-]	AAA1916	2.2	NL	40	In tank	Sludge
Trimethylbenzene [1,3,5-]	AAA1916	1.2	NL	32	In tank	Sludge
Xylenes (o + m + p) [mixed-]	AAA1916	0.26	0.01	160 000	In tank	Sludge

[a] EQL = Estimated quantitation limit.
[b] SAL = Screening action level.
[c] NC = Not calculated because of insufficient toxicity data.
[d] NL = Not listed.

TABLE 4-4

SURFACE TRITIUM ACTIVITIES GREATER THAN TA-33 BACKGROUND UTL

ANALYTE	SAMPLE ID	ACTIVITY (pCi/g)	LANL UTL[a]	TA-33 UTL (pCi/g)	SAL[b] (pCi/g)	DEPTH (in.)
Tritium	AAA1917	43	NA[c]	23.2	810	0-6
	AAA1921	213	NA	23.2	810	0-6
	AAA2237[d]	112	NA	23.2	810	0-6
	AAA1922	32.5	NA	23.2	810	0-6
	AAA2238[d]	67	NA	23.2	810	0-6
	AAA1924	38	NA	23.2	810	0-6
	AAA1931	540	NA	23.2	810	0-6
	AAA1934	**1728**	NA	23.2	810	0-6
	AAA1941	**5 449**	NA	23.2	810	0-6
	AAA2185	**1 457**	NA	23.2	810	0-6
	AAA1942	**11 963**	NA	23.2	810	0-6
	AAA1943	142	NA	23.2	810	0-6
	AAA1944	302.5	NA	23.2	810	0-6
	AAA2193[d]	27	NA	23.2	810	0-6
	AAA2060	28	NA	23.2	810	0-6
	AAA2063	42.5	NA	23.2	810	0-6
	AAA2086	27	NA	23.2	810	0-6
	AAA2092	44	NA	23.2	810	0-6

[a] UTL = Upper tolerance limit.
[b] SAL = Screening action level.
[c] NA = Not analyzed.
[d] Duplicate of sample directly above.

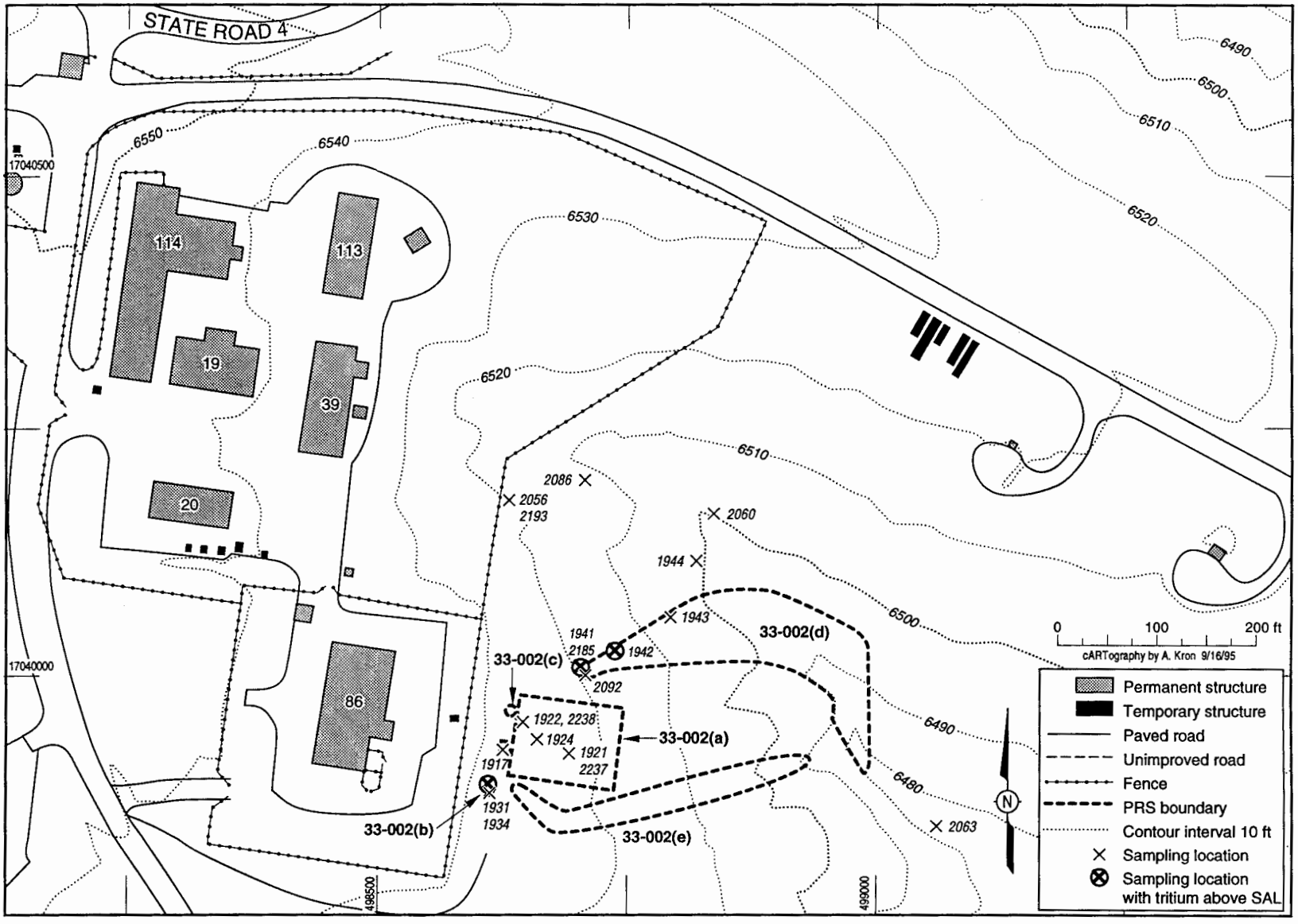

Fig. 4-4. Sampling locations with surface tritium above TA-33 background UTLs.

4.1.3.1.3 Deep Borehole Results

The following subsection discusses the deep boreholes at the lower (east) end of the drain field. Note that results were compared to surface background LANL and TA-33 background UTLs because no subsurface background UTLs are available at this time.

Table 4-5 list analytes (excluding tritium) exceeding LANL and TA-33 background UTLs at the north borehole, site ID 1230, and the middle borehole, site ID 1231. No analytes were detected above background at the south borehole, site ID 1232. No multiple constituent analysis was performed for these analytes because of the widely varying depths and disparate toxicological effects.

TABLE 4-5

ANALYTE CONCENTRATIONS ABOVE LANL AND TA-33 UTLs FOR BOREHOLES AT MDA K, EXCLUDING TRITIUM

ANALYTE	BOREHOLE ID	SAMPLE ID	CONCEN-TRATION (mg/kg)	LANL UTL[a] (mg/kg)	TA-33 UTL (mg/kg)	SAL[b] (mg/kg)	DEPTH (ft)
Antimony	33-1230	AAA3292	23	2.5	0.27	32	127
Cadmium	33-1231	AAA3321	4.2	2.7	2.7	80	314
	33-1230	AAA3884	3.6	2.7	2.7	80	0-1
Chromium	33-1230	AAA3884	57	34.2	20.7	400	0-1
Lead	33-1230	AAA3884	48	39	39	400	0-1
Nickel	33-1231	AAA3321	103	26.7	17	1 600	314
Uranium	33-1230	AAA3884	8.09	2.82	4.84	95	0-1
	33-1230	AAA3889	5.16	2.82	4.84	95	30
ANALYTE	**BOREHOLE ID**	**SAMPLE ID**	**ACTIVITY (pCi/g)**	**LANL UTL (pCi/g)**	**TA-33 UTL (pCi/g)**	**SAL (pCi/g)**	**DEPTH (ft)**
Plutonium-238	33-1230	AAA3281	0.145	0.01	0.0074	27	10
	33-1230	AAA3283	0.040	0.01	0.0074	27	10
Plutonium-239	33-1231	AAA3321	0.113	0.025	0.058	24	314

[a] UTL = Upper tolerance limit.
[b] SAL = Screening action level.

Table 4-6 lists all tritium activities in the three boreholes as pCi/g of soil. Tritium activities in the north and south boreholes, 33-1230 and 33-1232, were for the most part below TA-33 surface background UTLs. Elevated tritium levels were concentrated in the middle borehole, 33-1231. Tritium is present well above SAL for several samples from 94 ft to 155 ft, indicating the presence of a subsurface tritium plume.

TABLE 4-6

SOIL TRITIUM ACTIVITIES IN BOREHOLES 33-1230, 33-1231, and 33-1232

DEPTH (ft)	BOREHOLE 33-1230 SAMPLE ID	Tritium (pCi/g) RV[a]	Tritium (pCi/g) FL[b]	BOREHOLE 33-1231 SAMPLE ID	Tritium (pCi/g) RV	Tritium (pCi/g) FL	BOREHOLE 33-1232 SAMPLE ID	Tritium (pCi/g) RV	Tritium (pCi/g) FL
0	AAA3884	**1 222**	1.6	AAA3885	1	87	AAA3886	3.9	20.0
10	AAA3281	6.8	3.8	AAA3308	140	101	AAA3336	22	359
20	AAA3282	4.7	4.4	AAA3309	560	527	AAA3337	16	16.3
30	AAA3283	4.1	4.9	AAA3310	**920**	831	AAA3338	24	25.6
35							AAA4870	25	NA[c]
40				AAA4904	**1 300**	NA			
45							AAA4872	9.8	NA
55	AAA4940	7.5	NA	AAA4906	770	NA			
60							AAA3339	5.2	4.5
65	AAA3284	7.2	8.4	AAA3311	**1 300**	**2 835**	AAA4876	3.7	NA
70							AAA4878	2.7	NA
75	AAA4944	12	NA	AAA4910	**5 400**	NA			
80				AAA4912	**5 000**	NA			
85	AAA4946	9.2	NA						
95	AAA3286	11	10.8	AAA3312	**7 900**	**8 006**	AAA3340	2.2	2.6
100							AAA4882	1.6	NA
105	AAA4952	13	NA	AAA4916	**6 900**	NA	AAA4884	1.1	NA
115				AAA4918	**5 700**	NA			
120	AAA3289	16	NA				AAA3344	1.5	1.2
125	AAA3292	27	24.5	AAA3314	**4 000**	**5 898**	AAA3343	1.6	1.3
135	AAA4956	22	NA	AAA4922	**3 616**	NA	AAA4888	0.55	
145	AAA4958	22	NA	AAA4924	**1 722**	NA			
155	AAA4950	16	NA	AAA3317	**1 452**	**1 698**	AAA3345	1.8	0.8
160				AAA4928	550	NA	AAA4894	1.7	NA
165	AAA4962	17	NA						
170	AAA3290	12	18.4				AAA4896	0.79	NA
175				AAA4930	140	NA			
180	AAA3291	6.9	9.1						
185				AAA3318	4	5	AAA3346	1.5	2.2
190							AAA4900	2.3	NA
195	AAA4968	4.5	NA	AAA4934	1	NA			
200							AAA4902	0	NA
205				AAA4936	1	NA			
210				AAA3319	320	0.2	AAA3347	0	2.6
215	AAA3294	34	NA						
220	AAA3296	21	NA	AAA3320	1	NA	AAA5269	9	NA
225	AAA3295	23	NA	AAA4903	4	NA			
230	AAA3297	42	0.2				AAA5270	2.2	NA
235				AAA4905	5.2	NA	AAA5272	1.9	NA
245				AAA3325	9.1	6.8	AAA3350	1.3	1.2
250				AAA4911	5.6	NA			
270				AAA4915	1.6	1			
280				AAA4919	22	NA			
290				AAA4921	1.3	NA			
300				AAA4923	4.1	NA			
315				AAA3321	2.8	0.2			

[a] RV = Mobile radiation laboratory van.
[b] FL = Fixed analytical laboratory.
[c] NA = Not analyzed.
[d] SAL = 810 pCi/g.

4.1.3.2 Data Interpretation

This subsection discusses subsurface tritium results from the boreholes.

4.1.3.2.1 Borehole Observations

Tritium Profiles

Three separate efforts to measure subsurface tritium activities beneath MDA K have been conducted: drilling and sampling by Weston in 1989, drilling and sampling by the ER project in 1993, and Seamist™ sampling of ER borehole 33-1231 in 1994.

The 1989 Weston borehole sampling at borehole LAN33-0018 revealed a sharp tritium peak at a depth near 100 ft, with a maximum activity of 82 000 pCi/ml. ER samples collected from nearby 33-1231 in the fall of 1993 were analyzed by the mobile radiation laboratory van (RV). A subset of samples was analyzed by a fixed lab (FL). Considering the inherent difficulties in tritium analysis (due to its volatility and low-energy beta emissions) the two sets of results are in reasonable agreement. Compared to the Weston data, the ER results show a broader tritium peak, centered at a depth near 100 ft, with a maximum activity on the order of 70 000 pCi/ml.

An experiment was conducted to determine the suitability of Seamist™ technology to gain information on the tritium distribution in boreholes by installation of absorber pads to measure subsurface tritium activities. A 300-ft Seamist™ membrane was installed in Borehole 33-1231 in October 1994. The membrane was equipped with 60 absorber pads spaced at 5 ft intervals. After two months, the membrane was removed from the borehole and the pads analyzed for moisture content and tritium activity in the sorbed water. The resulting profile revealed an even broader tritium peak centered at a depths between 80 ft and 100 ft. Maximum tritium activities were on the order of 50 000 pCi/ml.

Comparison of the four sets of tritium activities in contaminated borehole 33-1231/LAN33-0018 is shown in Fig. 4-5. The 1993 ER results clearly show the vertical extent of the tritium plume. In addition, the results are in agreement with results from the earlier Weston study and the experimental Seamist™ study.

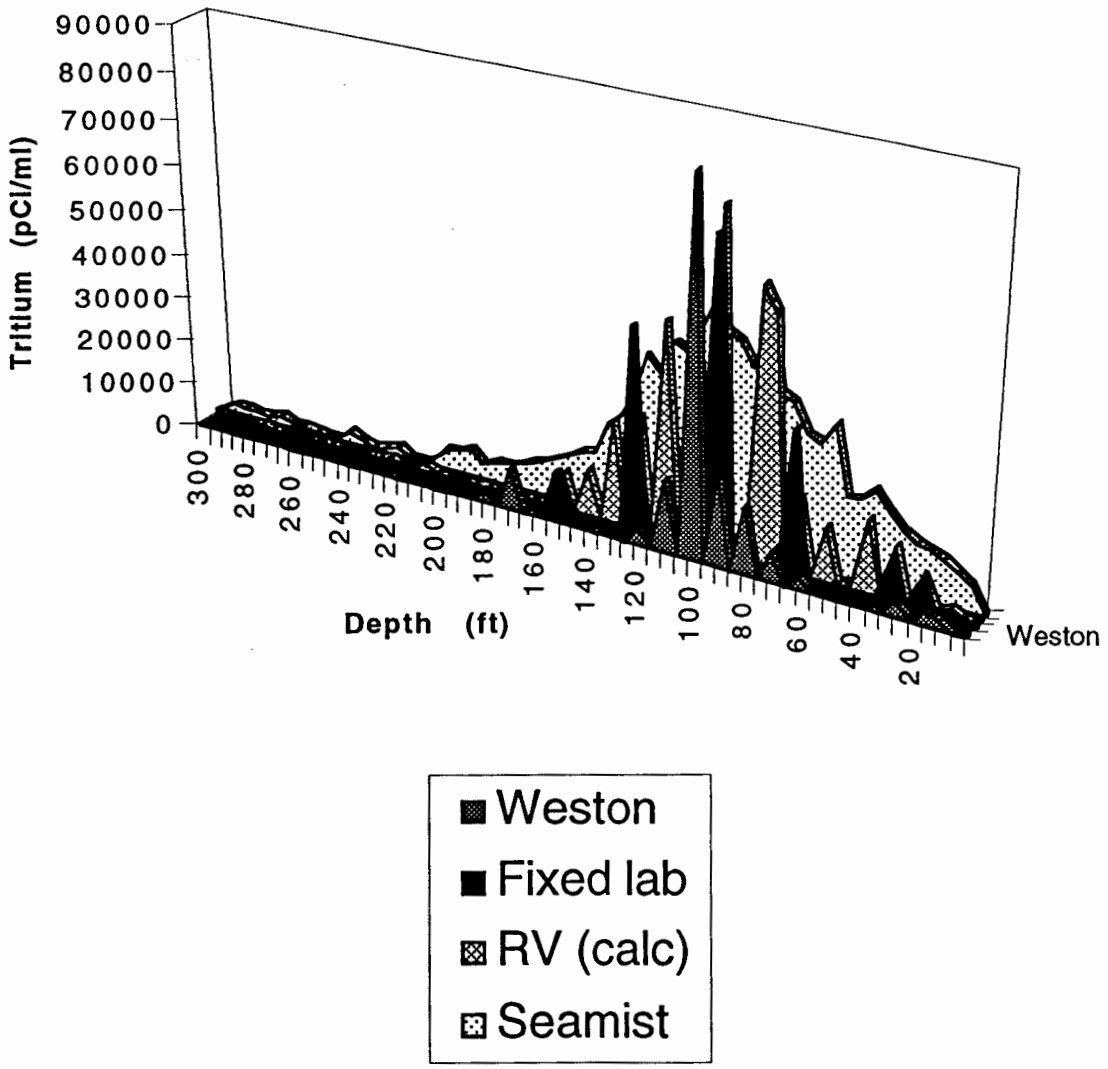

Fig. 4-5. Borehole 33-1231 tritium comparisons.

Moisture Profiles

The moisture profile measured on ER samples showed a generally increasing moisture content with depth, reaching a peak near 200 ft at the base of the Bandelier Tuff and then decreasing in the underlying sediments and basalts (Fig. 4-6). The moisture contents of the Seamist™ absorber pads were also measured. Because of different capillary properties, the moisture content of the pads will not duplicate the *insitu* tuff moisture content, but should be roughly proportional. Results are in general similar, although the highest Seamist™ moisture measurements were at greater depths, near the Puye/basalt contact at 268 ft. It is important to note that at no point during drilling operations or subsequent sampling has any perched water been detected in the boreholes at MDA K.

Geologic Logging

Detailed lithologic logging was performed on the core collected in the MDA K boreholes during the ER drilling in 1993 (Stimac 1995, 02-0102). Of primary importance is the lack of any distinguishing characteristics, particularly fractures or high percentage of voids in the vicinity of the 100 ft tritium peak. This depth lies within Unit 1v of the Tshirege Member of the Bandelier Tuff. This unit extends from a depth of 73 ft to 170 ft, and is quite homogeneous over that distance (Fig. 4-7).

Chaquehui Anomaly

Beginning in the fall of 1991, sediment samples collected in Chaquehui Canyon near its confluence with the Rio Grande in White Rock Canyon have consistently contained tritium activities above background. This anomaly was first observed during routine environmental surveillance sampling, and has been confirmed by subsequent sampling. The tritium facility at TA-33 is the nearest known source of tritium, and a connection between MDA K and the Chaquehui Canyon anomaly has been suspected. The most plausible pathway from MDA K to the mouth of Chaquehui Canyon is subsurface groundwater flow to the springs that discharge in the vicinity of the anomaly. To explore this pathway, water samples were collected from the springs in April 1994. All samples contained background tritium activities, in contrast to the nearby sediment samples. A summary of tritium activities at various locations in lower Chaquehui Canyon is presented in Table 4-7. Figure 4-8 shows the relation of MDA K to the sample collection area in Chaquehui Canyon.

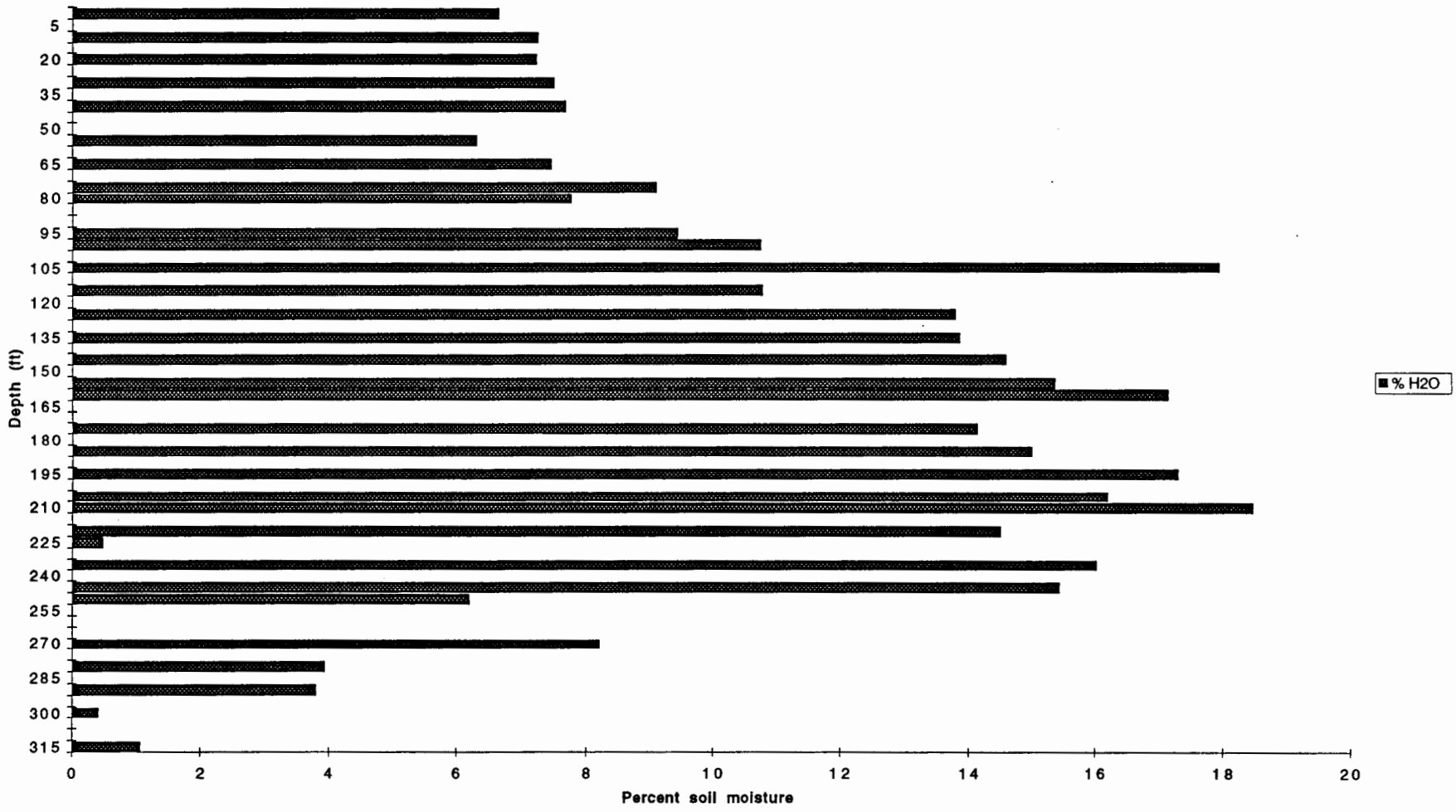

Fig. 4-6. Percent soil moisture in borehole 33-1231.

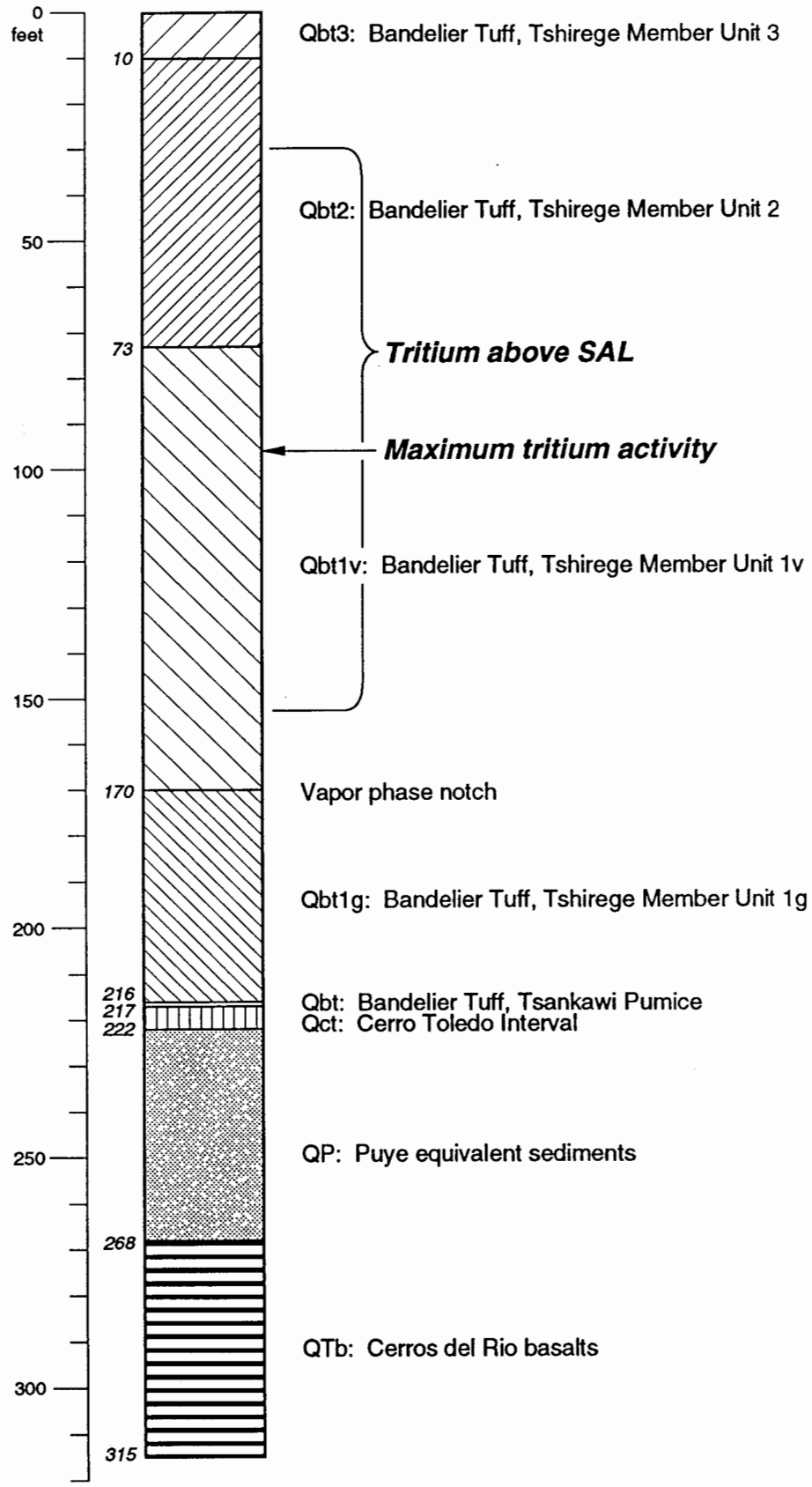

Fig. 4-7. Lithologic log.

TABLE 4-7

TRITIUM ACTIVITIES DETECTED IN CHAQUEHUI CANYON (1991-1994)

DATE	Oct-91	Feb-92	Oct-92	Oct-93	Aug-94	Aug-94
UNITS	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/g
Upstream Doe Spring	NC[a]	1 000	7 500	6 700	49	0.006
Downstream Doe Spring	NC	NC	1 100	400	1 350	0.291
Cliff face	NC	500	NC	3 100	305	0.069
Upstream 9A	NC	400	3 000	4 000	NC	NC
Confluence Doe &9A	NC	NC	NC	NC	806	0.163
Midway between points	NC	NC	NC	NC	169	0.154
30 m above Rio Grande	28 000	5 400	NC	NC	479	0.05

[a] NC = Not collected.

Notes: Tritium SAL (drinking water) = 20 000 pCi/L.
Tritium concentration in rainfall averages 40 pCi/L.
Tritium soil SAL = 810 pCi/g.

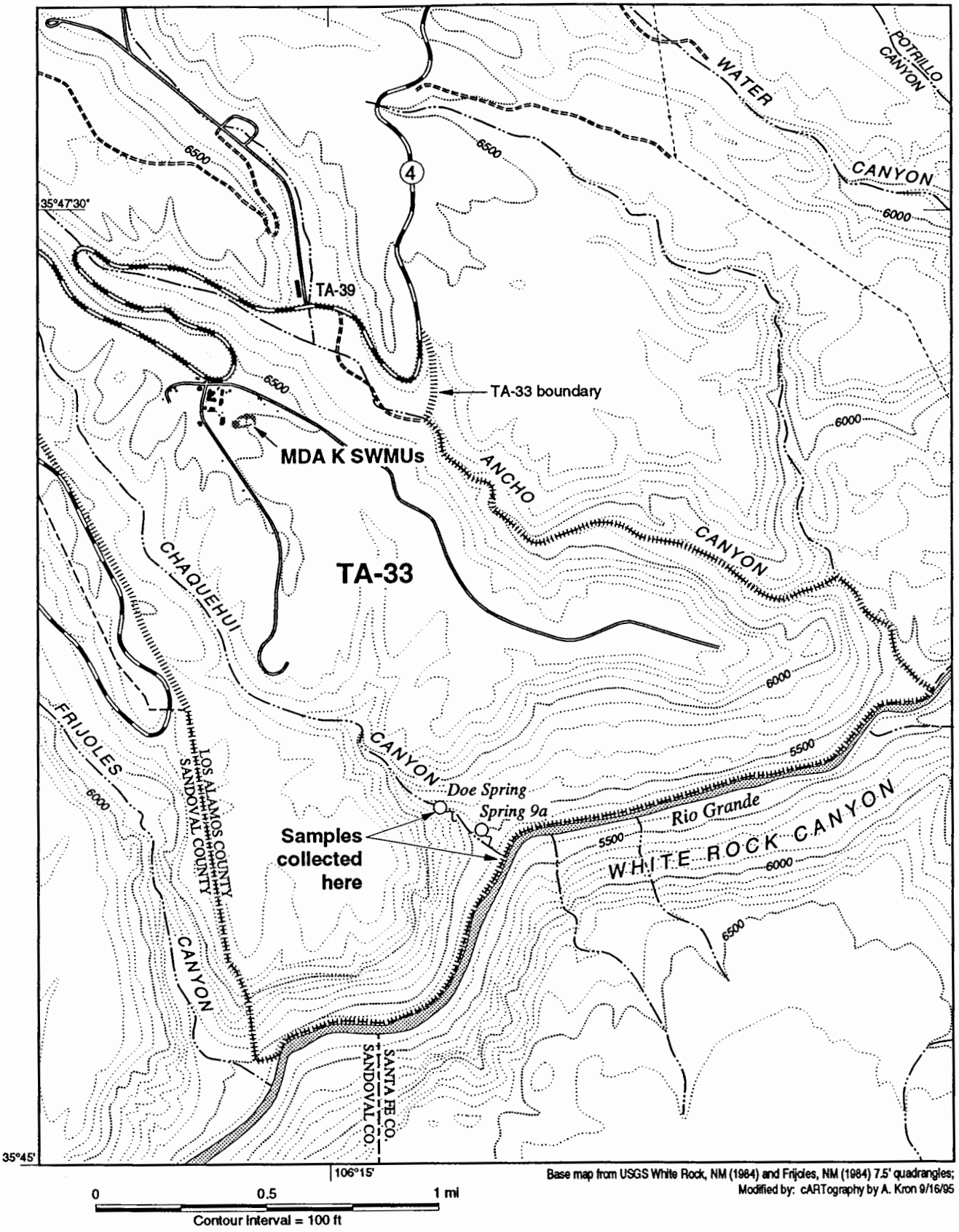

Fig. 4-8. Chaquehui Canyon sampling.

4.1.3.2.2 Borehole Interpretations

Tritium, Moisture, and Geologic Profiles

The availability of three different tritium profiles measured over a period of five years enables us to see how the subsurface tritium distribution is evolving with time. The center of mass of the peak has displayed no net movement of the center of mass of the peak, but the maximum activity has decreased and the peak has broadened over the five-year period. Based on the detailed geologic log, there does not appear to be any geologic control on the peak location. The tritium facility was active from 1955 to 1990. During that time there were active discharges to the surface outfall, sumps, and septic system of MDA K. Active discharges from the building continue at decreasing levels.

It is likely that most of the observed subsurface tritium was released near the ground surface (through outfalls, sumps, or drain fields) during operation of the facility. As tritium discharges decreased, continued discharges of water provided a hydrologic driving force that advectively transported the high tritium deeper into the tuff. The magnitude of these discharges was enough to support a thriving cattail population at the outfall. By 1989, the historic tritium peak had reached a depth of approximately 100 ft, as revealed by the Weston investigation. When tritium operations in TA-33-86 were terminated permanently in 1990, water discharges ceased (or were drastically decreased), as demonstrated by the death of the cattail population. With the driving force gone, the tritium peak ceased its downward migration, and became stranded at the 1989 depth of 100 ft. In the absence of advective forces, diffusion began to dominate the situation, spreading the plume both upwards and downwards while decreasing the peak activity. In the form of tritiated water, the tritium is subject to both liquid-phase and vapor-phase diffusion. As the tuff dries out, liquid diffusion will become slower, but vapor-phase diffusion will increase.

As long as downward advective movement is prevented, there is no reason to expect that the present behavior will change. Diffusion will continue to smear the peak vertically and horizontally, decreasing the maximum activity. Some tritium will diffuse to the land surface and be lost to the atmosphere, some will diffuse downward, and some will diffuse laterally away from the MDA K source area. At the same time, radioactive decay of tritium (half-life 12.33 years) will decrease overall activities everywhere.

Chaquehui Anomaly

The Chaquehui tritium anomaly is unexplained. The most plausible theory for a connection between MDA K and the Chaquehui sediments, groundwater transport via either a perched

aquifer or the main aquifer, seems to have been eliminated. Drilling at MDA K has not revealed any perched system, and the lack of elevated tritium in springs in the area seems to preclude a groundwater pathway. Vadose-zone transport seems extremely unlikely due to the great distance involved and the relatively slow rate of vadose-zone transport. Possibly a surface transport mechanism is involved, but it seems that rainfall and surface runoff would quickly dilute most likely sources to background levels.

4.1.3.3 Risk Assessment for MDA K

With the exception of one sample from a depth of 5 ft at SWMU 33-002(b), discussed as a separate risk assessment in Subsection 4.2.3.3, this risk assessment addresses surface and subsurface tritium for the whole of MDA K. The risk assessment is placed here for convenience in discussing tritium flux at TA-33. Results of sampling the five PRSs at MDA K revealed four surface soil locations where tritium exceeded its SAL of 810 pCi/g. These samples are listed in Table 4-8.

TABLE 4-8

SURFACE SOIL SAMPLES WITH TRITIUM ACTIVITIES EXCEEDING SAL

SAMPLE ID	PRS[a]	SAMPLE TYPE	TRITIUM (pCi/g)
AAA1934	33-002(b)	Sump 33-134	1 728
AAA1941	33-002(d)	Outfall EPA 04A147	5 449
AAA2185	33-002(d)	Duplicate of AAA1941	1 457
AAA1942	33-002(d)	Downgradient of outfall	11 963

[a] PRS = Potential release site.

In addition, tritium activities in cores collected from subsurface locations in borehole 33-1231 exceeded SAL, ranging from 831 pCi/g at a depth of 30 ft to a maximum of 8 006 pCi/g at a depth of 95 ft. The maximum depth where tritium activity (1 698 pCi/g) exceeded SAL was at 155 ft. Tritium activities in excess of SAL were measured in an approximate area of 200 ft x 300 ft (60 000 ft^2).

Because of the number of tritium activities exceeding SAL, an assessment of risk was performed using the Residual Radioactive Material (RESRAD) Computer Model, ver. 5.6 (DOE 1990, 0277). This model includes a tritium plume subroutine which approximates the movement of tritium though soil and the flux of tritium from soil to the atmosphere. The input parameters used in running the RESRAD tritium plume model were the "mesa top" parameters developed by Argonne National Laboratory for LANL (Dorries 1992, 1066) for LANL. Because MDA K is slated for industrial use only, the industrial worker exposure unit was used in the

model. Three site-specific parameters were necessary to run the model: contaminated area, depth of contamination, and tritium soil activity. The specific parameters used are given in Table 4-9.

TABLE 4-9

PARAMETERS USED IN RESRAD MODEL FOR MDA K

PARAMETER	VALUE	COMMENT
Contaminated area	6 667 m^2	200 ft by 300 ft area exceeding tritium SAL
Contamination depth	51 m	Highest depth (155 ft) where tritium exceeded SAL
Tritium soil activity	11 900 pCi/g	Highest activity detected[a]

[a] Using the highest detected activity is extremely conservative by comparison with RAGS guidance, which permits use of a 95% UCL for the mean. Therefore, the calculated 11.9 mrem/year is considered a conservative upper bound. Calculations using the maximum detected activity is not a usual risk assessment procedure, but rather a bounding exercise due to uncertainties in extent of the tritium plume at MDA K.

The only exposure pathway deemed credible is inhalation resulting from tritium flux from the soil. Because the depth to groundwater from the MDA K mesa top is between 315 ft and 830 ft, and there is no surface water nearby, ingestion from water was determined not to be a viable exposure pathway. Exposure to tritium through ingestion of plants is not credible, because MDA K is slated to be used for industrial activity for the foreseeable future.

RESRAD was run using the parameters described above. The results show that the effective dose equivalent (EDE) to an individual living at the site in 1993 would be 11.9 mrem/year, well below the DOE-allowable EDE of 30 mrem/year (DOE 1990, 0277). Because tritium has a relatively short half life (12.33 years), the EDE is estimated to drop to 9.7 mrem/year in 1995, to 8.6 mrem/year in 1996, and to 7.1 mrem/year in 1998. Because exposure to tritium fluxing from the soil at MDA K does not pose an unacceptable risk, no remediation is recommended. RESRAD calculations are given in Appendix D of this RFI report.

4.1.3.4 Ecotoxicological Screening Assessment

Analysis of soil samples from MDA-K provides data for estimating the radiological dose from tritium to plants and animals resident at the site. Soil data were converted from activities (pCi/g) to radiation doses to plants and animals (mrad/day). The doses were then compared to a recommended limit on radiation doses for plants and animals. Dose rates less than 100 mrad/day are considered by the International Atomic Energy Agency to cause no adverse effects in populations of exposed animals and plants (Inthernational Atomic Energy Agency 1992, 0983). The calculations are given in Appendix C of this RFI report.

Results for MDA K show that only sample AAA3900 at a 5-ft depth within sump TA-33-134 [SWMU 33-002(b)], at 187 mrad/day, has a dose rate greater than 100 mrad/day. The dose rates from the remaining locations at MDA K range from 0.000184 mrad/day to 3.7 mrad/day. From the soil data and conversions using Equation 1, there does not appear to be undue risk of adverse effects to the plants and animals that use MDA K except at a depth of 5 ft at the SWMU 33-002(b) sump location.

4.1.4 Conclusions and Recommendations

The following recommendations are made for the various components of SWMU 33-002(a):

- Surface tritium. Based on a risk assessment, no action is necessary. The MDA will be posted for radioactivity in accordance with the LANL RADCON manual (LANL 1994, 1235).

- Subsurface tritium plume. A Phase II sampling plan is presented in Appendix B of this report to further investigate the tritium plume. Elimination of hydrologic driving forces is proposed to stabilize the plume in place to allow for decay and natural dispersion. Recommendations for control of liquid driving forces are proposed in Subsection 4.1.4.2 of this report and must be considered in development of future plans for the facility. These recommendations will be made to the group responsible for future operation of TA-33-86.

- Septic tank. As part of Phase II sampling (Appendix B), a borehole will be drilled adjacent to the tank to determine if the tank is the source of the plume and if contaminants are escaping the tank. Although TA-33-86 is empty, sources within the building still route water to the septic system. The tank is recommended for cleaning to remove contaminated liquid and sludge.

4.1.4.1 Surface Tritium

As indicated by the risk assessment calculations of Subsection 4.1.3.3, no remediation is necessary to address surface tritium contamination at MDA K. Calculations indicate a 1993 exposure of 11.9 mrem/year, decreasing yearly through dispersion and decay. The allowable DOE exposure is 30 mrem/year (DOE 1990, 0277).

4.1.4.2 Subsurface Tritium

Based on available data using the maximum tritium activity (8 006 pCi/g at 95 ft) detected beneath MDA K, tritium (half-life 12.3 years) will decay to activities below SAL in less than 3.5 half-lives (approximately 45 years), ignoring the effects of diffusion. The Phase II sampling plan is designed to determine if the tritium activities in borehole 33-1231 are representative of activities in the plume as a whole.

For the MDA K plume, the previous driving forces (water sources from the cooling water outfall and/or septic drain field) for downward advection have been cut off. If potential driving forces (water sources from TA-33-86 or large-scale runoff events) resume and advective transport occurs before diffusion and decay have decreased the peak to harmless levels, it is possible that tritium would move downward and encounter a deep perched aquifer or the main aquifer, in which case it could be more rapidly transported to a discharge point and reach the accessible environment. Even in this case, dilution in the aquifer would probably eliminate any risk, but it seems prudent to avoid the situation if possible.

The key to avoiding future migration of the plume is preventing a downward driving force. As discussed previously, past operations at and around TA-33-86 led to surface water discharges and ponding. Operational changes have minimized intentional discharges; steps should be taken to eliminate any future intentional discharges, and to minimize incidental surface water flow into the vicinity of the MDA K plume. Specifically, outfalls, drain fields, and sumps in the vicinity of MDA K should be permanently removed from service and engineering controls should be instituted to divert natural runoff from buildings, roads, and paved areas away from MDA K. It is important to stress that these steps are not intended to divert only contaminated water from the area; they are intended to divert all run-on water from the area. There will be no attempt to divert rainfall and snowmelt from the site as they are necessary to restore and maintain natural vegetative conditions.

The question of tritium in sediments in Chaquehui Canyon has been referred to the Canyons Operable Unit of the ER Project (Martin 1995, 02-104). Environmental surveillance sampling in the area will continue. This program of regular annual sampling will reveal if tritium activities increase. If activities reach a level that pose an unacceptable risk or if activity trends show an ongoing increase, further action may then be warranted.

4.1.4.3 Septic Tank

To accomplish the removal of driving forces from MDA K, inflow to the tank must be rerouted to another system. An interim measure is recommended for the septic tank to remove fluid and sludge.

4.2 SWMU 33-002(b) Sump TA-33-134

SWMU 33-002(b) is sump TA-33-134 at MDA K. It is discussed in the RFI Work Plan for OU 1122 in Subsections 3.2.2.1, 4.1.4, and 4.2.3.1 (LANL 1992,0784). It is proposed for Phase II sampling based on one high tritium result and questions concerning sampling location.

The sump, constructed in 1955, is a rubble-filled, unlined seepage pit alleged to be 6 ft in diameter and 8 ft deep. It might better be described as a dry well. A 3-in. concrete cover overlaid by 1 in. of soil originally covered the sump. The cover was broken during sampling by Weston personnel in 1989. A sink and floor drain in the south part of TA-33-86 are connected to the sump. Archival information indicates that sump TA-33-134 received organic contaminants such as ethanol and methanol (less than 5 gal./year), trichloroethene, and tritium-contaminated benzene and acetone (about 5 gal./year). The sump may also have received beryllium, mercury, and depleted uranium (LANL 1992, 0784).

The sump lies on a level area about 20 ft south of septic tank TA-33-93. Broken pieces of concrete mark the site. The entire area is greatly disturbed and the vegetation consists of weeds. Soil is dry, dusty, and sandy with small pumice pebbles at the surface. Subsurface soil is sandy with tuff and no organic material at 2.5 ft.

4.2.1 Previous Investigations

Weston personnel collected a surface sample at sump TA-33-134 in 1989. Samples were analyzed for inorganics, radionuclides, pesticides, and polychlorinated biphenyls (PCBs). Only tritium, at 190 000 pCi/ml in soil moisture, was detected. No moisture analysis was performed so no activity per gram of soil can be calculated.

4.2.2 Field Investigation

The RFI work plan specified fluid and sludge samples be collected from the sump. The plan also directed that a borehole be drilled next to the sump and three subsurface samples (plus a duplicate) be taken from the core to determine if possible contamination was migrating from the sump to the environment. During the ER sampling campaign in 1993, the fluid and sludge samples were not collected because these components were not present in the sump. Drilling adjacent to the sump encountered the soil/tuff interface at 30 in. Because of the shallow depth of the hole, only a surface sample and a soil/tuff interface sample were collected. A third sample was taken at a depth of 5 ft from within the sump at the point of auger refusal (Fig. 4-9). All samples were analyzed for uranium, tritium, plutonium, gamma emitters, inorganics, and SVOCs. The two subsurface samples were analyzed for VOCs.

4.2.2.1 Results of Field Surveys

All sampling points were surveyed. No other field surveys were associated with SWMU 33-002(b).

4.2.2.2 Results of Field Screening

No radiation was detected during routine field screening of sampling locations at SWMU 33-002(b).

4.2.3 Screening Assessment

4.2.3.1 Comparison to Background/SALs

Weston results for a surface sample indicated that no inorganic, pesticides, PCBs, uranium, or gamma emitters were detected above LANL and TA-33 background UTLs. Tritium was detected at 190 000 pCi/ml of soil moisture. No moisture content was determined, so this value can not be converted to pCi/g. The surface sample AAA1931 collected at this same point in 1993 contained 3 370.5 pCi/ml of soil moisture; the subsurface sample AAA1934 taken at 30 in. contained 10 529 pCi/ml of soil moisture.

The ER 1993 results indicate that only tritium was detected above SAL. Table 4-10 lists inorganics and radionuclides detected above LANL and TA-33 background UTLs. Note that the value of 610 485 pCi/g is a mobile radiation laboratory measurement. (Table 4-6 provides a comparison of mobile radiation laboratory vs. fixed laboratory results). Of the 319 organic compounds for which analyses were performed, none was detected.

Sampling points are shown in Fig. 4-9.

TABLE 4-10

INORGANIC AND RADIONUCLIDE ANALYTES FOUND AT SWMU 33-002(b) WITH VALUES GREATER THAN LANL AND TA-33 BACKGROUND UTLS

ANALYTE	SAMPLE ID	CONCEN-TRATION	LANL UTL[a]	TA-33 UTL	SAL[b]	DEPTH (in.)
Cadmium	AAA3900	4 mg/kg	2.7 mg/kg	2.7 mg/kg	80 mg/kg	60
Plutonium-238	AAA3900	0.057 pCi/g	0.01 pCi/g	0.01 pCi/g	27 pCi/g	60
Plutonium-239	AAA1931	0.95 pCi/g	0.025 pCi/g	0.058 pCi/g	24 pCi/g	0-6
	AAA3900	0.078 pCi/g	0.025 pCi/g	0.058 pCi/g	24 pCi/g	60
Tritium	AAA1931	539.5 pCi/g	none	23.2 pCi/g	810 pCi/g	0-6
	AAA1934	**1 728** pCi/g	none	23.2 pCi/g	810 pCi/g	30
	AAA3900	**610 485** pCi/g[c]	none	23.2 pCi/g	810 pCi/g	60

[a] UTL = Upper tolerance limit.
[b] SAL = Screening action level.
[c] Mobile radiation laboratory measurement.

4.2.3.2 Data Interpretation

Comparison of the Weston 1989 surface tritium activity in soil moisture (190 000 pCi/ml) with the tritium activity of soil moisture in the ER 1993 surface sample (3 370.5 pCi/ml) indicates natural dilution of surface tritium by a factor of 55 over a 4-year period. The vertical extent of a possible subsurface tritium plume from the sump is not determined. Subsurface trace levels of plutonium detected this sump and in sump TA-33-133 [(SWMU 33-002(c)] may indicate past discharge from the building.

4.2.3.3 Risk Assessment

Three samples were collected from sump TA-33-134, SWMU 33-002(b), at MDA K. Results showed a measured tritium concentration of 610 485 pCi/g at a depth of 5 ft in the sump. A second sample collected at a depth of 2.5 ft showed a tritium concentration of 1 728 pCi/g, and a sample collected at the surface had a measured tritium concentration less than SAL.

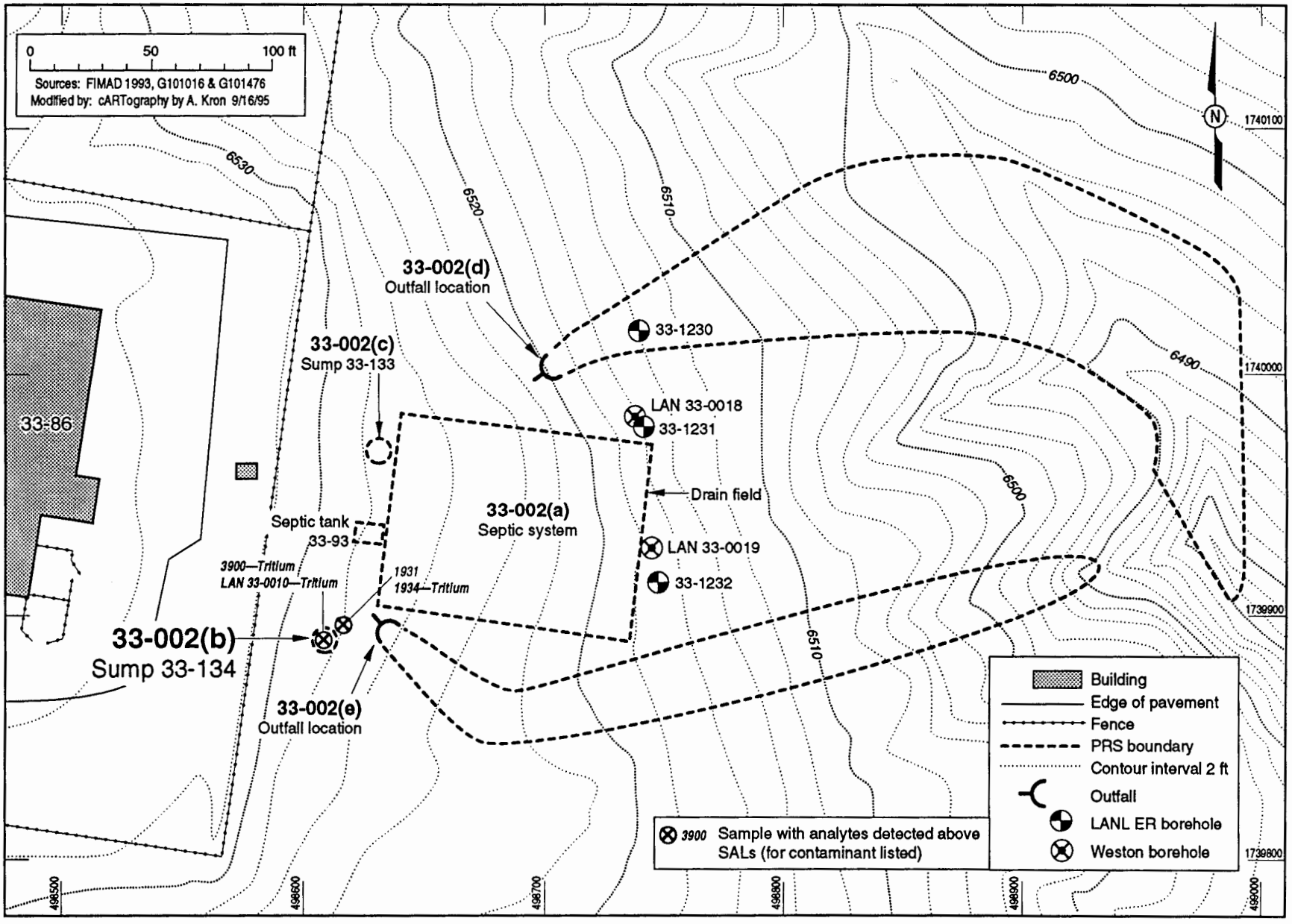

Fig. 4-9. SWMU 33-002(b) sump TA-33-134.

Because of the extent to which the tritium concentration in the 5-ft sample exceeded SAL, an assessment of risk was performed using the tritium plume subroutine of RESRAD, ver. 5.6, and the Argonne National Laboratory mesa top and industrial worker exposure parameters described in Subsection 4.1.3.3 of this RFI report. The site-specific parameters used in running the model are in Table 4-11.

TABLE 4-11

PARAMETERS USED IN RESRAD MODEL FOR SUMP TA-33-134

PARAMETER	VALUE	COMMENT
Contaminated area	4 m^2	6 ft diameter of sump
Contamination depth	27 m	80 ft[a]
Tritium soil activity	610 000 pCi/g	Highest activity detected

[a] Based on a worst-case assumption that an 80-ft-deep tritium plume exists below the sump as a result of a possible hydraulic head to the sump that existed until 1990, when operations at the building ceased.

The only exposure pathway deemed credible is inhalation resulting from tritium flux from the soil. Because the depth to groundwater is constrained to depths between 315 ft and 830 ft and because there is no surface water nearby, ingestion from water is not considered. Exposure to tritium through plants is not credible because MDA K is slated used for industrial use for the foreseeable future.

Using the parameters described above, RESRAD results show that the effective dose equivalent EDE to an individual working at the site of the sump in 1993 (when the tritium samples were collected) was 11.3 mrem/year. This EDE is well below the federally allowable EDE of 100 mrem/year (10 CFR 834, Radiological Protection of the Public and Environment). The DOE recommended EDE is 30 mrem/year, which is consistent with the guidance of the International Commission on Radiation Protection (DOE 1990, 0277). RESRAD calculations are provided in Appendix D of the RFI report.

4.2.3.4 Ecotoxicological Screening Assessment

Ecotoxicological assessment for MDA K is discussed in Subsection 4.1.3.4 of this report.

4.2.4 Conclusion and Recommendation

Sampling personnel and field notes verify that sample AAA3900 was taken where the hand auger hit refusal in the sump at 5 ft. Archival information indicates that the sump is 8 ft deep. Because of these uncertainties, a Phase II sampling plan is proposed in Appendix B of this RFI report. Results indicate that tritium is the most significant contaminant at SWMU 33-002(b).

SWMU 33-002(b) tritium activities at the surface and at a depth of 30 in. are included in the risk assessment for SWMU 33-002(a) in Subsection 4.1.3.3 of this report. Migration of subsurface tritium will be suppressed under the subsurface scenario for MDA K as described for SWMU 33-002(a). The sump has been posted for subsurface tritium contamination in accordance with the LANL RADCON manual (LANL 1994, 1235).

4.3 SWMU 33-002(c) Sump TA-33-133

SWMU 33-002(c) is sump TA-33-133 at MDA K. It is discussed in the RFI work plan for OU 1122 in Subsections 3.2.2.1, 4.1.4, and 4.2.4 (LANL 1992, 0784). Because of questions concerning 1993 sampling locations, the SWMU is proposed for Phase II sampling.

The sump, constructed in 1955, was originally connected to four sinks and four floor drains in the north part of TA-33-86. The sump is an unlined seepage pit allegedly 6 ft in diameter and 8-ft deep. It might better be called a dry well. The sump originally had a 3-in. concrete cover overlaid by 1 in. of soil. The cover was destroyed during Weston sampling in 1989; pieces of broken concrete are strewn about the site. Sump TA-33-133 was disconnected in 1959 and the drain line from the building extended approximately 90 ft past the sump to create the noncontact cooling water outfall, SWMU 33-002(d). Archival evidence indicates that the sump TA-33-133 may have received tritium and small quantities of solvents such as trichloroethene, methanol, ethanol, acetone, and propanol. It has been inactive since 1959.

The area is level and highly disturbed with a growth of chamisa and weeds. A few juniper trees are nearby. The sump is overlaid by piles of dirt mixed with broken tuff. On the surface, the soil is fine sand intermixed with silt and clay, with abundant tuff gravel, and little organic material. At 2.5 ft, the soil is a fine sand and clay, mixed with pulverized tuff presumed to be bedrock.

4.3.1 Previous Investigations

Weston personnel collected two surface samples at sump TA-33-133 in 1989. Samples were analyzed for inorganics, radionuclides, VOCs, SVOCs, pesticides, and PCBs. Tritium was detected at 90 and 890 pCi/g. Trace levels of SVOCs were detected.

4.3.2 Field Investigation

The RFI work plan specified fluid and sludge samples be collected from the sump. The plan also directed that a borehole be drilled next to the sump. Three subsurface samples (plus a duplicate) were taken to determine if possible contamination was migrating from the sump to the environment. During the ER sampling campaign in 1993, the fluid and sludge samples were

not collected because these components were not present in the sump. Drilling adjacent to the sump encountered the soil/tuff interface at 30 in. Because of the shallow depth of the borehole, only a surface sample and a soil/tuff interface sample (plus duplicate) were collected. A third sample was taken at auger refusal at a depth of 4 ft. All samples were analyzed for uranium, tritium, plutonium, gamma emitters, inorganics, and SVOCs. The two subsurface samples were analyzed for VOCs.

4.3.2.1 Results of Field Surveys

All sampling points were surveyed. No other field surveys were associated with SWMU 33-002(c). The sump was located by repeated drilling with a hand auger.

4.3.2.2 Results of Field Screening

No radiation was detected during routine field screening of sampling locations at SWMU 33-002(c).

4.3.3 Screening Assessment

4.3.3.1 Comparison to Background/SALs

Tritium was found in the 1989 Weston samples at 90 and 890 pCi/g. In the 1993 ER samples, no measurements were recorded above SAL. Analytes found above LANL and TA-33 background UTLs are listed in Table 4-12. Of the 465 organic compounds for which analyses were performed, only the solvent 2-hexanone was detected in trace amounts (0.059 mg/kg) in sample AAA1939. No other organics were detected. Sampling points are shown in Fig. 4-10.

TABLE 4-12

RADIONUCLIDE ANALYTES FOUND AT SWMU 33-002(c) WITH VALUES GREATER THAN LANL OR TA-33 BACKGROUND UTLs

ANALYTE	SAMPLE ID	CONCEN-TRATION (pCi/g)	LANL UTL[a] (pCi/g)	TA-33 UTL (pCi/g)	SAL[b] (pCi/g)	DEPTH (in.)
Plutonium-238	AAA1938	0.013	0.01	0.0074	27	30
	AAA3901	0.328	0.01	0.0074	27	48
Plutonium-239	AAA1937	0.182	0.025	0.058	24	0-6
	AAA3901	0.342	0.025	0.058	24	48
Tritium	AAA1939	52.5	none	23.2	810	30
	AAA3901	34	none	23.2	810	48

[a] UTL = Upper tolerance limit.
[b] SAL = Screening action level.

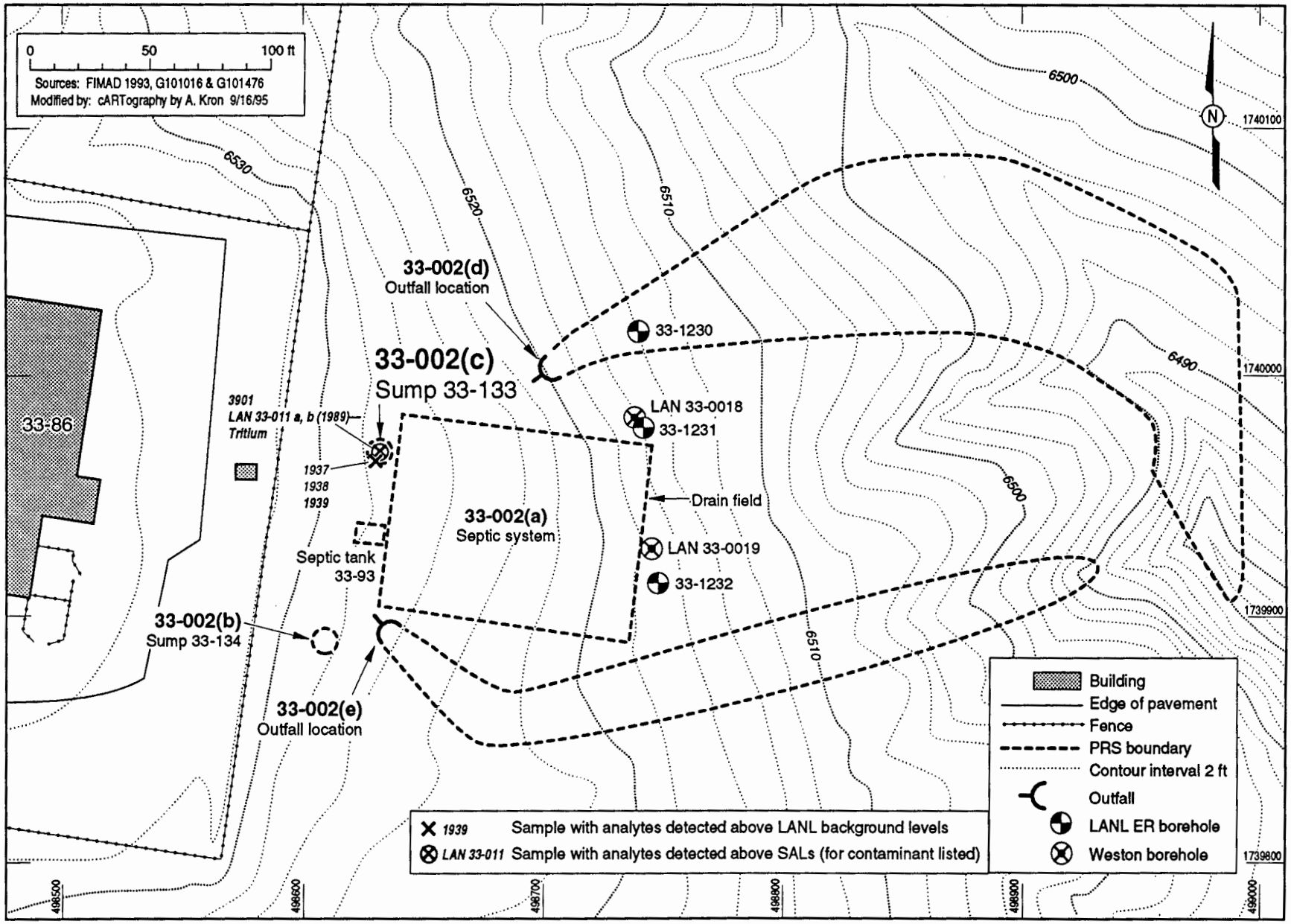

Fig. 4-10. SWMU 33-002(c) sump TA-33-133.

4.3.3.2 Data Interpretation

Trace levels of plutonium found in the sump may indicate past contamination. For tritium, comparison of the Weston 1989 surface tritium activity in soil moisture (15 000 and 3 000 pCi/ml) with the ER 1993 surface sample (69 pCi/ml in soil moisture) indicates a minimum natural dilution of surface tritium by a factor of approximately 45 over a period of 4 years.

4.3.3.3 Risk Assessment

No risk assessment was performed specifically for SWMU 33-002(c). Tritium results from SWMU 33-002(c) samples were considered in the MDA K risk assessment in Subsection 4.1.3.3 of this report.

4.3.3.4 Ecotoxicological Screening Assessment

Ecotoxicological assessment of MDA K is discussed in Subsection 4.1.3.4 of this report.

4.3.4 Conclusion and Recommendation

Field notes and interviews with sampling personnel indicate that sample AAA3901 was taken at the point of refusal of the hand auger at 4 ft. Archival information indicates that the sump is 8 ft deep. Because of these uncertainties, a Phase II sampling plan is proposed in Appendix B of this RFI report. Surface tritium is addressed under the risk assessment discussed for SWMU 33-002(a). The low levels of subsurface tritium will be constrained in place under the subsurface scenario for MDA K as described for SWMU 33-002(a).

4.4 SWMU 33-002(d) Noncontact Cooling Water Outfall

SWMU 33-002(d) is National Pollutant Discharge Elimination System (NPDES) permitted outfall EPA 04A147. It is discussed in the RFI Work Plan for OU 1122 in Subsections 3.2.2.1, 4.1.4, and 4.2.3.1 (LANL 1992, 0784). Tritium detected at the outfall was considered in the overall MDA K risk assessment. The SWMU is proposed for NFA based on sampling data collected in May and June 1993. Three additional surface samples were collected in December 1994.

SWMU 33-002(d) was the outfall for noncontact cooling water from a heat exchanger in the tritium facility. Water from the heat exchanger was directed into one of the floor drains leading to sump TA-33-133. The outfall was created when the sump was disconnected in 1959 and its drain line from TA-33-86 was extended approximately 90 ft past the sump. The outfall has not been disconnected nor has the water supply to TA-33-86 been shut off. The outfall is scheduled

to be deactivated in fiscal year 1995. The tritium facility ceased operations in December 1990. All equipment, including the heat exchanger, has been removed.

Because of the constant supply of water discharged over the years, vegetation was heavy in the drainage. Even cattails grew on the site. The outfall is located at the head of a shallow drainage leading into the tributary of Chaquehui Canyon east of Main Site. Remains of cattails and willows mark the drainage path for approximately a quarter mile beyond the outfall. Soil is loamy sand. Rocks and bedrock outcrops occur near the drainage. The soil in the drainage, a brown clay containing small pebbles, becomes up to 2 ft deep in sections of the tributary.

4.4.1 Previous Investigations

Weston 1989 surface sampling consisted of composite samples. Although these data have not received QA/QC data validation, results are presented in Table 4-13 for information purposes only.

TABLE 4-13

WESTON SURFACE SAMPLING RESULTS ABOVE BACKGROUND

ANALYTE	WESTON ID[a]	RESULT	LANL UTL[b]	SAL[c]	DEPTH (ft)	SAMPLE TYPE/DESCRIPTOR
Mercury	LAN33-0005	0.16 mg/kg	None	24	0-0.5	Composite soil
Mercury	LAN33-0013	0.5 mg/kg	None	24	0-0.5	Soil
Tetrachloroethane	LAN33-0005	0.005, 0.006 mg/kg [d]	None	270	0-0.5	Composite soil
Toluene	LAN33-0005	0.010, 0.015 mg/kg [d]	None	910	0-0.5	Composite soil
Toluene	LAN33-0007	0.005 mg/kg	None	910	0-0.5	Composite soil
Tritium	LAN33-0004	3 900 pCi/ml	None	810	0-0.5	Composite soil
Tritium	LAN33-0005	4 600 pCi/ml	None	810	0-0.5	Composite soil
Tritium	LAN33-0006	2 400 pCi/ml	None	810	0-0.5	Composite soil
Tritium	LAN33-0007	81, 73 pCi/mL [d]	None	810	0-0.5	Composite soil
Tritium	LAN33-0008	29 pCi/ml	None	810	0-0.5	Composite soil
Tritium	LAN33-0012	1 800 pCi/ml	None	810	0-0.5	Soil
Tritium	LAN33-0013	1 700 pCi/ml	None	810	0-0.5	Soil
Tritium	LAN33-0014	19 000 pCi/ml	None	810	0-0.5	Soil

[a] These borehole points are not shown on any figure.
[b] UTL = Upper tolerance limit.
[c] SAL = Screening action level.
[d] Sample analyzed twice for this analyte with results above detection limits or background in both samples. Weston did not determine percent moisture; assuming percent moistures of 1 to 10%, the LANL soil SAL of 810 pCi/g for trititum yields soils moisture SALs ranging from 8 200 to 82 000 pCi/mL.

4.4.2 Field Investigation

To investigate possible contamination from the outfall, five samples were taken for SWMU 33-002(d) during the ER 1993 sampling campaign. One sample and a duplicate were taken immediately below the outfall, two samples were taken in the drainage, and the fifth sample was taken at the junction of the outfall drainage and the tributary channel. Three water samples were specified in the work plan, but none was taken because no water was present.

All soil samples were analyzed for uranium, tritium, plutonium, gamma emitters, inorganics, and SVOCs. One sample was analyzed for PCBs, and three were analyzed for pesticides.

In December 1994 three samples were collected at the outfall in an attempt to assess the dispersion of tritium from natural processes in the course of 1.5 years.

4.4.2.1 Results of Field Surveys

All sampling points were surveyed. No other field surveys were associated with SWMU 33-002(d).

4.4.2.2 Results of Field Screening

No radiation was detected during routine field screening of sampling locations at SWMU 33-002(d).

4.4.3 Screening Assessment

4.4.3.1 Comparison to Background/SALs

Tritium was found well above SAL in three samples associated with the outfall. These tritium activities were included in the risk assessment for all of MDA K, discussed in Subsection 4.1.3.3 of this report. Activities are listed in Table 4-14 with activities above SAL in boldface. Sampling points are shown in Fig. 4-11.

TABLE 4-14

TRITIUM FOUND AT SWMU 33-002(d) WITH VALUE GREATER THAN TA-33 BACKGROUND UPPER TOLERANCE LIMIT

ANALYTE	SAMPLE ID	ACTIVITY (pCi/g)	LANL UTL[a] (pCi/g)	TA-33 UTL (pCi/g)	SAL[b] (pCi/g)	DEPTH (in.)
Tritium	AAA1941	**5 449**	ND[c]	23.2	810	0-6
	AAA2185[d]	**1 457**	ND	23.2	810	0-6
	AAA1942	**11 963**	ND	23.2	810	0-6
	AAA1943	142	ND	23.2	810	0-6
	AAA1944	302	ND	23.2	810	0-6

[a] UTL = Upper tolerance limit.
[b] SAL = Screening action level.
[c] NA = Not determined.
[d] Duplicate of AAA1941.

Several inorganic and radionuclide analytes were detected above LANL background UTLs but well below SAL, as listed in Table 4-15.

TABLE 4-15

INORGANIC AND RADIONUCLIDE ANALYTES FOUND AT SWMU 33-002(d) WITH VALUES GREATER THAN LANL AND TA-33 BACKGROUND UPPER TOLERANCE LIMITS

ANALYTE	SAMPLE ID	CONCEN-TRATION (mg/kg)	LANL UTL[a] (mg/kg)	TA-33 UTL (mg/kg)	SAL[b] (mg/kg)	DEPTH (in.)
Cadmium	AAA1942	3	2.7	2.7	80	0-6
Chromium	AAA1942	100	34.2	20.7	400	0-6
Lead	AAA1942	90	39	39	400	0-6
Silver	AAA1942	21	ND[c]	ND	400	0-6
	AAA1943	3.5	ND	ND	400	0-6
Uranium	AAA1942	10.2	2.82	4.84	95	0-6
Zinc	AAA1942	140	101	62.5	24 000	0-6
	SAMPLE ID	ACTIVITY (pCi/g)	LANL UTL (pCi/g)	TA-33 UTL (pCi/g)	SAL (pCi/g)	DEPTH (in.)
Plutonium-238	AAA1942	0.017	0.01	0.0074	24	0-6

[a] UTL = Upper tolerance limit.
[b] SAL = Screening action level.
[c] NA = Not determined.

Because of elevated inorganics, a multiple constituent analysis is presented in Table 4-16. A total SAL fraction (0.63) less than 1 indicates that these concentration do not present a hazard from inorganics.

TABLE 4-16

MULTIPLE CONSTITUENT ANALYSIS FOR SAMPLE AAA1942

ANALYTE	SAL[a] (mg/kg)	CONCENTRATION (mg/kg)	SAL FRACTION
Cadmium	80	3	0.038
Chromium	400	100	0.250
Lead	400	90	0.225
Silver	400	21	0.005
Uranium	95	10.2	0.107
Zinc	24 000	140	0.005
Total	**NA[b]**	**NA**	**0.630**

[a] SAL = Screening action level.
[b] NA = Not applicable.

A total of 393 analyses were performed for organic compounds. Concentrations of organic analytes found above detection limits in the samples are shown in Table 4-17.

TABLE 4-17

ORGANIC ANALYTES ABOVE DETECTION LIMIT AT SWMU 33-002(d)

ANALYTE	SAMPLE ID	CONCENTRATION (mg/kg)	EQL[a] (mg/kg)	SAL[b] (mg/kg)	DEPTH (in.)	MEDIUM
Aldrin	AAA1941	**0.042**	NL[c]	0.04	0-6	Soil
Aldrin	AAA2185	0.029	NL	0.04	0-6	Soil
Aroclor 1254™	AAA1942	0.25	NL	1	0-6	Soil
Aroclor [mixed-]™	AAA1942	0.25	NL	1	0-6	Soil
BHC [alpha-]	AAA1941	0.041	NL	0.1	0-6	Soil
BHC [alpha-]	AAA2185	0.027	NL	0.1	0-6	Soil
BHC [delta-]	AAA1941	0.037	NL	NC[d]	0-6	Soil
BHC [delta-]	AAA2185	0.026	NL	NC	0-6	Soil
Chrysene	AAA1942	0.45	0.33	96	0-6	Soil
DDD [p,p'-]	AAA1941	0.012	NL	2.9	0-6	Soil
DDD [p,p'-]	AAA2185	0.0075	NL	2.9	0-6	Soil
DDT [p,p'-]	AAA1941	0.011	NL	2.1	0-6	Soil
DDT [p,p'-]	AAA2185	0.023	NL	2.1	0-6	Soil
Endosulfan II	AAA1941	0.0043	NL	4	0-6	Soil
Endosulfan sulfate	AAA2185	0.018	NL	4	0-6	Soil
Fluoranthene	AAA1942	0.47	0.33	3 200	0-6	Soil
Pyrene	AAA1942	0.54	0.33	2 400	0-6	Soil

[a] EQL = Estimated quantitation limit.
[b] SAL = Screening action level.
[c] NL = Not listed.
[d] NC = Not calculated due to insufficient toxicity data.

PCBs and pesticides were also found down drainage with measurements for the pesticide Aldrin™ at SAL. Trace levels of three SVOCs were found in one sample located down drainage from the outfall pipe.

In December 1994 three locations were resampled to determine any changes in the tritium flux. Table 4-18 is a comparison of tritium activities in May 1993 and in December 1994. Locations are listed by site ID. Sample AAA9346 was collected somewhat up drainage from the original site ID 33-1032 because the marking stake had been removed. Estimated distance is within 15 ft of the original location.

TABLE 4-18

COMPARISON OF TRITIUM ACTIVITIES IN MAY 1993 AND DECEMBER 1994

LOCATION	TRITIUM, MAY 1993 (pCi/g)	TRITIUM, DEC. 1994 (pCi/g)
Outfall (AAA1941, AAA2185, AAA9345)	5 449 and 1 457	135
30 ft below outfall (AAA1942, AAA9346 [a])	11 946	186
100 ft below outfall (AAA1943, AAA9363)	142	31

[a] Within 15 ft up drainage of AAA1942, which was obliterated by subsequent site activities.

4.4.3.2 Data Interpretation

Table 4-19 is a comparison of the parameters used to calculate the soil activities given in Table 4-18. The table lists the analyzed activity of tritium in soil moisture (pCi/ml), the moisture fraction used to calculate the soil tritium activity, and the calculated tritium activity in soil (pCi/g). Sampling locations are identified by site ID. Site ID 33-1031 is at the outfall, site ID 33-1032 is approximately 30 ft below the outfall, and site ID 33-1033 is approximately 100 ft below the outfall. Of interest in this table is the similar moisture fractions at each site ID, indicating that lower tritium activity in soil is due to natural dilution rather than fluctuations in soil moisture. Radioactive decay is a small factor in the lower tritium activity in this short time frame.

Inspection of all analytical results for SWMU 33-002(d) indicates that tritium is the only contaminant detected. Tritium activities from SWMU 33-002(d) were used in the surface risk assessment analysis for all of MDA K discussed in Subsection 4.1.3.3 of this report. Subsequent sampling and analysis at three locations within the SWMU indicate a substantial reduction in tritium activities over the course of 1.5 years.

4.4.3.3 Risk Assessment

No risk assessment was performed specifically for SWMU 33-002(d). The highest tritium value (11 946 pCi/g) from SWMU 33-002(d) samples was used as input in the MDA K risk assessment, Subsection 4.1.3.3 of this report.

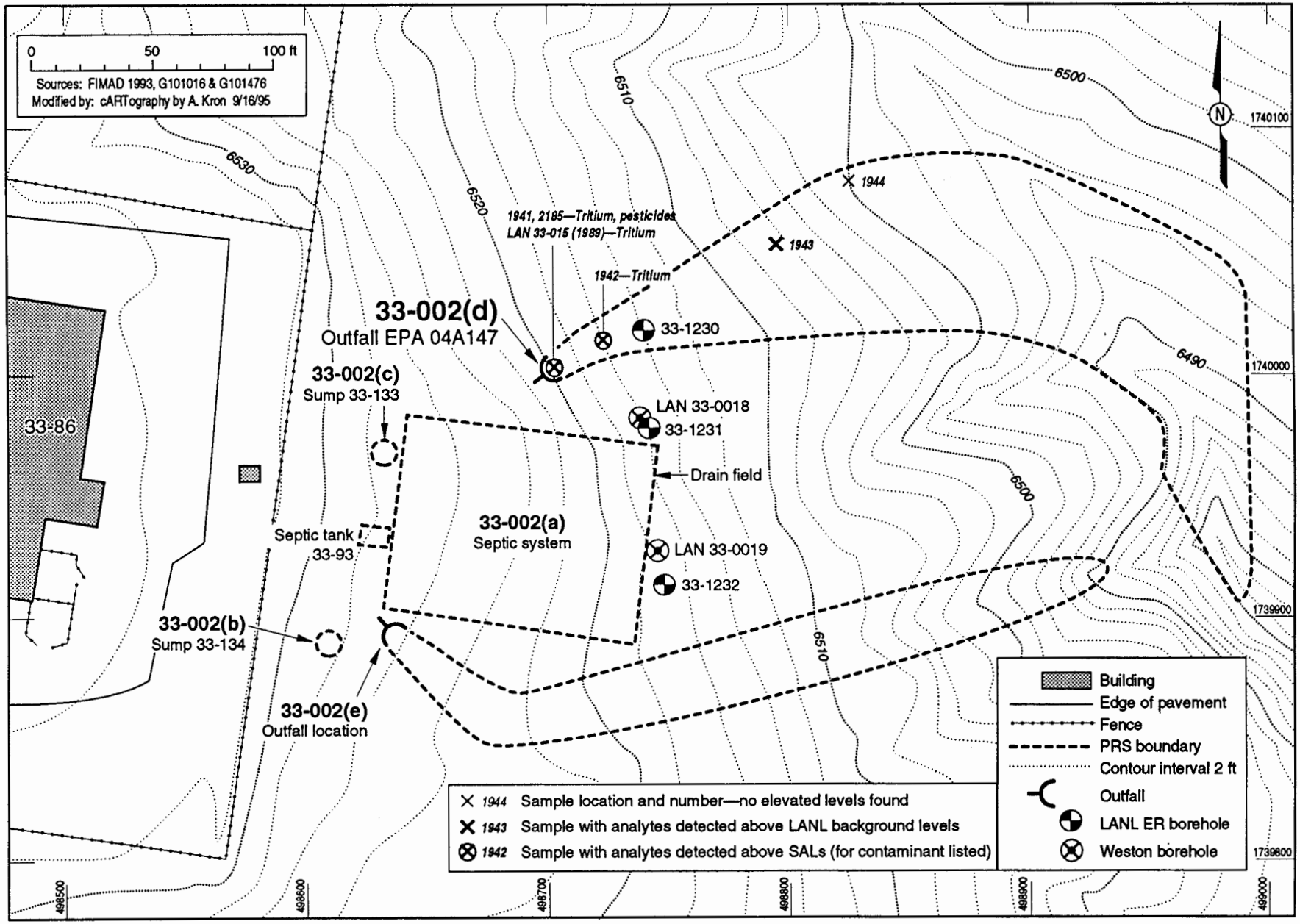

Fig. 4-11. SWMU 33-002(d) cooling water outfall.

TABLE 4-19

COMPARISON OF TRITIUM PARAMETERS IN MAY 1993 AND DECEMBER 1994

SITE ID	SAMPLE ID	DATE	TRITIUM (pCi/mL)	WATER (fraction)	TRITIUM (pCi/g)
33-1031	AAA1941	1993	29 259	0.157	5 449
33-1031	AAA2185	1993	8 129	0.152	1 457
33-1031	AAA9345	1994	557	0.195	135
33-1032	AAA1942	1993	18 400	0.394	11 946
33-1032	AAA9346[a]	1994	461	0.288	186
33-1033	AAA1943	1993	538	0.209	142
33-1033	AAA9363	1994	77	0.284	31

[a] Within 15 ft up drainage of AAA1942, which was obliterated by subsequent site activities.

4.4.3.4 Ecotoxicological Screening Assessment

Ecotoxicological assessment at MDA K is addressed in Subsection 4.1.3.4.

4.4.4 Conclusion and Recommendation

The multiple constituent analysis indicates that no inorganic hazards are present at this location. No action is proposed for pesticides because concentration is very slightly above SAL in only one sample. Tritium results from sampling locations in SWMU 33-002(d) were included in the MDA K-wide tritium risk assessments presented in Subsection 4.1.3.2 of this report. Results of those assessments and mitigation recommended for disposition of MDA K indicate that SWMU 33-002(d) presents no hazard to public health and the environment and is recommended for NFA under ER Criterion 4: the PRS has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants of concern are either not present or are present in concentrations that would pose an acceptable level of risk under the projected future land use (Environmental Restoration Project 1995, 1173). The SWMU will be included in the MDA K posting for radioactivity in accordance with the LANL RADCON manual (LANL 1994, 1235).

4.5 SWMU 33-002(e) TA-33-86 Roof Drain

SWMU 33-002(e) is the outfall of a roof drain from TA-33-86. It is discussed in the RFI Work Plan for OU 1122, Subsections 3.2.2.1, 4.1.4, and 4.2.3.1(LANL 1992,0784). It is proposed for NFA based on sampling data collected in May and June 1993. SVOCs shedding from the asphalt roof were detected at the outfall. It is determined that the roof is not a waste management area and the SVOCs are not a waste stream. The SWMU is recommended for NFA based on LANL ER Criterion 1: the PRS has never been used for the management of hazardous waste (LANL Environmental Restoration Project 1995, 1173).

SWMU 33-002(e) roof drain discharges east of the building near the septic tank and sump TA-33-134. This 12-in. drain line is approximately 90 ft long and is active during rainstorms and snowmelt. The roof of the tritium facility is flat and covered with asphalt. The roof receives regular maintenance and reroofing.

At the outfall opening is a concrete structure approximately 3 ft square with a concrete apron. A shallow, almost imperceptible, drainage leads from the box toward the lower (eastern) end of MDA K. Soils are shallow. Immediately below the outfall pipe the soil is rocky and brown in color and contains organic matter. The soil changes to dark and rocky with light-colored tuff pebbles down drainage. Runoff from the drainage enters one of the gullies leading to the Chaquehui Canyon tributary approximately 250 ft east of the outfall.

4.5.1 Previous Investigations

In 1989 Weston personnel collected one surface sample at the roof drain outfall. Analyses included VOCs, SVOCs, inorganics, pesticides, PCBs, gamma emitters, uranium, and high explosives. Four VOCs and 12 SVOCs, primarily polycyclic aromatic hydrocarbons (PAHs), were detected. No inorganics or radionuclides other than tritium were detected above LANL and TA-33 background UTLs. Tritium activity was 32.6 pCi/g.

4.5.2 Field Investigation

In 1993 five surface samples were collected to assess tritium contamination and to verify the Weston results. Locations included a sample and two duplicates at the outfall, one sample in the shallow drainage approximately 30 ft east of the outfall, and one sample approximately 300 ft below the outfall in a drainage leading to the Chaquehui tributary. All samples were analyzed for tritium and SVOCs.

4.5.2.1 Results of Field Surveys

All sampling points were surveyed. No other field surveys were associated with SWMU 33-002(e).

4.5.2.2 Results of Field Screening

No radiation was detected during routine field screening of sampling locations at SWMU 33-002(e).

4.5.3 Screening Assessment

4.5.3.1 Comparison to Background/SALs

Tritium results were only slightly above the TA-33 background UTL. Analyses were performed for a total of 390 organic compounds. SVOCs were detected in the three outfall samples and in the Weston sample. PAHs were detected above SAL in three of these samples. Organic analytes detected in the samples are listed in Table 4-20. Sampling points are shown in Fig. 4-12.

4.5.3.2 Data Interpretation

Inspection of all analytical results for SWMU 33-002(e) indicates that PAHs are confined to the area at the outfall.

4.5.3.3 Risk Assessment

No risk assessment was performed specifically for SWMU 33-002(e). Tritium results from SWMU 33-002(e) samples were considered in the MDA K risk assessment, Subsection 4.1.3.3 of this report.

4.5.3.4 Ecotoxicological Screening Assessment

Ecotoxicological assessment for tritium at MDA K is addressed in Subsection 4.1.3.4 of this report. No ecotoxicological assessment was performed for PAHs.

TABLE 4-20

ORGANIC ANALYTES DETECTED IN SURFACE SAMPLES AT SWMU 33-002(e)

VOCs and SVOCs	SAMPLE ID	CONCENTRATION (mg/kg)	EQL[a] (mg/kg)	SAL[b] (mg/kg)	DEPTH (in.)	MEDIUM
Acenaphthene	AAA1945	1.6	NL[c]	4 800	0-6	Soil
Acenaphthene	AAA2215	1	NL	4 800	0-6	Soil
Anthracene	AAA1945	2	0.33	24 000	0-6	Soil
Anthracene	AAA2214	0.55	0.33	24 000	0-6	Soil
Anthracene	AAA2215	1.4	0.33	24 000	0-6	Soil
Benzo[a]anthracene	AAA1945	4.3	0.33	0.64	0-6	Soil
Benzo[a]anthracene	AAA2214	1.5	0.33	0.64	0-6	Soil
Benzo[a]anthracene	AAA2215	2.9	0.33	0.64	0-6	Soil
Benzo[a]pyrene	AAA1945	3.9	0.33	0.1	0-6	Soil
Benzo[a]pyrene	AAA2214	1.8	0.33	0.10	0-6	Soil
Benzo[a]pyrene	AAA2215	3.1	0.33	0.10	0-6	Soil
Benzo[b]fluoranthene	AAA1945	4.3	0.33	0.7	0-6	Soil
Benzo[b]fluoranthene	AAA2214	1.8	0.33	0.70	0-6	Soil
Benzo[b]fluoranthene	AAA2215	3.2	0.33	0.70	0-6	Soil
Benzo[g,h,i]perylene	AAA1945	2.5	0.33	44	0-6	Soil
Benzo[g,h,i]perylene	AAA2214	0.73	0.33	44	0-6	Soil
Benzo[g,h,i]perylene	AAA2215	1.3	0.33	44	0-6	Soil
Benzo[k]fluoranthene	AAA1945	4.2	0.33	1.5	0-6	Soil
Benzo[k]fluoranthene	AAA2214	3.2	0.33	1.5	0-6	Soil
Benzo[k]fluoranthene	AAA2215	3.6	0.33	1.50	0-6	Soil
Chrysene	AAA1945	4.3	0.33	96	0-6	Soil
Chrysene	AAA2214	1.9	0.33	96	0-6	Soil
Chrysene	AAA2215	3.4	0.33	22.00	0-6	Soil
Dibenzofuran	AAA1945	1.0	0.33	NC[d]	0-6	Soil
Dibenzofuran	AAA2215	0.54	0.33	NC	0-6	Soil
Dibenzo[a,h]anthracene	AAA1945	1.0	0.33	NC	0-6	Soil
Dibenzo[a,h]anthracene	AAA2215	0.4	0.33	NC	0-6	Soil
Fluoranthene	AAA1945	10.1	0.33	3 200	0-6	Soil
Fluoranthene	AAA2214	3.3	0.33	3 200	0-6	Soil
Fluoranthene	AAA2215	5.8	0.33	3 200	0-6	Soil
Fluorene	AAA1945	1.8	0.33	3 200	0-6	Soil
Fluorene	AAA2215	0.95	0.33	3 200	0-6	Soil
Indeno[1,2,3-cd]pyrene	AAA1945	3.0	0.33	0.41	0-6	Soil
Indeno[1,2,3-cd]pyrene	AAA2214	0.71	0.33	0.41	0-6	Soil
Indeno[1,2,3-cd]pyrene	AAA2215	1.3	0.33	0.41	0-6	Soil
Methylnaphthalene [2-]	AAA1945	0.8	0.33	0.10	0-6	Soil
Naphthalene	AAA1945	1.9	0.33	3 200	0-6	Soil
Naphthalene	AAA2215	0.75	0.33	3 200	0-6	Soil
Phenanthrene	AAA1945	9.8	0.33	0.10	0-6	Soil
Phenanthrene	AAA2214	2.6	0.33	0.10	0-6	Soil
Phenanthrene	AAA2215	5.3	0.33	0.10	0-6	Soil
Pyrene	AAA1945	10	0.33	2 400	0-6	Soil
Pyrene	AAA2214	4.1	0.33	2 400	0-6	Soil
Pyrene	AAA2215	7.1	0.33	2 400	0-6	Soil

[a] EQL = Estimated quantitation limit.
[b] SAL = Screening action level.
[c] NL = Not listed.
[d] NC = Not calculated.

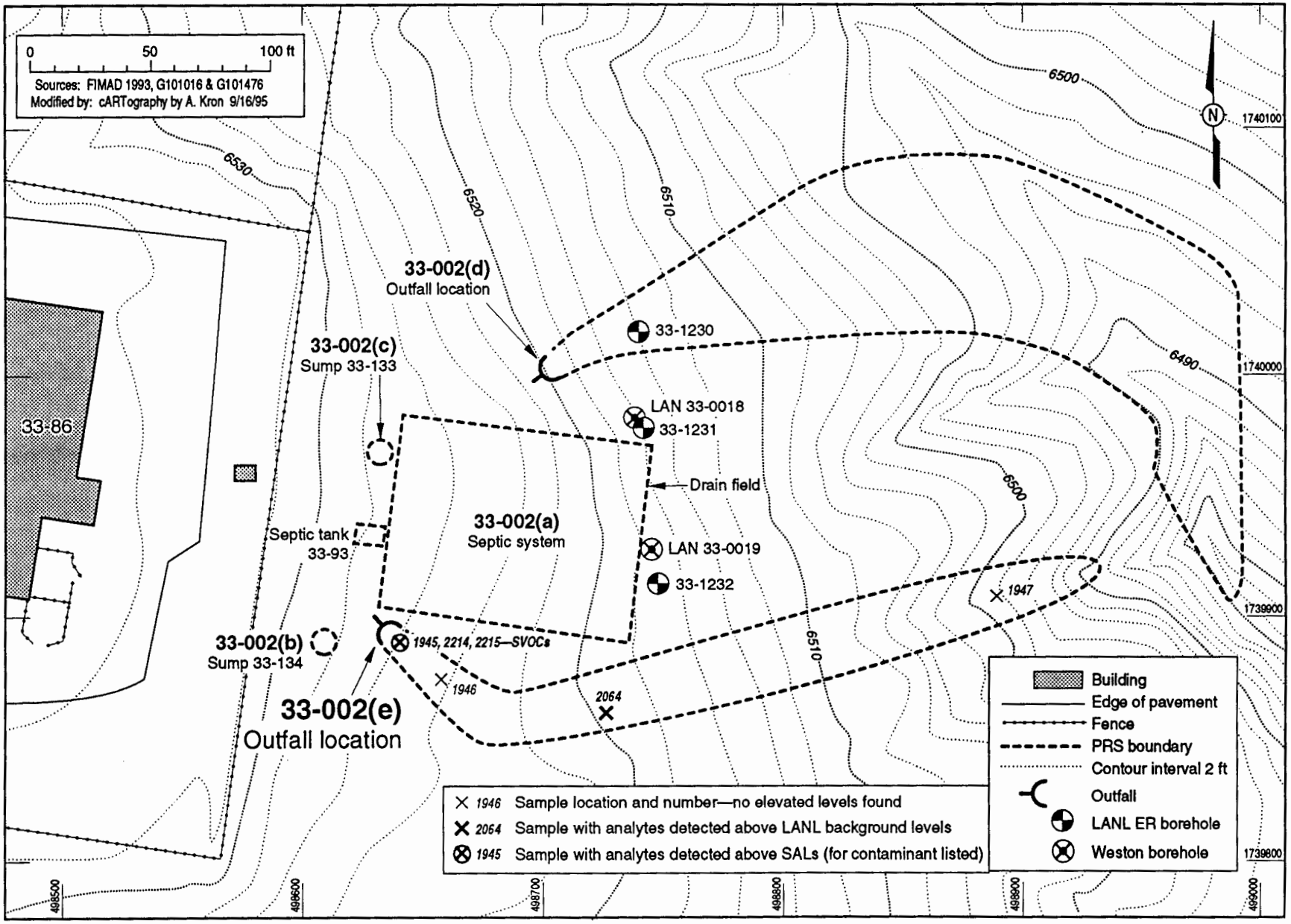

Fig. 4-12. SWMU 33-002(e) roof drain outfall.

4.5.4 Conclusion and Recommendation

The roof drain was designated a SWMU because it was expected to contain tritium (LANL 1990, 0145). SVOC analyses were performed to verify the Weston results. The detected SVOCs are PAHs derived from the asphalt roof covering. Because the roof is not waste and will keep shedding PAHs, it is deemed inappropriate to propose remediation under the ER Project. Therefore, SWMU 33-002(e) is recommended for NFA under the first LANL ER criterion: the PRS has never been used for management (i.e., generation, treatment, storage, or disposal) of RCRA solid or hazardous waste and/or constituents, radionuclides, or other CERCLA hazardous substances.

5.0 REFERENCES

Ahlquist, A. J., November 1, 1983. "Conversations with Harlow Russ Regarding TA-33, 10/27/83," Los Alamos National Laboratory Memorandum to HSE-8 file from A. J. Ahlquist (HSE-8), Los Alamos, New Mexico. **(Ahlquist 1983, 02-006)**

DOE (US Department of Energy), 1990. "RESRAD User's Manual." **(DOE 1990, 0277)**

Dorries, A., October 16, 1992. Personal communication (FAX transmittal) to S. Y. Chen, Argonne National Laboratory, pertaining to LANL-specific RESRAD parameters, Los Alamos National Laboratory, Los Alamos, New Mexico. **(Dorries 1992, 1066)**

Environmental Restoration Project, January 1995. "RFI Report for TA-33," Los Alamos National Laboratory Report LA-UR-95-882, Los Alamos, New Mexico. **(Environmental Restoration Project 1995, 1212)**

Environmental Restoration Project, March 1995. "Los Alamos National Laboratory Environmental Restoration Project - No Further Action (NFA) Criteria, ER Project Policy Paper EM/ER:95-PCT-015," Los Alamos National Laboratory, Los Alamos, New Mexico. **(Environmental Restoration Project 1995, 1173)**

EPA (US Environmental Protection Agency), April 10, 1990. Module VIII of RCRA Permit No. NM0890010515, EPA Region 6, issued to Los Alamos National Laboratory, Los Alamos, New Mexico, effective May 23, 1990, EPA Region 6, Hazardous Waste Management Division, Dallas, Texas. **(EPA 1990, 0306)**

EPA (US Environmental Protection Agency), February 1992. "Framework for Ecological Risk Assessment," EPA/630/R-92/001, Risk Assessment Forum, US Environmental Protection Agency, Washington, DC. **(EPA 1992, 0989)**

EPA (US Environmental Protection Agency), July 15, 1993. "RFI Work Plan for OU 1122, Approval," letter to Joseph Vozella, DOE Los Alamos Area Office, from Jack Divits for Allyn Davis, EPA, Dallas, TX. **(EPA 1993, 02-090)**

ICF Kaiser, February 17, 1994. "Summary of 1993 Survey and Sampling Activities at TA-33 (Main Site and Area 6)," ICF Kaiser Engineers, Inc., Contract 9-XS2-X5348-1, Los Alamos, New Mexico. **(ICF Kaiser 1994, 02-095)**

International Atomic Energy Agency 1992. "Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards." Technical Report # 332. Vienna. **(International Atomic Energy Agency 1992, 0983)**

LANL (Los Alamos National Laboratory), November 1990. "Solid Waste Management Units Report," Volumes I through IV, Los Alamos National Laboratory Report No. LA-UR-90-3400, prepared by International Technology Corporation under Contract 9-XS8-0062R-1, Los Alamos, New Mexico. **(LANL 1990, 0145)**

LANL (Los Alamos National Laboratory), May 1991. "Generic Quality Assurance Project Plan for RCRA Facility Investigations for the Los Alamos National Laboratory Environmental Restoration Program," Rev. 0, Los Alamos National Laboratory Report, Los Alamos, New Mexico. **(LANL 1991, 0412)**

LANL (Los Alamos National Laboratory), May 1992. RFI Work Plan for Operable Unit 1122, LA-UR-92-925. Los Alamos National Laboratory, Los Alamos, New Mexico. **(LANL 1992, 0784)**

LANL (Los Alamos National Laboratory), January 1993. "Los Alamos National Laboratory Environmental Restoration Program Standard Operating Procedures," Los Alamos National Laboratory Report, Los Alamos, New Mexico. **(LANL 1993, 0875)**

LANL (Los Alamos National Laboratory), November 1993. "Installation Work Plan for Environmental Restoration," Los Alamos National Laboratory Report LA-UR-93-3987, Los Alamos, New Mexico. **(LANL 1993, 1017)**

LANL (Los Alamos National Laboratory), 1994. *Radiation Control Manual*, Los Alamos National Laboratory, Los Alamos, New Mexico. **(LANL 1994, 1235)**

LANL (Los Alamos National Laboratory), June 16, 1994. "Environmental Restoration Program Operable Unit (OU) 1122 Cultural Resources Survey Report," Survey No. 518, Environmental Protection Group (ESH-8), Los Alamos National Laboratory, Los Alamos, New Mexico. **(LANL 1994, 02-103)**

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

Martin, B., August 29, 1995. "Anomalous Tritium in Chaquehui Canyon," Los Alamos National Laboratory Memorandum CST-18:WBM-95-19 to Allyn Pratt (ER/EM-5) from Brad Martin (CST-18) Los Alamos, New Mexico. **(Martin 1995, 02-104)**

Nyhan, J. W., L. W. Hacker, T. E. Calhoun, and D. L. Young, June 1978. "Soil Survey of Los Alamos County, New Mexico," Los Alamos Scientific Laboratory Report LA-6779-MS, Los Alamos, New Mexico. **(Nyhan et al. 1978, 0161)**

Reneau, S. L., D.P. Dethier, J. S. Carney, June 13, 1995. "Landslides and Other Mass Movements Near Technical Area 33," Los Alamos National Laboratory Report LA-12955-MS, Los Alamos, New Mexico. **(Reneau etal. 1995, 02-092)**

Stimac, J, April 26, 1995. "Logs of TA-33 Boreholes," Los Alamos National Laboratory Memorandum EES-1 to Jake Turin (EES-5) from Jim Stimac (EES-1) Los Alamos, New Mexico. **(Stimac 1995, 02-102)**

THIS PAGE LEFT INTENTIONALLY BLANK

APPENDIX A RAW DATA

Raw data are available from the EnvironmentalRestoration Project's Facility for Information Management, Analysis, and Display (FIMAD). If FIMAD is not accessible, data will be provided upon request.

THIS PAGE LEFT INTENTIONALLY BLANK

APPENDIX B PHASE II SAMPLING AND ANALYSIS PLANS FOR PRSS 33-002(a,b,c)

1.0 FURTHER INVESTIGATIONS OF SWMU 33-002(A) MDA K SEPTIC SYSTEM AND BOREHOLES

1.1 Phase II Sampling Objectives

Phase I data identified the contaminants but did not bound the vertical extent of contamination in the Solid Waste Management Unit (SWMU) 33-002(a) septic tank and drain field. Because the borehole adjacent to the septic tank terminated at soil/tuff interface at a depth of 4 ft, no sample was taken below the bottom of the tank. The source of the tritium plume identified in borehole 33-1231 was not established. The most likely source of the tritium plume is the septic tank.

The objectives of Phase II sampling are:

1) Trace the location of the geophysical anomaly that contains the tritium-contaminated deep borehole.

2) Determine the highest tritium activity in a new borehole located by geophysics between the septic tank and tritium-contaminated borehole 33-1231.

3) Determine whether contaminants other than tritium are located at depths greater than 4 ft in a new borehole near the septic tank.

The tritium-contaminated deep borehole was located using geophysical methods, particularly resistivity methods, in both the Weston study and the Environmental Restoration (ER) 1993 investigations. The resistivity method will be used to trace the westward extent of the geophysical anomaly containing the high-tritium borehole. Sampling in the new borehole will determine levels of tritium closer to the likely source (the septic tank) than the tritium-contaminated borehole. Rapid-turnaround tritium analyses will determine the depth of maximum tritium concentration and the depth to which tritium is at levels above Screening Action Levels (SALs). Fixed-laboratory analyses will determine levels of other subsurface contaminants. All samples will be analyzed for tritium in the mobile radiological laboratory; at least one in three of these samples will be sent for confirmatory fixed-laboratory analysis. All samples from depths less than 15 ft will be analyzed in the laboratory for tritium, radionuclides, Volatile organic Compounds (VOCs), Semivolatile organic compounds (SVOCs), and inorganics.

The data collected in Phase II sampling will be used to:

1) Establish the source of the tritium plume.

2) Refine the preliminary RESRAD calculations for tritium presented in this report.

3) Further investigate the existence of other contamination at SWMU 33-002(a).

4) Perform a risk assessment for any additional contaminants.

Results of these risk assessments will be used to determine the nature of further actions at Material Disposal Area (MDA) K. Further actions, in addition to the hydrologic controls recommended in this report, would include:

1) Wait for tritium to decay in place if risks to current receptors are below Department of Energy (DOE) mandated dose levels.

2) Fence the SWMU and allow tritium to decay if doses to current receptors are above DOE-mandated doses.

3) Excavate contaminated soil from shallow portions of SWMU 33-002(a) if calculated exposures due to contaminants other than tritium fail a risk assessment using an appropriate scenario.

1.2 Sampling and Analysis

All samples will be field screened for radioactivity and organic vapors to identify gross concentrations of contaminants. Appropriate health and safety precautions will be undertaken according to the most current revisions of Los Alamos National Laboratory (LANL) ER Program Health and Safety Plans (SOPs) (LANL 1993, 0875).

A resistivity survey of the region between the high-tritium borehole and the septic tank will be completed. The geophysical anomaly will be traced west from the high-tritium borehole. Results of the resistivity survey will be used to site the proposed deep borehole within SWMU 33-002(a). A map of the region, showing the location of the previous resistivity survey and the anomaly, is shown in Fig. B-1. The deep borehole will be located within the geophysical anomaly and between the septic tank and the east end of the drain field. If the geophysical anomaly extends to within 10 ft of the tank, the borehole will be drilled at that location. If the geophysical anomaly does not extend to the septic tank, a second borehole will be drilled within 10 ft of the septic tank. New borehole locations are shown in Fig. B-1.

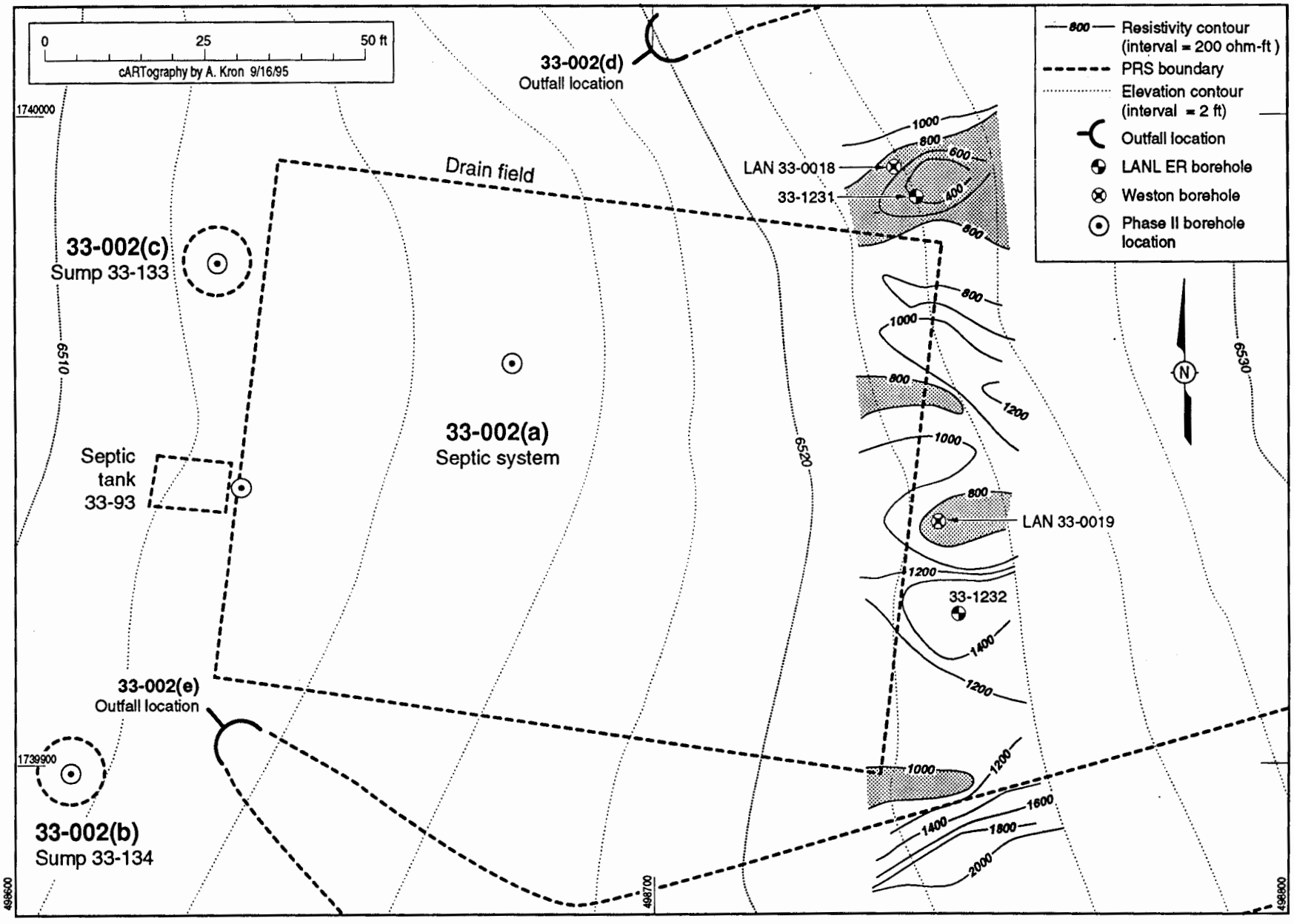

Fig. B-1. Results of resistivity survey and Phase II borehole locations at MDA K.

Sampling Techniques The boreholes will be drilled using a hollow stem auger drill rig. All shallow borehole drilling activities will conform to LANL-ER-SOP-04.01, Drilling Methods and Drill Site Management. Samples will be collected from the borehole using a stainless steel split-spoon sampler according to LANL-ER-SOP-06.24, Sample Collection from Split Spoon and Shelby Tube Samplers.

Sampling Summary For both boreholes, core will be continuously screened for radionuclides and for organic vapors immediately after opening the split spoon. VOC and tritium samples will be taken immediately upon opening the core barrel. Laboratory samples will be taken every 5 ft to a minimum depth of 15 ft. The first five-foot sample will be taken at the soil/tuff interface, if that interface can be easily located. Any core interval within this depth range that is anomalous (two times background or more) based on the radiological or organic screening, may also be sent for laboratory analysis. The borehole adjacent to the septic tank will terminate at 15 ft provided tritium contamination is bounded.

Starting at a depth of 15 ft, sample splits at each 5-ft interval will be sent to the mobile radiological laboratory for tritium analysis. This deep borehole sampling will extend to a minimum depth of 100 ft, the depth of the peak tritium value in the tritium-contaminated borehole. Sampling will continue beyond 100 ft until three consecutive sample analyses exhibit activities below tritium SALs based on the mobile radiological laboratory results. Every third interval (15 ft spacing) between 15 ft and the bottom of the core hole will be sent for laboratory analysis of tritium. In addition, the three samples in the core exhibiting the highest tritium levels and the three deepest samples will be sent for laboratory analysis of tritium. At a maximum, the sampling will continue to the depth attainable with the hollow-stem auger drill rig.

Laboratory Analysis All laboratory analytical samples will be analyzed for tritium. Samples from depths less than 15 ft will be analyzed for radionuclides (including plutonium), VOCs, SVOCs, and inorganics. Anomalous samples (two times background or more) from depths greater than 15 ft will also be analyzed for radionuclides and/or VOCs. Quality assurance samples will be selected at a rate consistent with current LANL/ER guidance.

2.0 FURTHER INVESTIGATION OF SWMU 33-002(B) SUMP 33-134

2.1 Phase II Sampling Objectives

The existing Phase I sampling data did not bound the vertical extent of contamination in SWMU 33-002(b). The deepest sample taken in sump TA-33-134 at a depth of five feet exhibited the highest tritium value, and this high-activity value is a mobile radiological laboratory result of unknown quality. The location representing the highest level of tritium contamination may not have been located.

The objectives of the Phase II sampling are to:

1) Determine the highest tritium concentration within or beneath the sump.

2) Confirm the high tritium activity obtained using the mobile radiological laboratory.

3) Define the vertical extent of contamination at this SWMU.

4) Determine whether contaminants other than tritium are located in or beneath the sump.

Investigations during the 1995 field campaign have demonstrated the utility of ground-penetrating radar (GPR) for locating buried vitrified clay pipe. GPR will be used to locate the inlet pipe to the sump and hence to verify the sump's location. Rapid-turnaround tritium analyses will be used to determine the depth of maximum tritium concentration in or beneath the sump and the depth at which tritium exceeds SAL. Laboratory analyses will be used to determine levels of other subsurface contaminants and levels of tritium in the zone of maximum tritium concentration. All samples will be analyzed for tritium in the mobile radiological van; at least one in three of these samples will be sent for confirmatory laboratory analysis. All samples from depths less than 15 ft will be analyzed in the laboratory for tritium, radionuclides, VOCs, SVOCs, and inorganics.

The data collected in Phase II will be used to:

1) Refine the preliminary RESRAD calculations for tritium presented in this report.

2) Confirm or deny the existence of other contaminants at SWMU 33-002(b).

3) Perform a risk assessment for any additional contaminants.

Results of these risk assessments will be used to determine the nature of further actions at this SWMU. Further actions could include:

1) Wait for tritium to decay in place, if risks to current receptors are below DOE-mandated levels.

2) Fence the SWMU and allow tritium to decay, if doses to current receptors are above DOE-mandated doses.

3) Excavate contaminated soil from shallow portions of SWMU 33-002(c), if calculated exposures due to contaminants other than tritium fail a risk assessment using an appropriate scenario.

2.2 Sampling and Analysis at SWMU 33-002(b) Sump TA-33-134

All samples will be field screened for radioactivity and organic vapors to identify gross concentrations of contaminants. Appropriate health and safety precautions will be undertaken according to the current version of the ER Project health and safety plans (LANL 1993, 0875).

A GPR survey of the region west of the sump will be undertaken to locate the vitrified clay pipe that feeds the sump. This survey will cover an area of approximately 5 ft x 30 ft due west of the broken concrete that was assumed to represent the location of the sump during Phase I sampling. Results of the GPR survey will be used to verify the location of the sump and thereby site the proposed drill hole within the sump. If the vitrified clay pipe is not detected by the GPR survey, then the field team will manually probe the area west of the sump until the vitrified clay pipe is located. The pipe will be traced to the sump.

Sampling Techniques The center of the sump will be drilled using a hollow stem auger drill rig. The sampling location is shown in Fig. B-1. All shallow borehole drilling activities will conform to LANL-ER-SOP-04.01, Drilling Methods and Drill Site Management. Samples will be collected from the borehole using a stainless steel split-spoon sampler according to LANL-ER-SOP-06.24, Sample Collection from Split Spoon and Shelby Tube Samplers.

Sampling Summary Core will be continuously screened for radionuclides and screened for organic vapors immediately after opening the split spoon. VOC and tritium samples will be taken immediately upon opening the core barrel. Laboratory samples will be taken at:

1) a depth of 5 ft,

2) a depth of 8 ft or the fill/tuff interface, and

3) a depth of 15 ft.

Any core interval within this depth range that is anomalous (two times background or more) based on the radiological or organic screening may also be sent for laboratory analysis. If the tritium level at 15 ft is above SAL, based on mobile radiological van analysis, then starting at a depth of 15 ft, sample splits at each five ft interval will be sent to the mobile radiological laboratory for tritium analysis. Sampling will continue until three consecutive sample analyses exhibit activities below the tritium SAL based on the mobile radiological laboratory results. At a minimum, every third interval (15 ft spacing) between 15 ft and the bottom of the core hole will be sent for fixed-laboratory analysis for tritium. In addition, the three samples in the core exhibiting the highest tritium levels and the three deepest samples will be sent for laboratory analysis of tritium. Maximum borehole depth will be the maximum depth achievable with the hollow-stem auger drill rig.

Laboratory Analysis All laboratory analytical samples will be analyzed for tritium. Samples from depths less than 15 ft will be analyzed for radionuclides (including plutonium), VOCs, SVOCs, and inorganics. Anomalous samples (two times background or more) from a depth greater than 15 ft will also be analyzed for radionuclides and VOCs. Quality assurance samples will be selected at a rate consistent with current LANL/ER guidance.

3.0 Further Investigations of SWMU 33-002(c) Sump TA-33-133

3.1 Phase II Sampling Objectives

The existing Phase I sampling data may not have bounded the vertical extent of contamination in SWMU 33-002(c), sump TA-33-133. The objectives of the Phase II sampling are to:

1) Determine the highest tritium concentration within or beneath the sump.

2) Determine whether contaminants other than tritium are located at depths greater than four feet in the SWMU.

Additional Phase II sampling objectives and uses of data are identical to those described for SWMU 33-002(b) in Section 2.0 of this report.

3.2 Sampling and Analysis for SWMU 33-002(c) Sump TA-33-133

The sampling and analysis plan for SWMU 33-002(c) is identical to that described for SWMU 33-002(b) in Section 2 of this report.

APPENDIX C CALCULATIONS FOR ECOTOXICOLOGICAL SCREENING ASSESSMENT

To calculate the ecotoxicological dose rate to plants and animals, the following equation shows the conversion of soil data to dose rates as

$$D = C_s E_r CF$$

where D is the dose rate (mrad/day), C_s is the soil activity in pCi/g, E_r is the energy of the beta decay of tritium (18 keV/disintegration), and CF is a conversion factor to render D in the appropriate units.

Tables C-1 through C- 5 show the tritium data from TA-33 to a depth of 10 ft, considered a conservative estimate of ecological concern. Table C-1 contains the soil data from the septic system at TA-33-86, SWMU 33-002(a) Table C-2 contains surface soil data from MDA K. Tables C-3, C-4, and C-5 contain the tritium data from core samples taken from the three boreholes drilled at TA-33. The tables include the dose rates calculated with the above equation. Dose rates less than 100 mrad/day are considered by the International Atomic Energy Agency to cause no adverse effects in populations of exposed animals and plants (International Atomic Energy Agency 1992, 0983).

TABLE C-1

SWMU 33-002(A): SEPTIC SYSTEM, TA-33-86

MATRIX	SAMPLE NUMBER	TRITIUM (pCi/g)	DOSE RATE (mrad/day)	COMMENT	DEPTH (ft)
Soil	AAA1917	43.1	0.0132		0-0.5
Soil	AAA1918	6.6	0.00203		3
Soil	AAA1919	8.2	0.00252		4
Soil	AAA1920	5.8	0.00178	Duplicate	3
Soil	AAA1921	212.8	0.0653		0-0.5
Soil	AAA2237	112.0	0.0344		0-0.5
Soil	AAA1922	32.5	0.00997		0-0.5
Soil	AAA2238	66.7	0.0205	Duplicate	0-0.5
Soil	AAA2239	12.4	0.00381	Duplicate	0-0.5
Soil	AAA1923	8.2	0.00252		0-0.5
Soil	AAA1924	37.8	0.0116		5
Soil	AAA1925	11.7	0.00359		10
Soil	AAA1926	8.0	0.00246		0-0.5
Soil	AAA1927	11.8	0.00362		5
Soil	AAA1928	11.4	0.00350		10
Soil SAL		*810*	*0.249*		
Soil conc. for a dose of 100 mrad/day			*320 000 pCi/mg*	*98.2 mrad/day*	

Range: dose rates: minimum = 0.00178 mrad/day; maximum = 0.0653 mrad/day

TABLE C-2

MDA K SUMPS AND OUTFALLS

MATRIX	SAMPLE NUMBER	TRITIUM (pCi/g)	DOSE RATE (mrad/day)	COMMENT	DEPTH (ft)
Soil	AAA1931	539.5	0.166	*Sump 33-134*	0-0.5
Soil	AAA1934	1 728	0.530		3
Soil	AAA3900	610 485	**187**		4
Soil	AAA1937	7.1	0.00218	*Sump 33-133*	0-0.5
Soil	AAA1938	13.67	0.00420		3
Soil	AAA1939	52.5	0.0161	Duplicate	3
Soil	AAA3901	34	0.0104		5
Soil	AAA1941	5 449	1.67	Outfall	0-0.5
Soil	AAA2185	1 457	0.447	Duplicate	0-0.5
Soil	AAA1942	11 963	3.67		0-0.5
Soil	AAA1943	142.1	0.0436		0-0.5
Soil	AAA1944	302.5	0.0928		0-0.5
Soil	AAA1945	17.9	0.00549	*Roof drain*	0-0.5
Soil	AAA2214	5.51	0.00169	Duplicate	0-0.5
Soil	AAA2215	8.17	0.00251	Duplicate	0-0.5
Soil	AAA1946	10.19	0.00313		0-0.5
Soil	AAA1947	2	0.000614		0-0.5
Soil	AAA2064	0.6	0.000184		0-0.5
Soil	AAA2065	13.8	0.00424		0-0.5
Soil	AAA2092	43.6	0.0134		0-0.5
Soil	AAA2093	13.71	0.00421		0-0.5

Range: dose rates: minimum = 0.000184 mrad/day; maximum = 187 mrad/day
Range: dose rates excluding sample AAA3900-minimum = 0.000184 mrad/day; maximum = 3.67 mrad/day

TABLE C-3

MIDDLE (TRITIATED) BOREHOLE 33-1231

MATRIX	SAMPLE NUMBER	TRITIUM (pCi/g)	DOSE RATE (mrad/day)	COMMENT	DEPTH (ft)
Core	AAA3885	86.9	0.0267		0-0.5
Core	AAA3308	101.2	0.0311		10

Range: dose rates: minimum = 0.0267 mrad/day; maximum = 0.0311 mrad/day

TABLE C-4

NORTH (CATTAIL) BOREHOLE 33-1230

MATRIX	SAMPLE NUMBER	TRITIUM (pCi/g)	DOSE RATE (mrad/day)	COMMENT	DEPTH (ft)
Core	AAA3884	1.6	0.000491		0
Core	3884R	1 475	0.453	Duplicate	0
Core	3281	3.8	0.00117		10

Range: dose rates: minimum = 0.000491 mrad/day; maximum = 0.453 mrad/day

TABLE C-5

SOUTH BOREHOLE 33-1232

MATRIX	SAMPLE NUMBER	TRITIUM (pCi/g)	DOSE RATE (mrad/day)	COMMENT	DEPTH (ft)
Core	AAA3886	20	0.00614		0
Core	AAA3896	11.3	0.00347	Duplicate	0
Core	AAA3897	17.3	0.00531	Duplicate	0
Core	AAA3336	359.1	0.110		10

Range: dose rates: minimum = 0.00347 mrad/day; maximum = 0.110 mrad/day

THIS PAGE LEFT INTENTIONALLY BLANK

APPENDIX D RESIDUAL RADIOACTIVE MATERIAL (RESRAD) RISK ASSESSMENT CALCULATIONS

TABLE D-1

TRITIUM SURFACE AND SUBSURFACE CONTAMINATION

THIS PAGE LEFT INTENTIONALLY BLANK

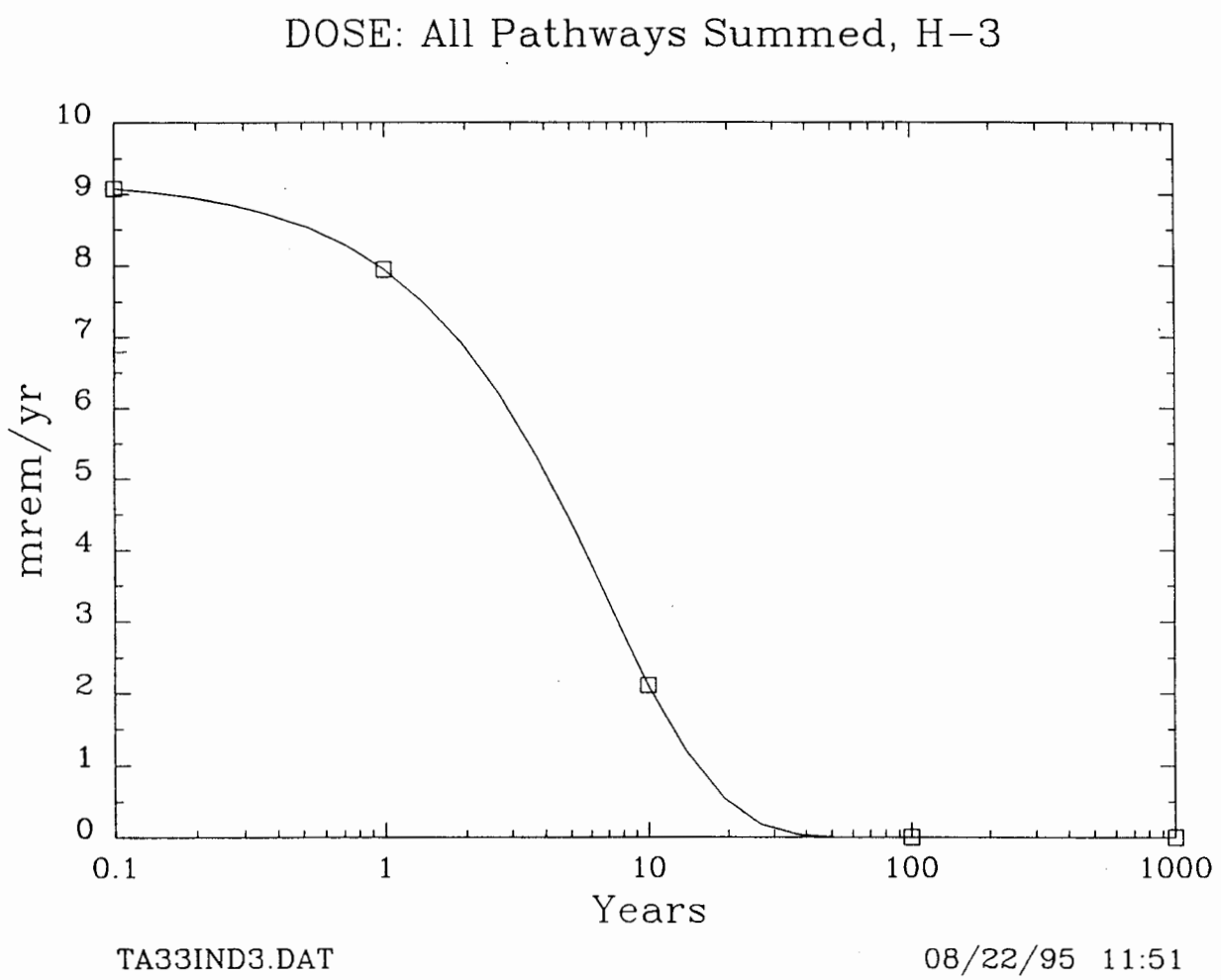
DOSE: All Pathways Summed, H-3
mrem/yr
10
9
8
7
6
5
4
3
2
1
0
0.1
1
10
100
1000
Years
TA33IND3.DAT
08/22/95 11:51

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary ... 2
Site-Specific Parameter Summary 3
Summary of Pathway Selections 6
Contaminated Zone and Total Dose Summary 7
Total Dose Components
Time = 0.000E+00 8
Time = 1.000E-01 9
Time = 1.000E+00 10
Time = 1.000E+01 11
Time = 1.000E+02 12
Time = 1.000E+03 13
Dose/Source Ratios Summed Over All Pathways 14
Single Radionuclide Soil Guidelines 14
Dose Per Nuclide Summed Over All Pathways 15
Soil Concentration Per Nuclide 15

Dose Conversion Factor (and Related) Parameter Summary
File: DOSFAC30.BIN

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	H-3	6.400E-08	6.400E-08	DCF2(1)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	H-3	6.400E-08	6.400E-08	DCF3(1)
D-34	Food transfer factors:			
D-34	H-3 , plant/soil concentration ratio, dimensionless	4.800E+00	4.800E+00	RTF(1,1)
D-34	H-3 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.200E-02	1.200E-02	RTF(1,2)
D-34	H-3 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-02	1.000E-02	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	H-3 , fish	1.000E+00	1.000E+00	BIOFAC(1,1)
D-5	H-3 , crustacea and mollusks	1.000E+00	1.000E+00	BIOFAC(1,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	6.667E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	5.100E+01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E-01	1.000E+00	---	T(2)
R011	Times for calculations (yr)	1.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.000E+02	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+03	1.000E+02	---	T(6)
R011	Times for calculations (yr)	not used	3.000E+02	---	T(7)
R011	Times for calculations (yr)	not used	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): H-3	1.190E+04	0.000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L): H-3	not used	0.000E+00	---	W1(1)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	5.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/cm**3)	8.000E+00	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	6.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	4.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	1.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	5.200E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	Zero shows Simpson's rule.	EPS
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	3.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	3.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.050E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	3.000E-01	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R015	Unsat. zone 2, thickness (m)	not used	0.000E+00	---	H(2)
R015	Unsat. zone 2, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(2)
R015	Unsat. zone 2, total porosity	not used	4.000E-01	---	TPUZ(2)
R015	Unsat. zone 2, effective porosity	not used	2.000E-01	---	EPUZ(2)
R015	Unsat. zone 2, soil-specific b parameter	not used	5.300E+00	---	BUZ(2)
R015	Unsat. zone 2, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(2)
R016	Distribution coefficients for H-3				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	0.000E+00	---	DCNUCU(1,1)
R016	Unsaturated zone 2 (cm**3/g)	not used	0.000E+00	---	DCNUCU(1,2)
R016	Saturated zone (cm**3/g)	not used	0.000E+00	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.632E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	2.000E-04	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	---	LM
R017	Exposure duration	1.000E+00	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	not used	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	1.800E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	5.000E-02	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	not used	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	4.200E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	not used	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	not used	1.000E+00	---	STOR_T(2)
STOR	Milk	not used	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	not used	2.000E+01	---	STOR_T(4)
STOR	Fish	not used	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	not used	7.000E+00	---	STOR_T(6)
STOR	Well water	not used	1.000E+00	---	STOR_T(7)
STOR	Surface water	not used	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	not used	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	not used	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	suppressed
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed

Contaminated Zone Dimensions	
Area:	6667.00 square meters
Thickness:	51.00 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g	
H-3	1.190E+04

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E-01	1.000E+00	1.000E+01	1.000E+02	1.000E+03
TDOSE(t):	9.210E+00	9.075E+00	7.950E+00	2.115E+00	3.719E-06	0.000E+00
M(t):	3.070E-01	3.025E-01	2.650E-01	7.050E-02	1.240E-07	0.000E+00

Maximum TDOSE(t): 9.210E+00 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	9.203E+00	0.9992	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.357E-03	0.0008
Total	0.000E+00	0.0000	9.203E+00	0.9992	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.357E-03	0.0008

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.210E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.210E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E-01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	frac
H-3	0.000E+00	0.0000	9.068E+00	0.9992	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.250E-03	0.00
Total	0.000E+00	0.0000	9.068E+00	0.9992	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.250E-03	0.00

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E-01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	frac
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.075E+00	1.00
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.075E+00	1.00

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
H-3	0.000E+00	0.0000	7.944E+00	0.9992	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.351E-03	0.000
Total	0.000E+00	0.0000	7.944E+00	0.9992	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.351E-03	0.000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.950E+00	1.000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.950E+00	1.000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fra
H-3	0.000E+00	0.0000	2.113E+00	0.9992	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.689E-03	0.0
Total	0.000E+00	0.0000	2.113E+00	0.9992	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.689E-03	0.0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	frac
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.115E+00	1.00
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.115E+00	1.00

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	3.716E-06	0.9992	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.971E-09	0.0008
Total	0.000E+00	0.0000	3.716E-06	0.9992	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.971E-09	0.0008

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.719E-06	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.719E-06	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	frac
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.00
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.00

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.00
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E-01	1.000E+00	1.000E+01	1.000E+02	1.000E+03
H-3	H-3	1.000E+00	7.739E-04	7.626E-04	6.681E-04	1.777E-04	3.125E-10	0.000E+00

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 30 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 30 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E-01	1.000E+00	1.000E+01	1.000E+02	1.000E+03
H-3	3.876E+04	3.934E+04	4.491E+04	1.688E+05	9.600E+10	*9.610E+15

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
H-3	1.190E+04	0.000E+00	7.739E-04	3.876E+04	7.739E-04	3.876E+04

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E-01	1.000E+00	1.000E+01	1.000E+02	1.000E+03
H-3	H-3	1.000E+00	9.210E+00	9.075E+00	7.950E+00	2.115E+00	3.719E-06	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E-01	1.000E+00	1.000E+01	1.000E+02	1.000E+03
H-3	H-3	1.000E+00	1.190E+04	1.173E+04	1.027E+04	2.733E+03	4.805E-03	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

TABLE D-2

TRITIUM IN SUMP TA-33-134, 3 METER DEPTH

THIS PAGE LEFT INTENTIONALLY BLANK

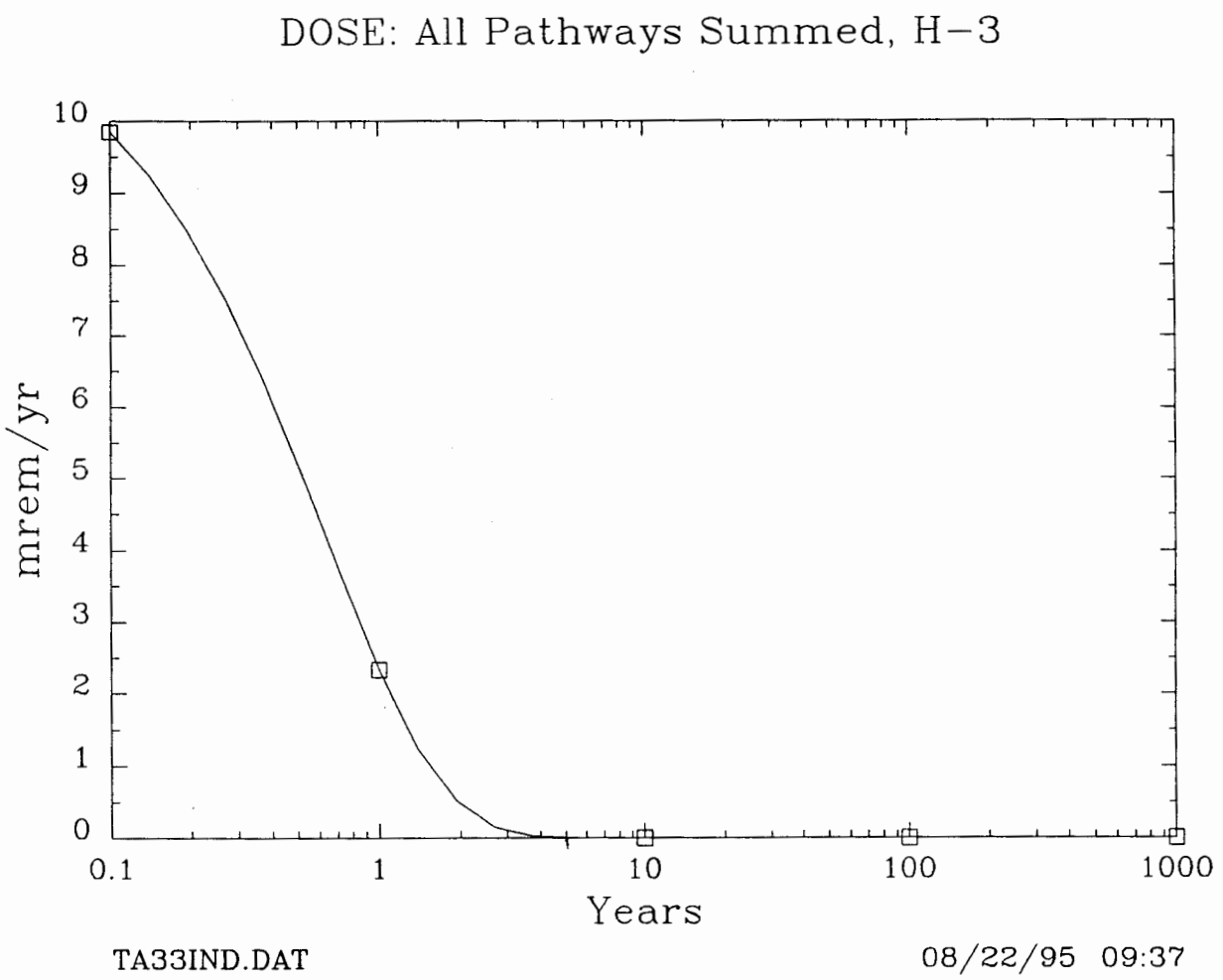
DOSE: All Pathways Summed, H-3
mrem/yr
10
9
8
7
6
5
4
3
2
1
0
0.1
1
10
100
1000
Years
TA33IND.DAT
08/22/95 09:37

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary ... 2
Site-Specific Parameter Summary 3
Summary of Pathway Selections 6
Contaminated Zone and Total Dose Summary 7
Total Dose Components
Time = 0.000E+00 8
Time = 1.000E-01 9
Time = 1.000E+00 10
Time = 1.000E+01 11
Time = 1.000E+02 12
Time = 1.000E+03 13
Dose/Source Ratios Summed Over All Pathways 14
Single Radionuclide Soil Guidelines 14
Dose Per Nuclide Summed Over All Pathways 15
Soil Concentration Per Nuclide 15

Dose Conversion Factor (and Related) Parameter Summary
File: DOSFAC30.BIN

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	H-3	6.400E-08	6.400E-08	DCF2(1)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	H-3	6.400E-08	6.400E-08	DCF3(1)
D-34	Food transfer factors:			
D-34	H-3 , plant/soil concentration ratio, dimensionless	4.800E+00	4.800E+00	RTF(1,1)
D-34	H-3 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.200E-02	1.200E-02	RTF(1,2)
D-34	H-3 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-02	1.000E-02	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	H-3 , fish	1.000E+00	1.000E+00	BIOFAC(1,1)
D-5	H-3 , crustacea and mollusks	1.000E+00	1.000E+00	BIOFAC(1,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	4.000E+00	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	3.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E-01	1.000E+00	---	T(2)
R011	Times for calculations (yr)	1.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.000E+02	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+03	1.000E+02	---	T(6)
R011	Times for calculations (yr)	not used	3.000E+02	---	T(7)
R011	Times for calculations (yr)	not used	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): H-3	6.100E+05	0.000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L): H-3	not used	0.000E+00	---	W1(1)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	5.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/cm**3)	8.000E+00	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	6.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	4.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	1.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	5.200E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	Zero shows Simpson's rule.	EPS
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	3.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	3.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.050E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	3.000E-01	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R015	Unsat. zone 2, thickness (m)	not used	0.000E+00	---	H(2)
R015	Unsat. zone 2, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(2)
R015	Unsat. zone 2, total porosity	not used	4.000E-01	---	TPUZ(2)
R015	Unsat. zone 2, effective porosity	not used	2.000E-01	---	EPUZ(2)
R015	Unsat. zone 2, soil-specific b parameter	not used	5.300E+00	---	BUZ(2)
R015	Unsat. zone 2, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(2)
R016	Distribution coefficients for H-3				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	0.000E+00	---	DCNUCU(1,1)
R016	Unsaturated zone 2 (cm**3/g)	not used	0.000E+00	---	DCNUCU(1,2)
R016	Saturated zone (cm**3/g)	not used	0.000E+00	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.175E-01	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	2.000E-04	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	---	LM
R017	Exposure duration	1.000E+00	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	not used	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	1.800E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	5.000E-02	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	not used	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	4.200E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	not used	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	not used	1.000E+00	---	STOR_T(2)
STOR	Milk	not used	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	not used	2.000E+01	---	STOR_T(4)
STOR	Fish	not used	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	not used	7.000E+00	---	STOR_T(6)
STOR	Well water	not used	1.000E+00	---	STOR_T(7)
STOR	Surface water	not used	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	not used	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	not used	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	suppressed
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed

Contaminated Zone Dimensions	
Area:	4.00 square meters
Thickness:	3.00 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g	
H-3	6.100E+05

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E-01	1.000E+00	1.000E+01	1.000E+02	1.000E+03
TDOSE(t):	1.156E+01	9.850E+00	2.330E+00	1.242E-06	0.000E+00	0.000E+00
M(t):	3.854E-01	3.283E-01	7.766E-02	4.140E-08	0.000E+00	0.000E+00

Maximum TDOSE(t): 1.156E+01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	1.156E+01	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.509E-03	0.0001
Total	0.000E+00	0.0000	1.156E+01	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.509E-03	0.0001

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.156E+01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.156E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E-01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	frac
H-3	0.000E+00	0.0000	9.849E+00	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.285E-03	0.00
Total	0.000E+00	0.0000	9.849E+00	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.285E-03	0.00

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E-01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	frac
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.850E+00	1.00
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.850E+00	1.00

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	2.329E+00	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.040E-04	0.0001
Total	0.000E+00	0.0000	2.329E+00	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.040E-04	0.0001

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.330E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.330E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	frac
H-3	0.000E+00	0.0000	1.242E-06	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.621E-10	0.00
Total	0.000E+00	0.0000	1.242E-06	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.621E-10	0.00

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	frac
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.242E-06	1.00
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.242E-06	1.00

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

adio- uclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
i-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
otal	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

adio- uclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
otal	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	frac
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.00
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.00

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	frac
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.00
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.00

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E-01	1.000E+00	1.000E+01	1.000E+02	1.000E+03
H-3	H-3	1.000E+00	1.895E-05	1.615E-05	3.819E-06	2.036E-12	0.000E+00	0.000E+00

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 30 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 30 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E-01	1.000E+00	1.000E+01	1.000E+02	1.000E+03
H-3	1.583E+06	1.858E+06	7.855E+06	1.473E+13	*9.610E+15	*9.610E+15

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
H-3	6.100E+05	0.000E+00	1.895E-05	1.583E+06	1.895E-05	1.583E+06

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E-01	1.000E+00	1.000E+01	1.000E+02	1.000E+03
H-3	H-3	1.000E+00	1.156E+01	9.850E+00	2.330E+00	1.242E-06	0.000E+00	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E-01	1.000E+00	1.000E+01	1.000E+02	1.000E+03
H-3	H-3	1.000E+00	6.100E+05	5.197E+05	1.229E+05	6.554E-02	0.000E+00	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

TABLE D-3

TRITIUM IN SUMP TA-33-134, 27 METER DEPTH

THIS PAGE LEFT INTENTIONALLY BLANK

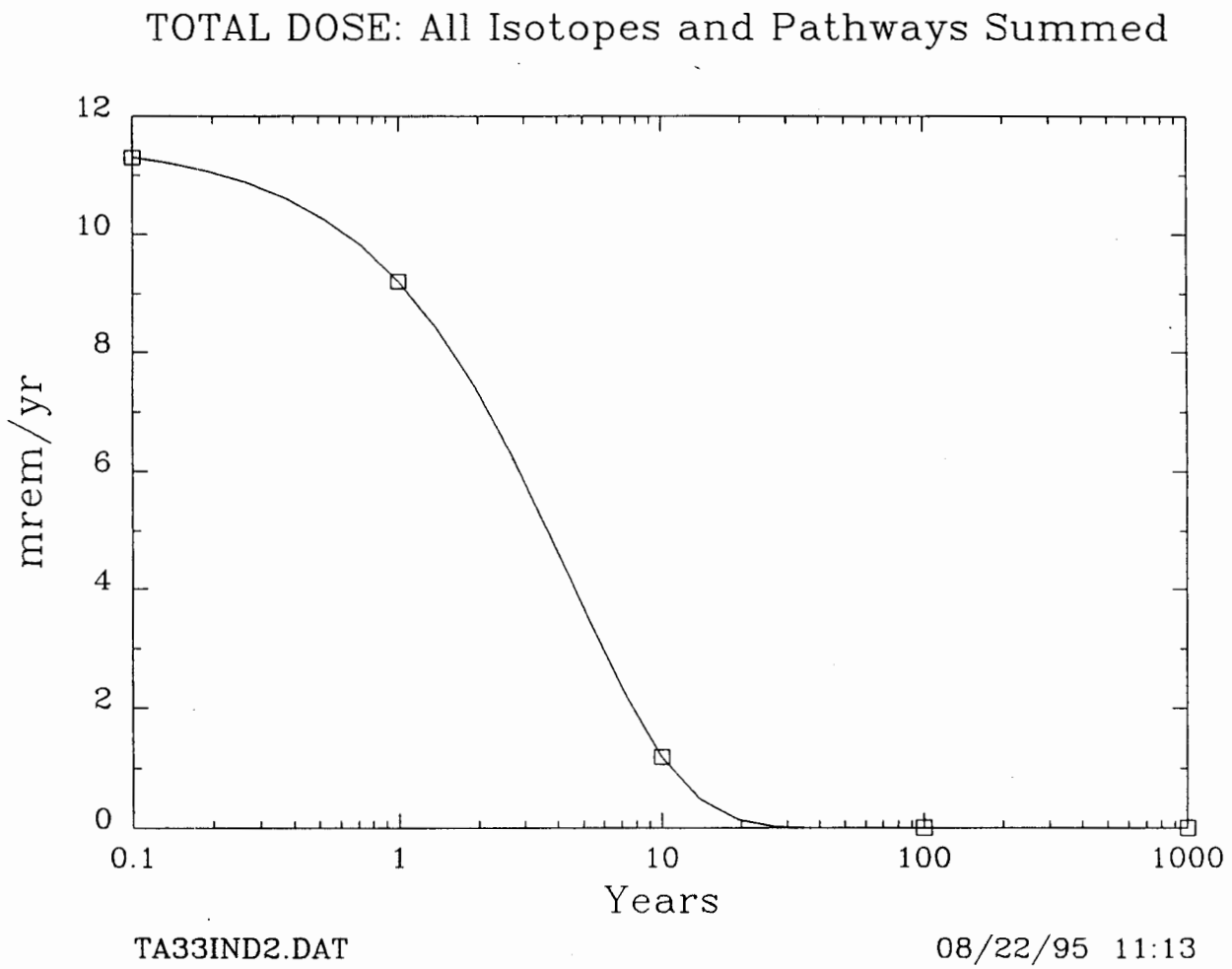
TOTAL DOSE: All Isotopes and Pathways Summed
mrem/yr
12
10
8
6
4
2
0
0.1
1
10
100
1000
Years
TA33IND2.DAT
08/22/95 11:13

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary ... 2
Site-Specific Parameter Summary 3
Summary of Pathway Selections 6
Contaminated Zone and Total Dose Summary 7
Total Dose Components
Time = 0.000E+00 8
Time = 1.000E-01 9
Time = 1.000E+00 10
Time = 1.000E+01 11
Time = 1.000E+02 12
Time = 1.000E+03 13
Dose/Source Ratios Summed Over All Pathways 14
Single Radionuclide Soil Guidelines 14
Dose Per Nuclide Summed Over All Pathways 15
Soil Concentration Per Nuclide 15

Dose Conversion Factor (and Related) Parameter Summary
File: DOSFAC30.BIN

Menu	Parameter	Current Value	Default	Parameter Name
3-1	Dose conversion factors for inhalation, mrem/pCi:			
3-1	H-3	6.400E-08	6.400E-08	DCF2(1)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
)-1	H-3	6.400E-08	6.400E-08	DCF3(1)
D-34	Food transfer factors:			
D-34	H-3 , plant/soil concentration ratio, dimensionless	4.800E+00	4.800E+00	RTF(1,1)
D-34	H-3 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.200E-02	1.200E-02	RTF(1,2)
)-34	H-3 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-02	1.000E-02	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	H-3 , fish	1.000E+00	1.000E+00	BIOFAC(1,1)
)-5	H-3 , crustacea and mollusks	1.000E+00	1.000E+00	BIOFAC(1,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	4.000E+00	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	2.700E+01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E-01	1.000E+00	---	T(2)
R011	Times for calculations (yr)	1.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.000E+02	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+03	1.000E+02	---	T(6)
R011	Times for calculations (yr)	not used	3.000E+02	---	T(7)
R011	Times for calculations (yr)	not used	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): H-3	6.100E+05	0.000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L): H-3	not used	0.000E+00	---	W1(1)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	5.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/cm**3)	8.000E+00	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	6.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	4.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	1.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	5.200E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	Zero shows Simpson's rule.	EPS
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	3.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	3.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.050E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	3.000E-01	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R015	Unsat. zone 2, thickness (m)	not used	0.000E+00	---	H(2)
R015	Unsat. zone 2, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(2)
R015	Unsat. zone 2, total porosity	not used	4.000E-01	---	TPUZ(2)
R015	Unsat. zone 2, effective porosity	not used	2.000E-01	---	EPUZ(2)
R015	Unsat. zone 2, soil-specific b parameter	not used	5.300E+00	---	BUZ(2)
R015	Unsat. zone 2, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(2)
R016	Distribution coefficients for H-3				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	0.000E+00	---	DCNUCU(1,1)
R016	Unsaturated zone 2 (cm**3/g)	not used	0.000E+00	---	DCNUCU(1,2)
R016	Saturated zone (cm**3/g)	not used	0.000E+00	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.861E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	2.000E-04	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	---	LM
R017	Exposure duration	1.000E+00	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	not used	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	1.800E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	5.000E-02	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	not used	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	4.200E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	not used	1.400E+01	---	STOR_T(1)
TOR	Leafy vegetables	not used	1.000E+00	---	STOR_T(2)
TOR	Milk	not used	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	not used	2.000E+01	---	STOR_T(4)
STOR	Fish	not used	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	not used	7.000E+00	---	STOR_T(6)
TOR	Well water	not used	1.000E+00	---	STOR_T(7)
TOR	Surface water	not used	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	not used	4.500E+01	---	STOR_T(9)
021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
.021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
P021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
.021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
021	Average annual wind speed (m/sec)	not used	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
.021	Building interior area factor	not used	0.000E+00	---	FAI
.021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	suppressed
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	4.00 square meters	H-3	6.100E+05
Thickness:	27.00 meters		
Cover Depth:	0.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E-01	1.000E+00	1.000E+01	1.000E+02	1.000E+03
TDOSE(t):	1.156E+01	1.130E+01	9.205E+00	1.183E+00	1.406E-09	0.000E+00
M(t):	3.854E-01	3.767E-01	3.068E-01	3.943E-02	4.687E-11	0.000E+00

Maximum TDOSE(t): 1.156E+01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	1.156E+01	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.509E-03	0.0001
Total	0.000E+00	0.0000	1.156E+01	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.509E-03	0.0001

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.156E+01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.156E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E-01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	frac
H-3	0.000E+00	0.0000	1.130E+01	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.475E-03	0.00
Total	0.000E+00	0.0000	1.130E+01	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.475E-03	0.00

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E-01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	frac
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.130E+01	1.00
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.130E+01	1.00

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	9.203E+00	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.201E-03	0.0001
Total	0.000E+00	0.0000	9.203E+00	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.201E-03	0.0001

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.205E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.205E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
H-3	0.000E+00	0.0000	1.183E+00	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.544E-04	0.000
Total	0.000E+00	0.0000	1.183E+00	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.544E-04	0.000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.183E+00	1.000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.183E+00	1.000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	1.406E-09	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.835E-13	0.0001
Total	0.000E+00	0.0000	1.406E-09	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.835E-13	0.0001

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.406E-09	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.406E-09	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.00

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	frac
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.00

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

rent (i)	Product (j)	Branch Fraction	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E-01	1.000E+00	1.000E+01	1.000E+02	1.000E+03
3	H-3	1.000E+00	1.895E-05	1.852E-05	1.509E-05	1.939E-06	2.305E-15	0.000E+00

ranch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
he DSR includes contributions from associated (half-life ≤ 30 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 30 mrem/yr

clide (i)	t= 0.000E+00	1.000E-01	1.000E+00	1.000E+01	1.000E+02	1.000E+03
-3	1.583E+06	1.619E+06	1.988E+06	1.547E+07	*9.610E+15	*9.610E+15

t specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

clide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
H-3	6.100E+05	0.000E+00	1.895E-05	1.583E+06	1.895E-05	1.583E+06

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E-01	1.000E+00	1.000E+01	1.000E+02	1.000E+03
H-3	H-3	1.000E+00	1.156E+01	1.130E+01	9.205E+00	1.183E+00	1.406E-09	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E-01	1.000E+00	1.000E+01	1.000E+02	1.000E+03
H-3	H-3	1.000E+00	6.100E+05	5.963E+05	4.857E+05	6.242E+04	7.419E-05	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

LANL
HSWA
FU 3
TA 33
18

RFI Report for Field Unit 3

Operable Unit 1122

Technical Area 33

RFI Report for PRSs

33-003(a)

33-004(a)

33-007(c)

33-009

33-011(d)

33-013

33-016

33-017

Revised Sampling Plans for PRSs

33-003(b)

33-004(k)

33-008(a)

33-008(b)

C-33-001

C-33-002

Environmental Restoration Project

Los Alamos National Laboratory

A Department of Energy

Environmental Cleanup Project

3
1122

CONTENTS

EXECUTIVE SUMMARY xiii

1.0 INTRODUCTION 1

1.1 Site History 1

1.2 RFI Overview 1

1.2.1 RFI Objectives 4

1.3 Field Activities 5

1.3.1 Field Surveys 5

1.3.2 Field Sampling 6

2.0 ENVIRONMENTAL SETTING 9

2.1 Climate 9

2.2 Geology 9

2.2.1 Geologic Setting 9

2.2.2 Soils 10

2.3 Hydrology 10

2.4 Biological and Cultural Surveys 10

3.0 APPROACH TO DATA ASSESSMENT AND ANALYSIS 11

3.1 Summary of Quality Assurance/Quality Control Activities 11

3.1.1 Inorganic Analyses 12

3.1.2 Organic Analyses 12

3.1.3 Radiochemical Analyses 12

3.1.4 High Explosives Analyses 12

3.1.5 Quality Assessment Samples 13

3.2 Screening Assessment Methodology 16

3.2.1 Background Comparison 16

3.2.2 Screening Action Levels Comparison 16

3.2.3 Ecotoxicological Screening Assessment Methodology 18

3.3 Risk Assessment Methodology 18

3.4 Development of Conclusions and Recommendations 19

4.0 SITE-SPECIFIC RESULTS, CONCLUSIONS, AND RECOMMENDATIONS 19

4.1 SWMU 33-003(a) Chamber TA-33-4 at MDA D 20

4.1.1 Previous Investigation 21

4.1.2 Field Investigation 21

4.1.3 Screening Assessment 21

4.1.3.1 Comparison to Background/SALs 21

4.1.3.2 Data Interpretation 23

4.1.3.3 Risk Assessment 23

4.1.3.4 Ecotoxicological Screening Assessment 24

4.1.4 Conclusion and Recommendation 24

4.2 SWMU 33-004(a) Main Site Septic System 24

4.2.1 Previous Investigations 25

4.2.2 Field Investigation 25

4.2.2.1 Results of Field Surveys 26

4.2.2.2 Results of Field Screening 26

4.2.3 Screening Assessment 26

4.2.3.1 Comparison to Background/SALs 26

4.2.3.2 Data Interpretation 32

4.2.3.3 Risk Assessment 32

4.2.3.4 Ecotoxicological Screening Assessment 34

4.2.4 Conclusion and Recommendation 34

4.3 SWMU 33-007(c) Firing Site Catcherboxes 34

4.3.1 Previous Investigations 34

4.3.2 Field Investigation 34

4.3.2.1 Results of Field Surveys 35

4.3.2.2 Results of Field Screening 35

4.3.3 Screening Assessment 35

4.3.3.1 Comparison to Background/SALs 35

4.3.3.2 Data Interpretation 36

4.3.3.3 Risk Assessment 36

4.3.3.4 Ecotoxicological Screening Assessment 38

4.3.4 Conclusions and Recommendations 38

4.4 SWMU 33-009 Area 6 Surface Disposal 38

4.4.1 Previous Investigations 39

4.4.2 Field Investigation 39

4.4.2.1 Results of Field Surveys 39

4.4.2.2 Results of Field Screening 39

4.4.3 Screening Assessment 40

4.4.3.1 Comparison to Background/SALs 40

4.4.3.2 Data Interpretation 42

4.4.3.2.1 Computations For PCBs at Area 6 42

4.4.3.3 Risk Assessment 44

4.4.3.4 Ecotoxicological Screening Assessment 44

4.4.4 Conclusion and Recommendation 44

4.5 SWMU 33-011(d) Storage at TA-33-20 45

4.5.1 Previous Investigations 45

4.5.2 Field Investigation 45

4.5.2.1 Results of Field Surveys 45

4.5.2.2 Results of Field Screening 46

4.5.3 Screening Assessment 46

4.5.3.1 Comparison to Background/SALs 46

4.5.3.2 Data Interpretation 46

4.5.3.3 Risk Assessment 46

4.5.3.4 Ecotoxicological Screening Assessment 46

4.5.4 Conclusion and Recommendation 46

4.6 SWMU 33-013 Liquid Waste Storage at the Tritium Facility 49

4.6.1 Previous Investigations 49

4.6.2 Field Investigation 49

4.6.2.1 Results of Field Surveys 49

4.6.2.2 Results of Field Screening 49

4.6.3 Screening Assessment 50

4.6.3.1 Comparison to Background/SALs 50

4.6.3.2 Data Interpretation 52

4.6.3.3 Risk Assessment 52

4.6.3.4 Ecotoxicological Screening Assessment 52

4.6.4 Conclusion and Recommendation 52

4.7 SWMU 33-016 Sump at TA-33-23 53

4.7.1 Previous Investigations 53

4.7.2 Field Investigation 53

4.7.2.1 Results of Field Surveys 53

4.7.2.2 Results of Field Screening 54

4.7.3 Screening Assessment 54

4.7.3.1 Comparison to Background/SALs 54

4.7.3.2 Data Interpretation 57

4.7.3.3 Risk assessment 57

4.7.3.4 Ecotoxicological Screening Assessment 57

4.7.4 Conclusion and Recommendation 57

4.8 SWMU 33-017 Operational Releases/Vehicle Maintenance Area 57

4.8.1 Previous Investigations 58

4.8.2 Field Investigation 58

4.8.2.1 Results of Field Surveys 59

4.8.2.2 Results of Field Screening 59

4.8.3 Screening Assessment 59

4.8.3.1 Comparison to Background/SALs 59

4.8.3.2 Data Interpretation 65

4.8.3.3 Risk Assessment 65

4.8.3.4 Ecotoxicological Screening Assessment 71

4.8.4 Conclusion and Recommendation 71

5.0 REVISED PHASE I SAMPLING AND ANALYSIS PLANS 71

5.1 SWMU 33-003(b) MDA-D, East Site 71

5.1.1 Previous Investigation 72

5.1.2 Field Investigation 73

5.1.2.1 Results of Field Surveys 74

5.1.2.2 Results of Field Screening 74

5.1.3 Screening Assessment 74

5.1.3.1 Comparison to Background/SALs 74

5.1.3.2 Data Interpretation 76

5.1.3.3 Risk Assessment 76

5.1.4 Conclusion and Recommendation 77

5.1.5 Phase I Revised Sampling and Analysis Plan 77

5.1.5.1 Phase I Sampling Objectives 77

5.1.5.2 Sampling and Analysis 79

5.2 SWMU 33-004(k) Outfall from TA-33-87, East Site 81

5.2.1 Previous Investigation 81

5.2.2 Field Investigation 81

5.2.2.1 Results of Field Surveys 81

5.2.2.2 Results of Field Screening 81

5.2.3 Screening Assessment 81

5.2.4 Conclusion and Recommendation 82

5.2.5 Sampling and Analysis Plan 82

5.3 SWMU 33-008(a,b) Landfills at South Site and East Site 82

5.3.1 Previous Investigations 84

5.3.2 Field Investigations 84

5.3.2.1 Results of Field Surveys 84

5.3.2.2 Results of Field Screening 84

5.3.3 Screening Assessment 87

5.3.3.1 Comparison to Background/SALs 87

5.3.3.2 Data Interpretation 87

5.3.4 Conclusions and Recommendations 87

5.3.5 Further Investigations 87

5.3.5.1 Sampling Objectives for SWMU 33-008(a,b) 87

5.3.5.2 Phase I Sampling and Analysis 88

5.4 C-33-001, C-33-002 Power transformers 90

5.4.1 Objectives 90

5.4.2 Sampling Plan 91

APPENDIX A RAW DATA A-1

APPENDIX B PHASE II SAMPLING AND ANALYSIS PLANS B-1

1.0 PHASE II SAMPLING AND ANALYSIS PLAN FOR SWMU 33-009 ..... B-1

1.1 Phase II Sampling Objectives B-1

1.2 Geophysical Survey and Removal of Capacitors B-3

1.3 Sampling and Analysis at SWMU 33-009 ..... B-3

2.0 PHASE II SAMPLING AND ANALYSIS PLAN FOR SWMU 33-011(d) STORAGE AT TA-33-20 ..... B-6

2.1 Phase II Sampling Objectives B-6

2.2 Phase II Sampling and Analysis Plan for SWMU 33-011(d) B-6

3.0 PHASE II SAMPLING AND ANALYSIS PLAN FOR SWMU 33-013 LIQUID WASTE STORAGE AT THE TRITIUM FACILITY B-9

3.1 Phase II Objectives B-9

3.2 Sampling and Analysis of SWMU 33-013 Liquid Waste Storage B-10

4.0 PHASE II SAMPLING AND ANALYSIS PLAN FOR SWMU 33-017 VEHICLE MAINTENANCE AREA B-12

4.1 Phase II Sampling Objectives B-12

4.2 Phase II Sampling and Analysis Plan for SWMU 33-017 ..... B-14

APPENDIX C PCB IMMUNOASSAY KIT C-1

APPENDIX D RISK ASSESSMENT CALCULATIONS FOR SWMU 33-017 ..... D-1

1.0 EXPOSURE ASSESSMENT D-1

2.0 TOXICITY ASSESSMENT D-1

3.0 RISK CALCULATION FOR LEAD AT SWMU 33-017 VEHICLE MAINTENANCE AREA D-2

3.1 Calculations for Lead at the SWMU 33-017 Exposure Unit D-2

3.2 Results of the EPA Lead Model (version 0.99d) based on 95% UCL Lead Concentration in Soil at the SWMU 33-017 Exposure Unit D-4

4.0 RISK CALCULATION FOR PAHs AT SWMU 33-017 VEHICLE MAINTENANCE AREA D-7

4.1 Risk Calculations for PAHs D-7

5.0 REFERENCES D-11

ATTACHMENT D-1 ..... D-13

ADDENDUM 1 ..... ADD-1

LIST OF TABLES

Table ES-1 TA-33 PRSs in this RFI Report xiv

Table 3-1 Estimates of Replicability of Measurements of Radionuclides and Inorganics in Soil Samples 15

Table 3-2 Range (Excluding Outliers) and Upper Tolerance Limits for Inorganics in Soil Samples 17

Table 3-3 Range (Excluding Outliers) and Upper Tolerance Limits for Radionuclides in Soil Samples 17

Table 4-2 Inorganic Compounds in Fluid and Sludge Samples from Septic Tank TA-33-31 26

Table 4-4 Analytes Detected in the Borehole Adjacent to the Septic Tank 28

Table 4-7 Inorganic Contaminants Found Above LANL and TA-33 Background UTLs in the Drainage at SWMU 33-004(a) 32

Table 4-8 Inorganics Detected Above LANL and TA-33 Background UTLs at SWMU 33-007(c) Catcherboxes 35

Table 4-9 Multiconstituent Analysis of Inorganics at SWMU 33-007(c) Catcherboxes, Excluding Uranium 36

Table 4-10 Analytes Detected Above LANL and TA-33 UTLs at SWMU 33-009a 40

Table 4-13 Analytes Above LANL and TA-33 Background UTLs and SALs at SWMU 33-011(d) 47

Table 4-14 Analytes Exceeding UTLs at SWMU 33-013 50

Table 4-15 Organics Detected in Sump Sludge at SWMU 33-016 54

Table 4-16 Inorganic Contamination Above LANL and TA-33 Background UTLs in SWMU 33-017 Grid Samples 60

Table 4-17 Organics Detected in SWMU 33-017 Grid Samples 61

Table 4-18 Inorganic Analytes Above LANL and TA-33 Background UTLs at SWMU 33-017 Drainages 64

Table 4-19 Organic Analytes Above LANL and TA-33 Background UTLs at SWMU 33-017 Drainages 64

Table 4-20 Inorganics Detected Above LANL and TA-33 Background UTLs at SWMU 33-017 Vehicle Maintenance Area 66

Table 4-21 Organics Detected at SWMU 33-017 Vehicle Maintenance Area 67

Table 5-2 Analytes Detected Above LANL and TA-33 Background UTLs in the TA-33-6 Elevator Shaft 74

Table 5-3 SVOCs Detected at Landfill SWMU 33-008(a) 87

Table B-1 Phase II Sampling and Analysis Plans B-1

Table B-2 Lower Limits of Detection for the Spectrace 9000™ X-Ray Fluorescence Analyzer and LIBS Field Instrument B-9

Table C-1 Interpretation of Detechtor™ Readings (from D TECH™ Instruction Guide) C-1

Table D-1 Lead Values in Exposure Unit East of TA-33-39 ..... D-2

Table D-2 PAHs in Exposure Unit East of TA-33-39 ..... D-7

Table D-3 Mean and 95% UCLs for PAHs in Exposure Unit East of TA-33-39 ..... D-8

LIST OF FIGURES

Fig. 1-1. Location of TA-33. 2

Fig. 1-2. The five sites at TA-33. 3

Fig. 4.1. SWMU 33-003(a), chamber TA-33-4 at MDA D. 22

Fig. 4-2. Main Site: SWMU 33-004(a), septic system. 33

Fig. 4-3. Catcher boxes at SWMU 33-007(c). 37

Fig. 4-4. Area 6: SWMU 33-009 showing overlapping SWMU 33-004(g). 41

Fig. 4-5. Main Site: SWMU 33-011(d), surface storage. 48

Fig. 4-6. Main Site: SWMU 33-013, drum storage. 51

Fig. 4-7. Main Site: SWMU 33-016, sump. 56

Fig. 4-8. Locations of grid samples assigned to SWMU 33-017. 63

Fig. 4-9. Main Site: SWMU 33-017, vehicle maintenance area risk assessment exposure area showing overlapping SWMUs 33-004(i) and 33-012(a). 70

Fig. 5-1. East Site: SWMU 33-003(b) Weston boreholes and ER 1994 sampling campaign. 75

Fig. 5-2. East Site: SWMU 33-003(b) sampling locations. 80

Fig. 5-3. East Site: SWMU 33-004(k), outfall from TA-33-87, shown in relation to SWMU 33-008(b), landfill. 83

Fig. 5-4. South Site: SWMU 33-008(a), landfill, 1994 sampling campaign. 85

Fig. 5-5. East Site: SWMU 33-008(b), landfill. 86

Fig. 5-6. Main Site: Area of concern (AOC) C-33-001, transformer. 92

Fig. 5-7. East Site: Area of concern (AOC) C-33-002, transformer. 93

Fig. B-1. Area 6: SWMU 33-009 Phase II PCB sampling plan. B-4

Fig. B-2. SWMU 33-011(d) sampling plan. B-8

Fig. B-3. Main Site: SWMU 33-013 sampling locations. B-11

Fig. B-4. SWMU 33-017 Phase II sampling locations. B-16

Fig. C-1. D-TECH plot. C-3

Fig. D-1. Probability plot of lead values. D-6

Fig. D-2. Distribution of benzo[a]anthracine in SWMU 33-017 exposure unit (lognormal plot). D-10

EXECUTIVE SUMMARY

Between 1947 and 1972 Technical Area (TA)-33 was a test site for components of nuclear weapons called initiators. This Resource and Recovery Conservation Act (RCRA) Facility Investigation (RFI) report discusses potential release sites (PRSs) at various locations within TA-33 at Main Site, Area 6 , South Site, and East Site.

Phase I sampling was performed at Area 6 and Main Site between May and November 1993. This RFI report documents the findings at eight (PRSs) proposed for voluntary corrective action (VCA), expedited cleanup (EC), or Phase II sampling. In seven of these eight PRSs, contamination was above screening action levels (SALs).

Information discovered after the RFI Work Plan was submitted in 1992 indicates that sampling and analysis plans for six PRSs require modification. Revised Phase I sampling and analysis plans for these PRSs are presented in Section 5.0 of this report. In addition, information gathered after the work plan was submitted indicates that solid waste management unit (SWMU) 33-003(a) can be recommended for no further action (NFA). All PRSs discussed in this RFI report are listed in Table ES-1. The year the PRS was included in the Los Alamos National Laboratory (LANL) Hazardous and Solid Waste Amendments (HSWA) Permit is listed in column two.

Holding times were met for all analyses used for decision-making purposes. All samples specified in the work plan were collected with the exception of samples from within the septic system seepage pits at SWMU 33-004(a). Seepage pit samples from SWMU 33-004(a) were collected from boreholes drilled beside the pits.

The following is a summary of the PRSs included in this report for which Phase I sampling has been completed. When referring to a specific PRS, the term solid waste management unit (SWMU) is used in accordance with RCRA terminology.

SWMU 33-003(a) is underground chamber TA-33-4 at Material Disposal Area (MDA) D. Although polychlorinated biphenyls (PCBs) or their combustion products may be present in the chamber, SWMU 33-003(a) is proposed for NFA based on results of an assessment that indicated absence of exposure pathways.

SWMU 33-004(a) is the septic system at Main Site. Organic compounds were detected in sludge from the septic tank. Several organics, including benzo[a]pyrene above its SAL, were detected at trace levels in the sample taken adjacent to the tank at a depth of 3 to 5 ft. Organics detected in the drain field are derived from construction material. Lead was detected above SAL. Because the septic system is active, no action is planned at this SWMU.

TABLE ES-1

TA-33 PRSs IN THIS RFI REPORT

PRS ID	HSWA PERMIT	NFA[a]	ACCELERATED CLEANUP	FURTHER INVESTIGATION	RATIONALE
33-003(a)	1990	X			No pathway (4.1)
33-003(b)	1990			Phase I	PCB extent (5.1)
33-004(a)	1990		DA[b]		Active system (4.2)
33-004(k)	1990			Phase I	Outfall not found (5.2)
33-007(c)	1990		EC[c]		Uranium chunks (4.3)
33-008(a)	1990			Phase I	Revised plan (5.3)
33-008(b)	1990			Phase I	Revised plan (5.3)
33-009	1990			Phase II	PCB extent (4.4)
33-011(d)	1994			Phase II	Uranium spots (4.5)
33-013	1990			Phase II	Inorganic extent (4.6)
33-016	1994		VCA[d]		VCA Completed (4.7)
33-017	1990			Phase II	Organic extent (4.8)
C-33-001	No			Phase I	Never sampled (5.4)
C-33-002	No			Phase I	Never sampled (5.4)

[a] NFA = No further action.
[b] DA = Deferred action.
[c] EC = Expedited cleanup.
[d] VCA = Voluntary corrective action.

SWMU 33-007(c) is the firing sites at Area 6. During 1994 trenching in the catcherboxes, subsurface uranium deposits were discovered. When the RFI report LA-UR-95-882 was submitted in January 1995, no results had been received for inorganic analyses of the catcherbox samples. This RFI report contains results of those analyses, but only for the catcherbox segment of SWMU 33-007(c). An EC is recommended to remove the uranium contamination.

SWMU 33-009 is a surface disposal area at Area 6. Low levels of PCBs were found in samples over the face of the disposal area. SWMU 33-009 is targeted for Phase II sampling.

SWMU 33-011(d) is an area once used for storage outside warehouse TA-33-20. Lead, uranium, and tritium were detected above SAL in one asphalt sample and its duplicate. A radiological survey and cleanup is proposed for uranium. A Phase II sampling plan is presented to determine the extent of lead contamination.

SWMU 33-013 is a surface disposal area on pavement east of the former tritium facility, TA-33-86. Cadmium, chromium, and tritium were measured above SALs. Beryllium was measured above soil background levels. However, elevated inorganics were associated with serious problems in the quality control data. A Phase II sampling plan is presented to determine the extent of contamination.

SWMU 33-016 is a sump and outfall at bunker TA-33-23. Organics above SALs were discovered in the sump sludge. A VCA, consisting of cleaning and filling the tank, has been completed at this SWMU.

SWMU 33-017 encompasses the eastern section of the fenced area at Main Site. Elevated levels of lead and organic compounds are associated with samples from an area east of shop TA-33-39. This area is known as the vehicle maintenance area. A risk assessment for lead in this area was presented in Subsection 4.4.4 of RFI Report LA-UR-95-882 (LANL 1995, 1212). In this RFI report, the vehicle maintenance area is proposed for Phase II sampling to determine concentrations and extent of organic contamination.

THIS PAGE LEFT INTENTIONALLY BLANK

1.0 INTRODUCTION

1.1 Site History

Technical Area-(TA)33 is located in the southeastern section of Los Alamos National Laboratory (LANL) (Fig. 1-1). TA-33 was used between 1947 and 1972 as a site to test components of nuclear weapons called initiators. TA-33 contains five sites (Fig. 1-2).

- Area 6, South Site, and East Site are inactive firing sites occasionally used for short-term experiments.
- The National Radio Astronomy Observatory (NRAO) Site was a storage area that now houses a radiotelescope.
- Main Site contains offices, a warehouse, and shops. Main Site is an active site behind a security fence.

Initiator testing activities ended in 1972. Later operations were confined to office and storage activities for a geology group until 1989, when an electronics development group occupied Main Site. The firing sites are inactive except for occasional short-term experiments. This RFI report evaluates contamination at potential release sites (PRSs) at Main Site, Area 6, and East Site. Revised sampling plans are proposed for PRSs at East and South Sites.

1.2 RFI Overview

Resource and Recovery Conservation Act (RCRA) Facility Investigation (RFI) Work Plan for Operable Unit (OU) 1122 was submitted to the Environmental Protection Agency (EPA) Region 6 in May 1992 and was approved with minor modifications by EPA in July 1993 (LANL 1992, 0784; EPA 1993, 02-090). The technical approach in the RFI work plan utilizes phased sampling plans to ensure that any environmental impacts associated with LANL activities are investigated in compliance with the LANL Hazardous and Solid Waste Amendments (HSWA) Module VIII of the LANL RCRA Facility Permit (EPA 1990, 0306). Specific PRSs in this report are either solid waste management units (SWMUs) or Areas of Concern (AOCs).

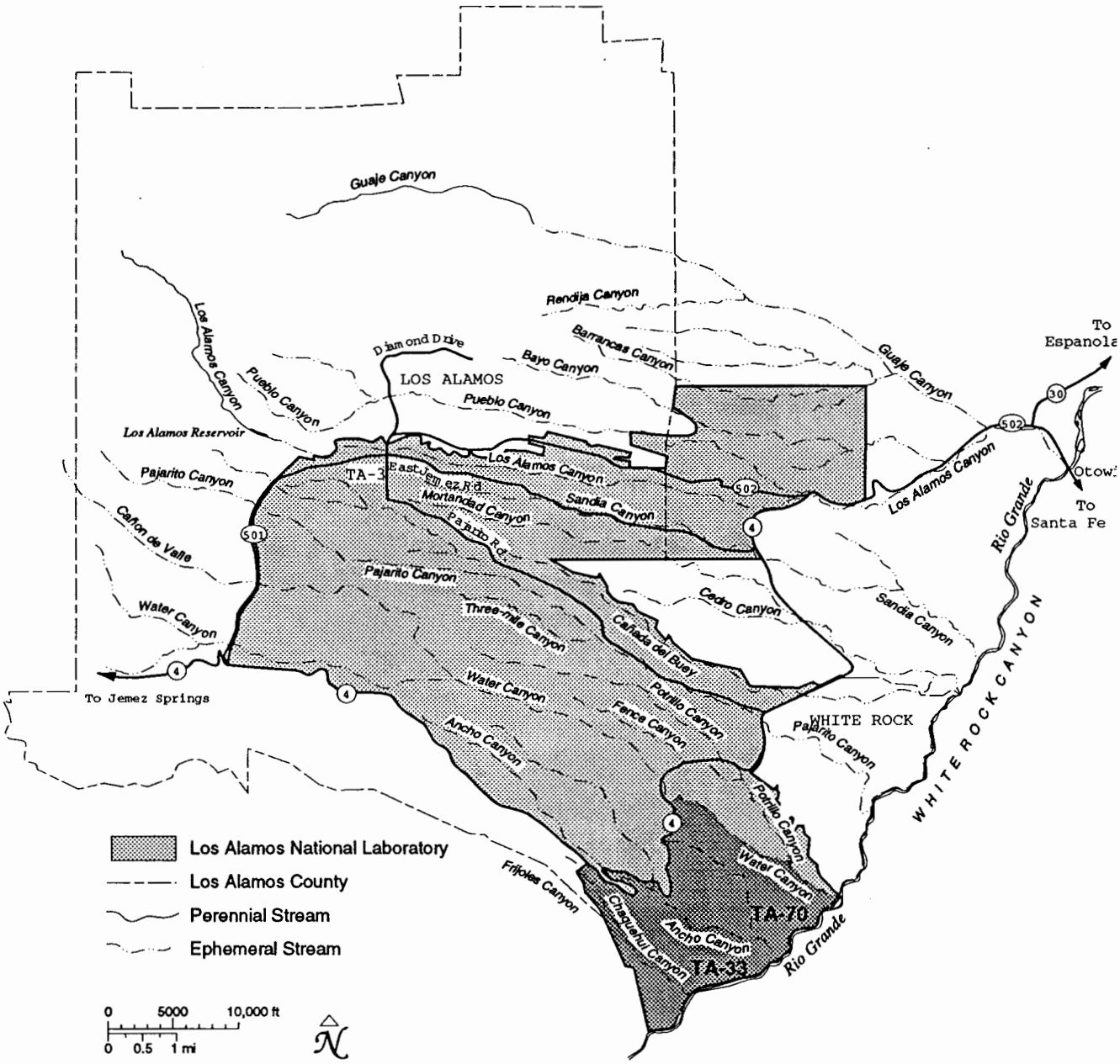

Fig. 1-1. Location of TA-33.

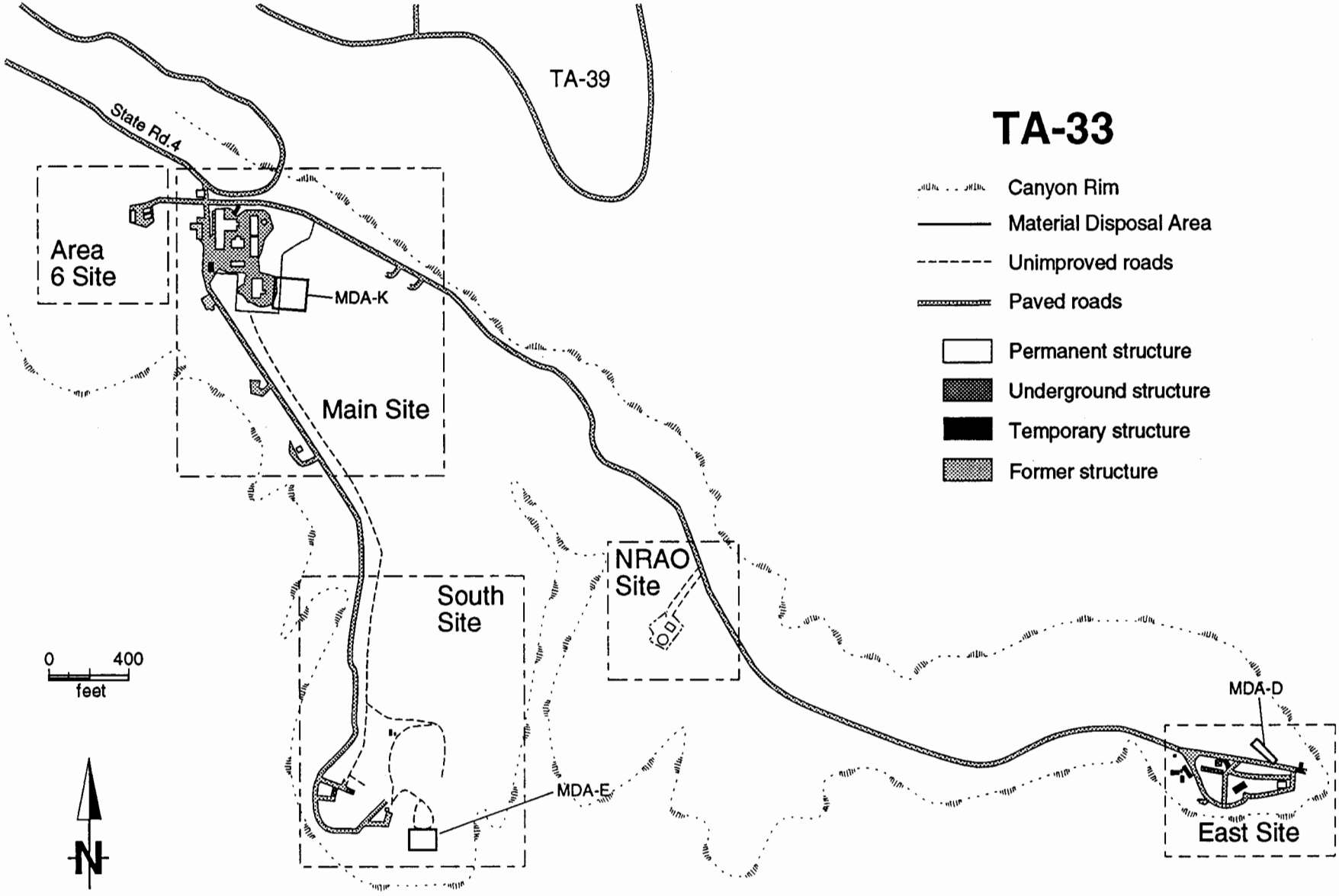

Fig. 1-2. The five sites at TA-33.

1.2.1 RFI Objectives

Because little was known of contamination levels at TA-33, the objective of the first phase of RFI sampling plans was to ascertain presence, levels, and distribution of contaminants. Options for subsequent actions for each PRS based on the Phase I analytical results include the following:

- No further action (NFA) and request for removal of the PRS from the LANL HSWA permit;
- Voluntary corrective action (VCA);
- Expedited Cleanup (EC);
- Phase II study to provide data for baseline risk assessment, which may lead to VCA, EC or to NFA; or,
- Corrective measures study (CMS).

In the RFI work plan, the following field activities were planned to facilitate sampling decisions.

- Accurate land and geophysical surveys and channel mapping
- Radiation surveys
- Surface sampling to identify:
    1) areas of elevated contamination associated with PRSs
    2) transport of contaminants along stream channels
    3) average contaminant concentrations around gun-firing areas
    4) average concentrations and trends with distance from a potential source
    5) spatial variability and predictability of contaminant concentrations
- Subsurface sampling to identify:
    1) possible vapor phase plumes from sumps and septic tanks
    2) contaminated soil and solid material in berms

RFI sampling plans were devised to provide data for preliminary risk assessments should analyses indicate that contamination is present. Three conceptual exposure models were developed for current activities, construction, and recreational scenarios as described in Chapter 3, page 3-11, of the RFI Work Plan for OU 1122 (LANL 1992, 0784).

For the PRSs in Section 4.0, this RFI report concludes Phase I of the RFI work plan. Data from sampling and analyses are available in the environmental restoration (ER) Project Facility for Information Management, Analysis, and Display (FIMAD) database, as stated in Appendix A. Phase II sampling and analysis plans for SWMUs 33-009, 33-011(d), 33-013, and 33-017 are given in Appendix B.

1.3 Field Activities

Field activities at Main Site and Area 6 were conducted by ICF Kaiser Engineers (ICF KE) personnel during the 1993 sampling season from May to November (ICF Kaiser 1994, 02-095).

1.3.1 Field Surveys

Field surveys included land surveys, radiation surveys, and geophysical surveys. The land survey established geodetic control points, coordinates for all sample locations, and grids for the radiation and geophysics surveys. The land survey was conducted by Santiago Romero, Jr. and Associates to established geodetic control points at Main Site and Area 6. Grid systems were then established as required by the RFI work plan for OU 1122 to identify measurement points for the radiation and geophysical surveys (LANL 1992, 0784). Sample locations for the May 1993 sampling activities were surveyed by Santiago Romero, Jr. and Associates or by ICF KE personnel using a Brunton™ compass and surveyor's tape.

Radiation surveys were conducted by Afftrex, Ltd. on approximately 568 grid locations at Main Site and Area 6. The surveys were conducted using a Ludlum Model 12S Micro-R Meter™ held at 3 ft above the ground surface. This instrument uses an internal nominal one-inch sodium-iodide detector to measure low-energy gamma radiation for the detection of uranium, plutonium, and americium. The objective of the surveys was to redirect the locations of reconnaissance samples if above-background radiation levels were found. Data from the radiation surveys at Main Site and Area 6 were recorded on LANL's daily activity logs and radiation survey forms.

Geophysical surveys were conducted at Main Site and Area 6 by ICF KE personnel. The RFI Work Plan for OU 1122 states that electromagnetic (EM) and magnetometer/gradiometer (MAG) readings are to be reported for each node of 5-ft and 10-ft grids at Main Site and Area 6 (LANL 1992, 0784). The stated objectives of the survey were:

- to delineate drain fields and drain lines,
- to locate buried projectiles, and
- to define saturated areas.

To achieve these three objectives, the EM method was used to assess shallow geophysical anomalies (e.g., septic tanks and drain fields). The MAG method was used to locate shallow, buried, metallic objects (projectiles). The EM instrumentation consisted of a Geonics EM31-DL™ ground conductivity meter and an Omnidata™ data logger. The MAG instrumentation was a GEM GSM-19™ proton precession magnetometer/gradiometer.

1.3.2 Field Sampling

Field sampling activities for the PRSs in this RFI report included surface soil and sediment sampling, structure sampling (e.g., sludge from sumps), and shallow subsurface soil sampling (using a hand auger and hollow-stem auger drill rig). Sample locations at TA-33 were selected using the criteria outlined in the RFI Work Plan for OU 1122. The work plan identifies the criteria for selecting reconnaissance (biased) sample locations, characterization (random) sample locations, and collocated or neighbor sample locations (LANL 1992, 0784).

- Reconnaissance sample locations were selected specifically to maximize the likelihood of detecting any contamination that might be present within the PRS of interest.
- Characterization samples were selected within PRSs of interest without regard to specific site characteristics. Freedom from judgmental influences on selecting sample locations was achieved by the use of a grid-based randomization protocol and an area-based randomization protocol.
- Collocated and neighbor samples were collected in the field to provide data for estimating spatial variability of contaminants in the surface and subsurface soils and sediments. Collocated samples (designated as field duplicates in the work plan) were selected from nine percent of the grid-

based sample locations at SWMUs 33-017 and 33-007(c). Locations of the collocated samples were established one foot north of their respective grid-based sample locations.

Before each sample was taken, the health physics technician and a field team member checked the undisturbed sample location for the presence of above-background levels of radioactivity and volatile organic compounds (VOC). If VOCs or elevated levels of radioactivity were detected, the site was evacuated and sampling procedures for that site were re-evaluated. If VOCs or elevated levels of radioactivity were not detected, the samplers then proceeded to collect the sample, document weather and site conditions, take photos where appropriate, and document the environmental sample. All samples were cooled with ice packs in portable ice chests as soon as possible after sample collection. Samples collected in the morning and mid-afternoon were submitted to LANL's mobile radiation laboratory on the day of collection. Samples collected in the late afternoon were maintained in coolers at the site and submitted to the mobile radiation laboratory the following morning.

LANL ER Project Standard Operating Procedures (SOPs) were used for all field documentation and sampling activities (LANL 1993, 0875). Field documentation was carried out conforming to LANL-ER-SOP-1.04, Sample Control and Field Documentation. This documentation includes field notes, sample collection logs, and chain of custody forms. Chain-of-Custody/request for analysis forms were completed at the time of sampling to identify and document personnel responsible for safeguarding sample integrity. These forms provide a record of sample collection and transfer between field personnel and personnel at LANL's mobile radiation laboratory.

All surface sample collection activities at Main Site and Area 6 during 1993 conformed to LANL-ER-SOP-06.09, Spade and Scoop Method for Collection of Soil Samples. Surface soil samples are defined in the work plan as samples taken from the surface to a depth of 6 in. Surface soil samples were taken to this depth and within a diameter of approximately 6 to 8 in. Soil was collected from each sample location using a dedicated (single use) stainless steel spoon. The soil was placed in a dedicated stainless steel bowl and homogenized by mixing with the spoon.

All fluid and sludge sample collection activities at Main Site during 1993 conformed to LANL-ER-SOP-06.15, Coliwasa Samples for Liquids and Slurries. A HAZCO™ Teflon mucksucker sampler was used to collect fluid and sludge samples from septic tanks and

sumps. This translucent plastic sampler consists of sampling tube, stop-cock, and closure system. The mucksucker was inserted into the tanks, the fluid or sludge was drawn, up and then transferred directly to the appropriate sample containers.

All shallow hand auger sample collection activities at Main Site during 1993 conformed to the procedures described in LANL-ER-SOP-06.10, Hand Auger and Thin-Wall Tube Sampler. Subsurface soil samples were recovered from depths up to 10 ft using a stainless steel hand-held auger that was manually driven into the soil. The soil or sediment was removed from the auger, placed into a stainless steel bowl, and homogenized with a stainless steel spoon.

All shallow borehole drilling activities at Main Site during 1993 conformed to LANL-ER-SOP-04.01, Drilling Methods and Drill Site Management. A hollow-stem auger rig was used to drill boreholes at locations where sample depths or subsurface obstacles precluded the use of the hand auger. Shallow borehole drilling was performed by Rodgers Environmental Services, Inc. with the following equipment:

- C.M.E. 75™ auger rig,
- 3.75-in.-inner-diameter heavy-duty augers and bit, and
- stainless steel split-spoon samplers, 2-ft by 3-in.

Samples were collected from the borehole using a stainless steel split-spoon sampler according to LANL-ER-SOP-06.24, Sample Collection from Split-Spoon Samplers and Shelby Tube Samplers. The split-spoon samplers were monitored for radiation and VOCs immediately after opening. At SWMU 33-004(a), the sample was also monitored for mercury using a Jerome Mercury Analyzer™. The core material was then removed from the split-spoon sampler and placed into a stainless steel bowl. Samples that were to be analyzed for VOCs were immediately placed into 40-ml sample containers. The remaining material was broken up, mixed with a stainless steel spoon, and placed into the appropriate sample containers.

All samples specified in the work plan were collected. Samples for the seepage pits at the Main Site septic system, SWMU 33-004(a), were collected beside the pits. Quality assurance (QA) field activities are discussed in Subsection 3.1 of this report.

2.0 ENVIRONMENTAL SETTING

2.1 Climate

Weather at TA-33 is similar to other areas of LANL. Subsection 2.5.3 of the LANL ER Installation Work Plan (IWP) describes a semiarid, temperate, mountain climate (LANL 1993, 1017). TA-33 is at the lower elevations of the laboratory; summers are hotter and winter snow cover of shorter duration than at most areas of the Laboratory, which are at higher elevations.

2.2 Geology

2.2.1 Geologic Setting

Main Site and Area 6, the subjects of this RFI report, are located near the head of the TA-33 mesa. Both sites were leveled during construction. Adjacent terrain is generally level or gently sloping. Canyon sides are moderately sloping, with the exception of the west side of Area 6 at SWMU 33-009, where a tributary to Chaquehui Canyon becomes fairly steep sided. Detailed descriptions of terrain are provided with each PRS description. Exposed bedrock at Main Site and Area 6 consists of Unit 3 of the Tshirege Member of the Bandelier Tuff (Reneau et al. 1995, 02-092). Deep drilling at Main Site established that tuff formations extend approximately 200 ft deep. Underlying the tuff are basalt flows of the Cerros del Rio volcanic field, which lie on sedimentary formations of the Santa Fe Group. Part of the Area 6 firing site is built on an exposed basaltic cinder cone that predates the formation of the tuff units. Deep drilling into tuff at MDA K intercepted basaltic cinders of the subsurface shoulders of the Area 6 cone, indicating that this formation underlies the tuff at Main Site. Extent of the cone's base is unknown. The deep drilling terminated at basalts of the Cerros del Rio flows. Reneau et al. (1995, 02-092) provides a detailed description of the geology and geomorphology at TA-33.

2.2.2 Soils

Soils at Main Site and Area 6 are classified as Hackroy Rock (Nyhan et al 1978, 0161). Soils range in appearance from sandy loam to fine clay. Pumice pebbles are deposited on the surface. Drainage catchments collect sand, pumice pebbles, and sediments. Soils are generally shallow, with bedrock exposed at many areas on the mesa. Shallow hand-auger drilling during the 1993 sampling campaign indicated that depths of most soils ranged from 2 to 5 ft. The deepest soil sampled was at a depth of 15 ft at the Main Site septic tank, which is built in fill formed by grading of Main Site.

2.3 Hydrology

Ephemeral surface water flow may be expected in the major canyons during the spring snowmelt and summer thunderstorm seasons. Groundwater is expected to be at a considerable depth below the mesa tops. Deep drilling conducted at Main Site (elevation 6 530 ft) in 1993 reached a depth of 315 ft (elevation 6 215 ft) without encountering any perched water. The nearest evidence of groundwater is at Ancho Spring in Ancho Canyon at an elevation of 5 700 ft. The depth to groundwater in the vicinity of Main Site at TA-33 is therefore expected to be between 315 and 830 ft. There is no information available on the existence of alluvial aquifers in Ancho or Chaquehui Canyons. There are no data available concerning water transport through fissures and fractures of bedrock at TA-33.

2.4 Biological and Cultural Surveys

Biological and cultural surveys were performed at TA-33 prior to sampling. As described in Appendix B of the RFI Work Plan for OU 1122, no sensitive habitats were identified on the mesas; sensitive habitats are limited to areas in Ancho, Chaquehui, and White Rock Canyons (LANL 1992, 0784). Cultural surveys found 64 archaeological sites on the 782.63 acres surveyed at TA-33 during the summer of 1991. Three archaeological sites near the tritium facility, TA-33-86, were listed as being located in potentially contaminated areas (LANL 1994, 02-0103). The report is in error; these sites are not within the boundaries of any PRS, nor were they affected by sampling activities.

3.0 APPROACH TO DATA ASSESSMENT AND ANALYSIS

3.1 Summary of Quality Assurance/Quality Control Activities

Field quality-control samples were collected during the 1993 field campaign at TA-33 to provide means of assessing the quality of the data that resulted from these activities. Field quality-control samples were collected during the investigation as specified and defined in LANL's ER Generic Quality Assurance Project Plan (QAPjP) for RCRA Facility Investigations (LANL 1991, 0412). All quality control samples were collected at a minimum frequency of 1 per 20 samples. The frequency was higher if less than 20 samples were collected per sampling period. Field quality-control samples include field blanks, rinsate blanks, and field duplicates.

Field blank samples are checked for sample contamination from sample collection and handling procedures. Field blanks collected before October 1993 were taken from "clean" soil collected from a site near Bandelier National Monument. Samples were collected using the same methods and under the same conditions as the environmental field samples. The field blanks collected after October 1993 were taken from distilled and deionized water supplied by LANL's EM-9 laboratory. These samples were also collected under the same conditions as the environmental field samples. The discrepancy in types of material submitted as field blanks was a result of different interpretations of LANL's QAPjP requirements.

Rinsate blank samples were checked for potential cross-contamination of samples resulting from ineffective decontamination procedures. Following decontamination of non-dedicated equipment, the equipment was rinsed again with commercially packaged distilled water. This rinsate was collected in dedicated stainless steel bowls. Rinsate blank samples were collected from this water under the same conditions as the environmental field samples.

Field duplicate samples are analyzed to check for both sampling and laboratory analytical reproducibility. The collection procedure for duplicate samples varied slightly from the environmental sample procedure in that more material was placed into the stainless steel sampling bowl before homogenizing the material. This practice ensured that enough homogenized material was available for both samples before the samples were removed from the sampling bowl. The off-site and the mobile radiation laboratories were not told which samples were duplicates.

All samples used for decision purposes in this report met holding times.

A detailed assessment of quality assurance/quality control (QA/QC) data and the derivation of local background concentrations for inorganic and radionuclide constituents was presented in OU 1122 RFI Report LA-UR-95-882 (LANL 1995, 1212) submitted to EPA in January 1995. This subsection summarizes that assessment.

3.1.1 Inorganic Analyses

Two laboratories performed inorganic analyses over the course of 11 to 14 months. Statistical analyses indicate that no systematic differences were noted between the two laboratories. Inspection of quality control data indicate that analytical processes, especially for arsenic and selenium, were occasionally outside of EPA-defined limits. However, all results were accepted as valid.

3.1.2 Organic Analyses

Four laboratories performed organic analyses over the course of a year. No systematic differences were noted between laboratories. Anomalies that occurred are detailed in Subsection 3.1.3 of RFI report LA-UR-95-882. Inspection of quality control data indicates that individual surrogates and quality control analytes in blind samples were occasionally outside of EPA-defined limits. However, all results were accepted as valid.

3.1.3 Radiochemical Analyses

No systematic differences were noted among three laboratories performing radiochemical analyses. QA/QC data indicate that recoveries in duplicates and blinds were generally satisfactory. Cesium-137 recoveries were occasionally from 25 to 45% high. Uranium and plutonium recoveries from blind samples were satisfactory. Tritium recoveries from control samples were often low, sometimes high, possibly tritium was present in QC samples near its detection limit. Anomalies that occurred are detailed in Subsection 3.1.4 of RFI Report LA-UR-95-882.

3.1.4 High Explosives Analyses

Two laboratories analyzed high explosives (HE) samples. Holding times were met for all samples. Blank QC samples were all in control. No spiked or blind samples were analyzed.

3.1.5 Quality Assessment Samples

The following field QA samples were collected for the purpose of assessing the entire collection and analysis procedures.

- Seventeen soil field banks: uncharacterized, homogenized soil from an off site location, about a mile west of TA-33 near the entrance to Bandelier National Monument
- Seven rinsate blanks to assess decontamination procedures of equipment
- Thirty-two samples split in the field after collection
- Sixteen collocated samples, each within one foot of another sample

The following section summarizes QA assessment associated with PRSs included in this RFI report.

Field blank samples One of the soil field blank samples, sample AAA2188, appeared to be contaminated with silver (7 mg/kg), cadmium (6.6 mg/kg), and chromium (46 mg/kg). These observations are all well above background values. Sample AAA2188 was analyzed for the standard inorganics suite together with approximate 20 other samples included in Report 21424. This report includes sample AAA2035, a sample from PRS 33-013 with high levels of silver (10 mg/kg), cadmium (620 mg/kg) and chromium (670 mg/kg). Also included in this report is grid sample AAA2099 with silver at 4.6 mg/kg, cadmium at 5.2 mg/kg and chromium at 35 mg/kg. Other samples in this batch appear to be unaffected. However, the inorganics results for field blank samples AAA2099 and AAA2188 are considered unusable, because this unusual pattern may be the result of cross contamination or a measurement process out of control. Other evidence from an associated quality control blank sample suggests a laboratory rather than a field problem. The inorganics results for sample AAA2035 from SWMU 33-013 are suspect, but possibly real. PRS 33-013 is a former storage site behind TA-33-86 (Subsection 4.6 of this RFI report). Two other samples from this site showed only background-level inorganics. Phase II investigations are planned for this area to see if the high observations can be replicated and to determine the extent of contamination.

The only organics positively identified in field blanks were bis(2-ethylhexyl)phthalate (at 0.36 mg/kg in sample AAA2240) and di-n-butyl phthalate (at 3.2 mg/kg in sample AAA2248 and 3.6 mg/kg in sample AAA2249). Organic compounds were tentatively identified in 10 of the 17 field blanks. These field blanks were sent to external laboratories for semivolatile analysis; the LANL organics laboratory does not report tentatively identified compounds (TICs). The possibility of some cross contamination is indicated, but not strongly. It is more likely that the TICs represent background levels of organic compounds.

Rinsate samples These samples were collected for the purpose of assessing procedures used to decontaminate equipment, such as an auger, that was to be reused during the sampling campaign. The only organic compound reported in any rinsate blank was 4-hydroxy-4-methyl-2-pentanone, tentatively identified at 11 µg/L in sample AAA2198. The same compound was tentatively identified at 14 mg/kg in sample AAA2063, a sample from the SWMU 33-017 drainages to the east of Main Site that was included in the same batch of samples. Sample AAA2063 was a surface sample that was not collected with an auger, so its presence in the rinsate blank does not indicate a problem with the decontamination procedure.

Some inorganics (barium, nickel, lead, selenium, and zinc) and radionuclides (plutonium and uranium) were reported in the remaining rinsate blanks. Generally, these reported values are barely above detection level, and the associated uncertainty estimate is unrealistically small. Possible exceptions are:

- Plutonium-238 was detected at 0.035 pCi/L in sample AAA2208, a rinsate sample from the coliwasa tube used to collect sample AAA1915 from the 33-002(a) septic tank and samples AAA2040 and AAA2041 from the 33-016 sump. The septic tank sample had a trace (0.013 pCi/L) of plutonium-238. The 33-016 field samples were not analyzed for plutonium, which was not a contaminant of potential concern at this sump. No explanation can be made for this anomaly.

- Lead (4.5 µg/L) and zinc (170 µg/L) were detected in sample AAA6870, a rinsate sample associated with field samples from SWMU 33-011(d). Two samples, AAA6866 and AAA6867, a pavement sample and a soil sample from beneath the asphalt, had high concentrations of lead and zinc. It is possible that decontamination of the pick used to excavate through the asphalt was incomplete.

With the possible exception of the last rinsate sample, these results indicate no significant problem with the decontamination procedures used at TA-33.

Collocated and split samples Sampling and analysis results include 16 pairs of collocated samples, 42 independent pairs of samples from 32 locations, and 45 samples for which the laboratory measurements were replicated for some analytes. The most significant replicability discrepancies were observed between field duplicates (either splits or laboratory samples) and in reported laboratory uncertainties reported for tritium. Reported uncertainty in this case underestimates the replicability of the measurement process. For other radionuclides, the uncertainty appears to represent approximately "two sigma," although uranium data indicate that the measurement process is much better than the reported uncertainties suggest.

Table 3-1 summarizes the observed replicability of QA/QC analytes specific to the 1993 sampling season at TA-33 (columns 2, 3 and 4) and compares the estimates to the uncertainty claimed by the analytical laboratories (column 5).

TABLE 3-1

ESTIMATES OF REPLICABILITY OF MEASUREMENTS OF RADIONUCLIDES AND INORGANICS IN SOIL SAMPLES

ANALYTE	BETWEEN COLLOCATED SAMPLES	BETWEEN SPLITS OF ONE SAMPLE	BETWEEN LABORATORY REPLICATES	TYPICAL REPORTED UNCERTAINTY
Arsenic	4%	4%	2%	20%
Barium	3%	<1%	<0.1%	10%
Beryllium	7%	1%	1%	10%
Cadmium	7%	4%	[a]	20%
Cesium-137	13%	13%	5%	30%
Chromium	7%	2%	<1%	10%
Lead	9%	5%	<1%	20%
Nickel	29%	11%	8%	13%
Plutonium-238	65%	25%	20%	65%
Plutonium-239	50%	22%	3%	30%
Tritium	30%	30%	[a]	1%
Uranium	3%	1%	[a]	20%
Zinc	6%	1%	<1%	10%

[a] Insufficient data.

3.2 Screening Assessment Methodology

3.2.1 Background Comparison

For Main Site and Area 6, samples were collected to calculate background ranges of inorganics and radionuclides. RFI report LA-UR-95-882 contains a detailed analysis of these background data and compares them to LANL-wide background ranges. Comparing both local and LANL background ranges with results of analyses at individual PRSs identifies areas that may have received releases from past LANL activities at TA-33. The values are then compared with screening action levels (SALs) to estimate hazards that may be present.

Table 3-2 presents a comparison of local background concentrations with the LANL-wide framework studies concentrations (Longmire et al in preparation, 1142). TA-33 grid data and background results from cinder cone samples at Area 6 were combined to calculate the local background concentrations(LANL 1995, 1212). Results are compared both with respect to the data ranges (minimum and maximum observations), and with respect to estimated upper tolerance limits (99%, 0.95 UTLs). As indicated in the third column of the table, calculations were performed on the logarithms of the data for several analytes.

Table 3-3 compares radionuclide data from the TA-33 grid with the surveillance data from perimeter stations around LANL. Results are compared both with respect to the data ranges (minimum and maximum observations), and with respect to estimated upper tolerance limits.

3.2.2 Screening Action Levels Comparison

All analytical results relevant to each PRS, by nature of their locations within the PRS or receiving runoff from the PRS, were compared to their respective SALs. PRSs with sampling points failing this test received further evaluation in the form of a preliminary risk assessment or the proposal of EC, VCA, or a Phase II sampling and analysis plan. Sampling points with more than one constituent above background but below SALs were subject to multiple constituent analysis. A detailed discussion of the use of screening methods is found in Appendix J of the IWP (LANL 1993, 1017).

TABLE 3-2

RANGE (EXCLUDING OUTLIERS) AND UPPER TOLERANCE LIMITS FOR INORGANICS IN SOIL SAMPLES

ANALYTE	LOG?	FRAMEWORK DATA			TA-33 LOCAL BACKGROUND		
		MIN (mg/kg)	MAX (mg/kg)	UTL[a] (99%,0.95) (mg/kg)	MIN (mg/kg)	MAX (mg/kg)	UTL (99%,0.95) (mg/kg)
Antimony	NA[b]	<5	<5	2.5 (MAX)	<0.02	0.27	NC[c]
Arsenic	No	0.7	11.2	11.6	1	3.6	4.36
Barium	Yes	27	730	1 140	31	260	268
Beryllium	No	0.31	4	3.31	0.31	1.4	1.51
Cadmium	NA[b]	<0.4	2.7	2.7 (MAX)	<0.4	2.7	NC[c]
Chromium	Yes	1.9	37	34.2	3.4	19	20.7
Lead	No	<4	38	39	7	28	39[d]
Nickel	No	<2	19	26.7	<2	32	17.0[e]
Selenium	NA[b]	<0.6	1.7	1.7 (MAX)	<0.6	1.39	NC[c]
Uranium	Yes	<0.2	2.4	2.82	1.8	5	4.84
Zinc	No	14	120	101	16	76	62.3

[a] UTL = Upper tolerance limit.
[b] These data sets have too many below-detection-level observations to calculate background UTLs.
[c] NC = Not calculated.
[d] The distribution of lead on the grid was too nonnormal to obtain a reliable background UTL. However, the upper tail of the local background data (excluding outliers) is very similar to that of the framework studies data; so the framework background UTL of 39 mg/kg may be used.
[e] Nickel in cinder cone samples is significantly different from nickel in either the background data or on the general grid. A reasonable background UTL for the grid is 17 mg/kg. A more representative background UTL for the combined distribution is 33.4 mg/kg, based on log transformed data.

TABLE 3-3

RANGE (EXCLUDING OUTLIERS) AND UPPER TOLERANCE LIMITS FOR RADIONUCLIDES IN SOIL SAMPLES

ANALYTE	LOG?	SURVEILLANCE DATA			TA-33 GRID DATA		
		MIN (pCi/g)	MAX (pCi/g)	UTL[a] (99%,0.95) (pCi/g)	MIN (pCi/g)	MAX (pCi/g)	UTL (99%,0.95) (pCi/g)
Cesium-137	No	<0.01	1.4	1.5	<1	2.61	2.75
Plutonium-238	No	<0.001	0.140	NN[b]	0.001	0.008	0.0074
Plutonium-239	No	<0.001	0.052	0.025	0.003	0.174	0.058
Tritium	Yes	NA[c]	NA	NA	0.08	43.6	23.2

[a] UTL = Upper tolerance limit.
[b] The distribution of plutonium-238 is too nonnormal to obtain a reliable background UTL. Surveillance plutonium-238 data has more undetected Plutonium-238 than the TA-33 grid data, but the ranges are comparable.
[c] Tritium is not available in pCi/g in the surveillance data (only pCi/ml are given). In terms of pCi/ml, about half of the TA-33 grid observations are above the surveillance maximum of 13 pCi/ml.

3.2.3 Ecotoxicological Screening Assessment Methodology

Ecotoxicological risk assessment is a method of determining effects of hazardous activities on the environment. Several legislative acts provide directives for including ecotoxicological risk assessment to estimate environmental impacts of a number of practices, including releases of hazardous wastes. The directives were formulated to protect the environment and human health, to ensure compliance with state and federal environmental regulations, and to provide a means of recovering damage to natural resources caused by release of hazardous materials. As a result of environmental legislation, the EPA developed guidelines for ecotoxicological risk assessment (EPA, 1992, 0989). The methods for ecotoxicological risk assessment are presently evolving.

Although LANL is addressing management and possible remediation of hazardous wastes under RCRA and a HSWA permit, the LANL ER Project is also currently developing methods for incorporating ecotoxicological assessment. This activity is being undertaken in consultation with EPA and will result in ER guidance documents for ecotoxicological risk assessments. The TA-33 assessment team considered ecotoxicological risk assessment in a manner that was consistent with evolving ER Project and EPA guidance. A review of Main Site and Area 6 by a LANL ecologist indicated that no critical habitat exists in that area. It is unlikely that significant risk is associated with the PRSs discussed in this report.

3.3 Risk Assessment Methodology

The first step of risk assessment methodology is hazard identification. Other steps include assessing the potential for human exposure to contamination, assessing the toxicity of contaminants of concern, and characterizing the site-specific risk to human health. A complete discussion of risk assessment at LANL is described in Appendix K of the IWP (LANL 1993, 1017).

In evaluating the results of the 1993 RFI sampling at TA-33, measured concentrations were compared directly with LANL and TA-33 background UTLs and with media-specific SALs. A complete discussion of the assumptions used in developing SALs can be found in Appendix J

of the IWP (LANL 1993, 1017). SALs provide estimates of environmental concentrations that could affect human health under chronic exposure scenarios. These levels of concern are adjusted downward when more than one contaminant is present close to its SAL. Comparisons with background are used for a small number of constituents (e.g., arsenic and beryllium in soil) for which the calculated SALs are below natural background levels.

3.4 Development of Conclusions and Recommendations

The RFI work plan technical approach was based on a phased effort using reconnaissance (biased) sampling to detect contamination, if present. Conclusions and recommendations in this RFI report are based on sampling and analysis results specified in the RFI work plan. After all results were assembled for a PRS, each sampling point and its data were examined as to appropriateness for the decisions being made for that PRS. Analytical results were compared to TA-33 and LANL background UTLs and to SALs. Recommendations were developed following procedures described in Appendix I of the IWP (LANL 1993, 1017). At many PRSs discussed in this report, contamination above SALs failed a preliminary risk assessment. These PRSs are proposed for either cleanup or Phase II sampling to determine extent of contamination as input for a risk assessment. A brief cleanup proposal or Phase II sampling and analysis plan is included in each discussion. Cleanup plans will be submitted to EPA in accordance with ER Project directives.

4.0 SITE-SPECIFIC RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

Assessment of 1993 Phase I sampling and analysis data identified seven PRSs in which hazardous materials were observed above SALs. Contaminants included VOCs, semivolatile organic compounds (SVOCs), lead, and uranium. Data and evaluation for these PRSs are presented in this section, together with recommendations of VCA, EC, or Phase II sampling. Information located after the RFI work plan was submitted leads to a recommendation of NFA for SWMU 33-003(a), chamber TA-33-4, at material disposal area (MDA D). The PRSs, together with known contaminants, are listed in Table 4-1.

TABLE 4-1

PRSs RECEIVING PHASE I EVALUATIONS IN THIS RFI REPORT

PRS[a]	ACTION	DESCRIPTION	CONTAMINANTS
33-003(a)	NFA[b]	Chamber at MDA D	No pathway for PCB[c] exposure
33-004(a)	Defer action	Active Main Site septic tank	SVOCs[d], VOCs[e] in sludge
33-004(a)	VCA[f]	Abandoned drain field	Lead, SVOCs in drain field
33-007(c)	EC[g]	Area 6 firing site	Uranium
33-009	Phase II	Area 6 surface disposal	PCBs, uncharacterized debris
33-011(d)	Phase II	Storage area, TA-33-20	Uranium, lead
33-013	Phase II	Storage, TA-33-86	Cadmium, chromium
33-016	VCA	TA-33-23 sump	SVOCs in sump sludge
33-017	Phase II	Vehicle maintenance area	SVOCs

[a] PRS= Potential release site.
[b] NFA = No further action.
[c] PCB = Polychlorinated biphenyls.
[d] SVOCs = Semivolatile organic compounds.
[e] VOCs = Volatile organic compounds.
[f] VCA = Voluntary corrective action.
[g] EC = Expedited cleanup.

All PRSs in this section were subject to the initial radiation survey prior to sampling as specified in the RFI Work Plan for OU 1122. In addition, each sample was individually screened at the time of collection as required by the OU 1122 site-specific health and safety plan. Radiation above background was detected at SWMU 33-011(d), described in section 4.4. No radiation was detected at any other site.

4.1 SWMU 33-003(a) Chamber TA-33-4 at MDA D

SWMU 33-003(a) is chamber TA-33-4 at MDA D in East Site. It is discussed in the RFI Work Plan for OU 1122, Subsections 3.5.2.1 and 4.5.3.1 (LANL 1992, 0784). Polychlorinated biphenyls (PCBs) may be present in the chamber. SWMU 33-003(a) is proposed for NFA based on the absence of exposure pathways.

Two chambers were constructed at MDA D in 1948. The chambers are 18 ft by 18 ft octagonal, vault-like structures 11 ft high. They are buried with the roof approximately 30 ft below grade. Access was through a 4 ft by 6 ft elevator shaft at the side of the chamber. The shaft was approximately 46 ft deep. The chambers were used for initiator tests involving milligram

quantities of beryllium. Polonium-210 (half-life 138 days) was used as a source of alpha particles. Chamber TA-33-4 was used once. No debris broke the surface and no radioactive contamination was detected following the test (Buckland 1948, 02-048).

MDA D is located at East Site. From the mid-1950s until 1989, chamber TA-33-4 was buried by the arm of a large berm. The overburden was removed by Weston personnel in 1989 in order to sample the chamber. The remaining surface indication of the chamber is an 8 by 12 ft concrete pad surrounded by chamisa bushes. The chamber lies in a slight depression approximately 25 ft north of the paved loop road at East Site.

4.1.1 Previous Investigation

In 1989 personnel from Roy F. Weston, Inc. drilled three boreholes at TA-33-4 (Fig. 4-1). Samples from the boreholes were analyzed for inorganics, radionuclides, and HE. One sample was analyzed for VOCs and SVOCs. Results are discussed in Subsection 4.1.3.1 of this RFI report.

In 1994 an archival search was conducted to determine the probable contents of the chambers, with emphasis on the composition of the neutron counters. The search revealed the following: steel, copper, and aluminum were present in kilogram amounts; lead from solder was probably present in gram amounts. The chamber contained capacitors which may have contained a total of 5 lb of PCBs at most. No shielding material (lead, cadmium, paraffin) was used. No scintillation fluids or uranium were used (Morgan 1994, 02-088). Beryllium was present in milligram amounts.

4.1.2 Field Investigation

No ER samples were taken directly relevant to the chamber.

4.1.3 Screening Assessment

4.1.3.1 Comparison to Background/SALs

Weston sample LAN33-0022-3, collected at 44 ft beside the chamber, contained 7.7 mg/kg uranium. No other analytes above LANL and TA-33 background UTLs were detected in the Weston boreholes.

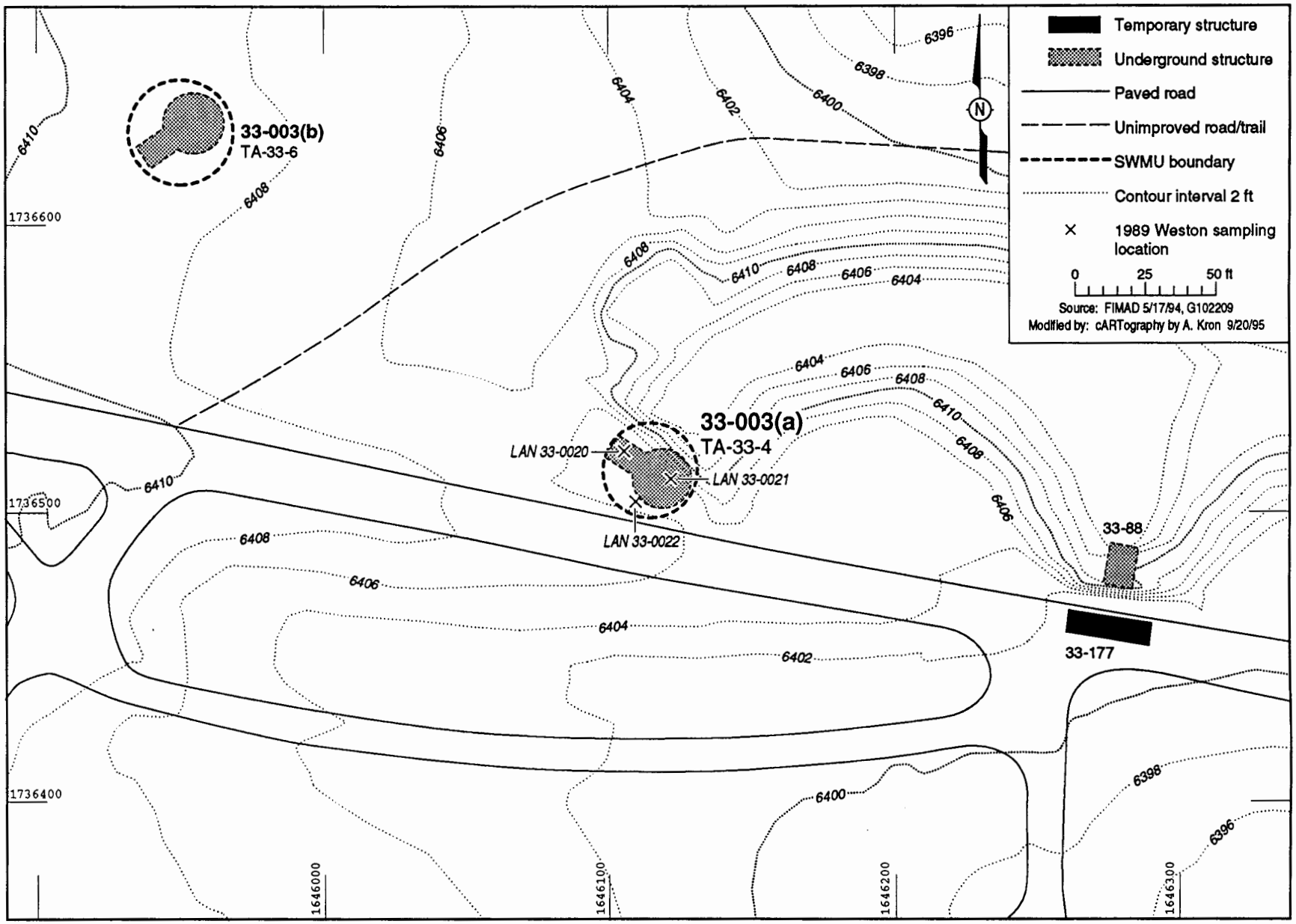

Fig. 4.1. SWMU 33-003(a), chamber TA-33-4 at MDA D.

4.1.3.2 Data Interpretation

Although Weston results have not undergone ER data validation, QA/QC documentation provided with the analyses indicate that the data are credible. No contamination was found near hazardous levels.

4.1.3.3 Risk Assessment

No risk assessment was performed for SWMU 33-003(a). The following is a discussion of pathway from the chamber to receptors.

The recommendation for NFA is based on the absence of any credible exposure pathways for humans to come in contact with contaminants in the chambers. The rationale for this recommendation is as follows:

An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at, or originating from, a site. The following four elements must be present for an exposure pathway to exist.

- A source and mechanism of chemical release,
- A retention or transport medium (e.g., soil),
- A point of potential human contact with the contaminated medium (e.g., exposure point), and
- An exposure route (e.g., ingestion, inhalation, or dermal contact).

Material within the underground chambers is the source of contamination at the MDA D chamber and possibly the elevator shaft. Based upon documentation of experiments at MDA D, materials that may be present in the underground chambers include steel, copper, aluminum, PCBs, and zinc. Gram amounts of lead and sub-gram amounts of beryllium may be present. Trinitrotoluene (TNT) and its combustion products may also be present. PCBs from detector components may be present in the chambers in amounts estimated at a total less than 5 lb (Morgan 1994, 02-088). No research data on the generation of PCB detonation products have been found. Therefore, no statement can be made as to the form of PCB waste in the chamber.

There was no indication that chamber TA-33-4 was breached by the test shot (Buckland 1948, 02-048). Subsequent investigation of the identical chamber at MDA D, TA-33-6, indicated that it was intact after its first test shot (Blackwell 1952, 02-034). Therefore, it is reasonable to presume that the identically designed chamber TA-33-4 maintained its integrity.

Engineering drawing ENG-C 426 indicate that the chambers contain eight vent holes of 6-in. diameter at 3 ft above the bottom of the chamber. Consequently, there is potential for some small fraction of contaminants to escape the chamber. Considering the depth of the chamber (50 ft) and the tendency of PCBs to adsorb on clay particles or concrete, it is unlikely that PCBs or combustion products can migrate upward to a depth (12 ft below surface) where exposure to humans or the environment is feasible. Any undetonated PCBs remaining in chamber TA-33-4 are expected to be adsorbed on the concrete chamber walls, where they become immobile.

Engineering drawing ENG-C 427 indicates that a vent from the chambers extended to the surface. This surface was disturbed during building of the berms and further mixed when the chamber surface features were excavated for Weston sampling in 1989. It is reasonable to presume that any PCBs that may have escaped during detonation in the chamber have been mixed with soil so as to be undetectable.

4.1.3.4 Ecotoxicological Screening Assessment

A global ecotoxicological assessment is presented in Subsection 3.2.3 of this RFI report.

4.1.4 Conclusion and Recommendation

The potential for future migration of PCBs and other potential contaminants from the chamber is negligible because of the lack of a driving force to bring contaminants to the surface, the depth to groundwater (greater than 660 ft to the spring in Ancho Canyon), and the inaccessibility of material in the chambers to potential receptors. Because the floor of the chamber is approximately 50 ft below grade, contaminants are not accessible to LANL workers or visitors. A potential future construction scenario is unlikely to expose workers to chamber contamination because excavation would not occur at depths greater than 12 ft, the average depth of a typical basement. Using the same logic, a residential scenario would not result in exposure to contamination. For these reasons, the chamber is recommended for NFA under LANL ER NFA Criterion 2, "no release to the environment has occurred" (Environmental Restoration Project 1995, 1173).

4.2 SWMU 33-004(a) Main Site Septic System

SWMU 33-004(a) is an active septic system at Main Site. It is discussed in the RFI Work Plan for OU 1122, Subsections 3.2.2.3 and 4.2.3.1 (LANL 1992, 0784). VOCs and SVOCs were detected in sludge. Several SVOCs, including benzo[a]pyrene, were detected at trace levels in the sample taken adjacent to the tank at a depth of 3 to 5 ft. SVOCs and lead were detected in the abandoned drain field. Because the system is active, no remediation is proposed at this time.

The septic system serves all major buildings at Main Site except the tritium facility. The system consists of a 1 360 gal. septic tank, TA-33-31, associated drain lines, two seepage pits, and an abandoned drain field. The system was originally built for sanitary waste. Overflow from the septic tank was directed to a tiled drain field northeast of the tank. The system was redesigned in 1951 to accept industrial waste, primarily from laboratories in TA-33-19, TA-33-113, TA-33-114, and shop TA-33-39. Overflow was rerouted to two 50 ft-deep seepage pits and the drain field was abandoned. Potential contaminants from operations in these buildings over the years were inorganics, industrial solvents (VOCs), photochemical solutions, radionuclides, and SVOCs.

The septic tank lies east of the paved area near shops TA-33-39 and TA-33-113. It is located at the bank cut about 10 ft below the level of the pavement. The entire bank and area around the tank is covered by a dense thicket of chamisa. Below the tank is a channel leading through a densely vegetated area into a shallow tributary of Chaquehui Canyon. The tributary has eroded to bedrock. A National Pollutant Discharge Elimination System (NPDES) noncontact cooling water outfall, EPA-04A147, also drains into this channel. The seepage pits and abandoned drain field are northeast of the tank in a more level area. Lines connecting buildings to the septic tank criss-cross the entire Main Site paved area.

4.2.1 Previous Investigations

No previous investigations were conducted at this PRS.

4.2.2 Field Investigation

Of the samples taken for SWMU 33-004(a), one was sludge and two were liquid taken from the tank itself. Four samples were taken from a borehole drilled adjacent to the tank at 6 in. (in duplicate), 3 to 5 ft, and 13 to 15 ft depths. Boreholes were drilled to a depth of approximately 50 ft adjacent to each of the two seepage pits, and four samples were taken from each borehole. Four samples were collected at joints in the vitrified clay tiles of the abandoned drain field. The remaining samples, 7 surface and 2 subsurface, were taken at random locations in the drain field. Samples AAA2078 and AAA2079 from the sampling grid for SWMU 33-017 (operational releases) also fell within the drain field boundaries. Three other samples, also related to SWMU 33-017, were collected in the drainage below the septic tank, within 100 ft of the tank.

All samples were analyzed for inorganics, SVOCs, uranium, radionuclides by gamma spectroscopy, and tritium. Liquid, sludge, and all subsurface samples were also analyzed for VOCs. Five samples were also analyzed for herbicides, pesticides, and PCBs.

4.2.2.1 Results of Field Surveys

All sampling points were surveyed. No other field surveys were associated with SWMU 33-004(a).

4.2.2.2 Results of Field Screening

No radiation was detected during routine field screening of sampling locations at SWMU 33-004(a).

4.2.3 Screening Assessment

4.2.3.1 Comparison to Background/SALs

Fluid/sludge Inorganics and organic analytes were found in fluid and sludge samples. Table 4-2 lists inorganic analyte concentrations. Table 4-3 lists organic analytes detected. Although UTLs and SAL are not relevant to components of septic tanks, soil UTLs and SALs and drinking water SALs are listed here merely as points of reference.

TABLE 4-2

INORGANIC COMPOUNDS IN FLUID AND SLUDGE SAMPLES FROM SEPTIC TANK TA-33-31

ANALYTE	SAMPLE ID	DEPTH (in.)	MEDIUM	CONCEN-TRATION	LANL UTL[a]	TA-33 UTL	SAL[b]	UNITS
Arsenic	AAA1949	Tank	Sludge	3	11.6	4.4	None	mg/kg
Barium	AAA1948	Tank	Fluid	41	NA[c]	NA	2 000	µg/L
	AAA2232	Tank	Fluid	36	NA	NA	2 000	µg/L
	AAA1949	Tank	Sludge	271	1 140	268	5 600	mg/kg
Cadmium	AAA1949	Tank	Sludge	12.7	2.7	2.7	80	mg/kg
Chromium	AAA2232	Tank	Fluid	7.8	NA	NA	100	µg/L
	AAA1949	Tank	Sludge	50.6	34.3	20.7	400	mg/kg
Nickel	AAA1949	Tank	Sludge	26.8	26.7	17	1 600	mg/kg
Mercury	AAA1948	Tank	Fluid	0.21	NA	NA	2	µg/L
	AAA2232	Tank	Fluid	0.18	NA	NA	2	µg/L
Lead	AAA1948	Tank	Fluid	14.5	NA	NA	50	µg/L
	AAA2232	Tank	Fluid	14.5	NA	NA	50	µg/L
	AAA1949	Tank	Sludge	64.4	39	39	400	mg/kg
Silver	AAA1949	Tank	Sludge	9.2	ND[d]	NA	400	mg/kg
Uranium	AAA1948	Tank	Fluid	1	NA	NA	20	µg/L
	AAA2232	Tank	Fluid	1	NA	NA	20	µg/L
	AAA1949	Tank	Sludge	5	2.82	4.84	95	mg/kg
Zinc	AAA1948	Tank	Fluid	223	NA	NA	10 000	µg/L
	AAA2232	Tank	Fluid	209	NA	NA	10 000	µg/L
	AAA1949	Tank	Sludge	770	101	62.3	24 000	mg/kg

[a] Upper tolerance limit for soil.
[b] Screening action level for soil.
[c] NA = Not applicable.
[d] ND = Not determined.

TABLE 4-3

ORGANICS DETECTED IN FLUID AND SLUDGE SAMPLES FROM SEPTIC TANK TA-33-31

ANALYTE	SAMPLE ID	DEPTH	MEDIUM	RESULT	SAL[a]	EQL[b]	UNIT
Benzo[a]anthracene	AAA1949	Tank	Sludge	28	0.64	0.33	mg/kg
Benzo[a]pyrene	AAA1949	Tank	Sludge	28	0.1	0.33	mg/kg
Benzo[b]fluoranthene	AAA1949	Tank	Sludge	24	0.7	0.33	mg/kg
Benzo[g,h,i]perylene	AAA1949	Tank	Sludge	20	44	0.33	mg/kg
Benzo[k]fluoranthene	AAA1949	Tank	Sludge	23	1.5	0.33	mg/kg
Bis(2-ethylhexyl)phthalate	AAA2232	Tank	Fluid	11	4	0.33	µg/L
Bis(2-ethylhexyl)phthalate	AAA1949	Tank	Sludge	1500	50	0.33	mg/kg
Butanone [2-]	AAA1949	Tank	Sludge	1.6	4 000	0.02	mg/kg
Butyl benzyl phthalate	AAA1949	Tank	Sludge	26	16 000	0.33	mg/kg
Butylbenzene [n-]	AAA1949	Tank	Sludge	0.7	NC[c]	0.005	mg/kg
Butylbenzene [sec-]	AAA1949	Tank	Sludge	0.62	NC	0.005	mg/kg
Butylbenzene [tert-]	AAA1949	Tank	Sludge	0.85	NC	0.005	mg/kg
Carbon disulfide	AAA1949	Tank	Sludge	0.24	7.4	0.005	mg/kg
Chloroform	AAA1948	Tank	Fluid	9.1	100	0.005	µg/L
Chloroform	AAA2232	Tank	Fluid	8.6	100	0.005	µg/L
Chloroform	AAA1949	Tank	Sludge	5.1	0.21	0.005	mg/kg
Chrysene	AAA1949	Tank	Sludge	36	22	0.33	mg/kg
Di-n-butyl phthalate	AAA1949	Tank	Sludge	48	8 000	0.33	mg/kg
Di-n-octyl phthalate	AAA1949	Tank	Sludge	10	1 600	0.33	mg/kg
Dichlorobenzene (1,4) [p-]	AAA1949	Tank	Sludge	5.3	290	0.005	mg/kg
Dichloroethane [1,1-]	AAA1949	Tank	Sludge	3.9	410	0.005	mg/kg
Ethylbenzene	AAA1949	Tank	Sludge	1.9	3 100	0.005	mg/kg
Fluoranthene	AAA1949	Tank	Sludge	42	3 200	0.33	mg/kg
Indeno[1,2,3-cd]pyrene	AAA1949	Tank	Sludge	18	0.41	0.33	mg/kg
Isopropylbenzene	AAA1949	Tank	Sludge	0.73	NC	0.005	mg/kg
Isopropyltoluene [4-]	AAA1949	Tank	Sludge	1.8	NC	0.005	mg/kg
Methylene chloride	AAA1949	Tank	Sludge	0.51	5.6	0.005	mg/kg
Methylphenol [4-]	AAA1948	Tank	Fluid	210	175	0.33	µg/L
Methylphenol [4-]	AAA2232	Tank	Fluid	240	175	0.33	µg/L
Methylphenol [4-]	AAA1949	Tank	Sludge	600	400	0.33	mg/kg
Phenanthrene	AAA1949	Tank	Sludge	37	NC	0.33	mg/kg
Phenol	AAA1948	Tank	Fluid	20	21 000	0.33	µg/L
Phenol	AAA2232	Tank	Fluid	27	21 000	0.33	µg/L
Propylbenzene	AAA1949	Tank	Sludge	2.4	NC	0.005	mg/kg
Pyrene	AAA1949	Tank	Sludge	47	2 400	0.33	mg/kg
Tetrachloroethane [1,1,2,2-]	AAA1949	Tank	Sludge	0.76	3.9	0.005	mg/kg
Tetrachloroethylene	AAA1949	Tank	Sludge	0.51	5.9	0.005	mg/kg
Toluene	AAA1948	Tank	Fluid	30	1 000	0.005	µg/L
Toluene	AAA2232	Tank	Fluid	20	1 000	0.005	µg/L
Toluene	AAA1949	Tank	Sludge	32.8	890	0.005	mg/kg
Trichloro-1,2,2-trifluoroethane [1,1,2-]	AAA1949	Tank	Sludge	80.4	NC	0.005	mg/kg
Trichloroethane [1,1,1-]	AAA1949	Tank	Sludge	78.6	1 000	0.005	mg/kg
Trichloroethene	AAA1949	Tank	Sludge	91.2	3.2	0.005	mg/kg
Trimethylbenzene [1,2,4-]	AAA1949	Tank	Sludge	2.7	NC	0.005	mg/kg
Xylenes (o + m + p) [mixed-]	AAA1949	Tank	Sludge	1.8	160 000	0.005	mg/kg

[a] SAL = Screening action level.
[b] EQL = Estimated quantitation limit.
[c] NC = Not calculated due to insufficient toxicity data.

Borehole In the borehole drilled next to the septic tank, organics were found at the 3 to 5 ft level. Uranium (5.2 mg/kg) was detected slightly above TA-33 background UTL in sample AAA1952. These analytes are listed in Table 4-4.

TABLE 4-4

ANALYTES DETECTED IN THE BOREHOLE ADJACENT TO THE SEPTIC TANK

ANALYTE	SAMPLE ID	DEPTH (in)	MEDIUM	RESULT (mg/kg)	SAL[a] (mg/kg)	EQL[b] (mg/kg)
Benzo[a]anthracene	AAA1952	36-60	Soil	0.41	*1*	*0.33*
Benzo[a]pyrene	AAA1952	36-60	Soil	***0.41***	*0.1*	*0.33*
Benzo[k]fluoranthene	AAA1952	36-60	Soil	0.4	*1*	*0.33*
Chrysene	AAA1952	36-60	Soil	0.45	*96*	*0.33*
Di-n-butyl phthalate	AAA1951	0-6	Soil	0.52	*8 000*	*0.33*
Di-n-butyl phthalate	AAA2242	0-6	Soil	0.47	*8 000*	*0.33*
Di-n-butyl phthalate	AAA1952	36-60	Soil	0.53	*8 000*	*0.33*
Fluoranthene	AAA1952	36-60	Soil	0.89	*3 200*	*0.33*
Phenanthrene	AAA1952	36-60	Soil	0.7	*NC* [c]	*0.33*
Pyrene	AAA1952	36-60	Soil	0.83	*2 400*	*0.33*
Uranium	AAA1952	36-60	Soil	5.2	*95*	*1.4*

[a] SAL = Screening action level.
[b] EQL = Estimated quantitation limit.
[c] NC = Not calculated due to insufficient toxicity data.

Seepage pits The seepage pits could not be sampled directly as called for in Subsection 4.2.4 of the RFI Work Plan for OU 1122 (LANL 1992, 0784) because the pits were filled with large stones. Instead, 50-ft boreholes were drilled as close as feasible to each pit to assess possible contaminant migration. No contaminants were found above background UTLs in samples from these boreholes except di-n-butylphthalate in sample AAA1967, which was also found in the laboratory blanks, suggesting laboratory contamination of the samples.

Drain field Polycyclic aromatic hydrocarbons (PAHs) were found well above SAL. These are listed in Table 4-5. Inorganics detected above LANL and TA-33 background UTLs in the drain field are listed in Table 4-6.

TABLE 4-5

ORGANICS FOUND ABOVE LANL AND TA-33 BACKGROUND UTLs IN THE DRAIN FIELD AT SWMU 33-004(a)

ANALYTE	SAMPLE ID	DEPTH (in)	MEDIUM	RESULT (mg/kg)	SAL[a] (mg/kg)	EQL[b] (mg/kg)
Acenaphthene	AAA9366	36	Soil	0.61	*4 800*	*Not listed*
Acenaphthylene	AAA9362	42	Soil	2.6	*NC* [c]	*0.33*
Acenaphthylene	AAA9364	36	Soil	1.4	*NC*	*0.33*
Acenaphthylene	AAA9366	36	Soil	7.7	*NC*	*0.33*
Acenaphthylene	AAA9368	24	Soil	0.68	*NC*	*0.33*
Anthracene	AAA9362	42	Soil	5.4	*24 000*	*0.33*
Anthracene	AAA9364	36	Soil	2.3	*24 000*	*0.33*
Anthracene	AAA9366	36	Soil	15	*24 000*	*0.33*
Anthracene	AAA9368	24	Soil	1.3	*24 000*	*0.33*
Benzo[a]anthracene	AAA9362	42	Soil	**19**	*1*	*0.33*
Benzo[a]anthracene	AAA9364	36	Soil	**9.8**	*1*	*0.33*
Benzo[a]anthracene	AAA9366	36	Soil	**64**	*1*	*0.33*
Benzo[a]anthracene	AAA9368	24	Soil	**5.4**	*1*	*0.33*
Benzo[a]pyrene	AAA9362	42	Soil	**13**	*0.1*	*0.33*
Benzo[a]pyrene	AAA9364	36	Soil	**8.2**	*0.1*	*0.33*
Benzo[a]pyrene	AAA9366	36	Soil	**56**	*0.1*	*0.33*
Benzo[a]pyrene	AAA9368	24	Soil	**4.7**	*0.1*	*0.33*
Benzo[b]fluoranthene	AAA9362	42	Soil	**15**	*1*	*0.33*
Benzo[b]fluoranthene	AAA9364	36	Soil	**6.6**	*1*	*0.33*
Benzo[b]fluoranthene	AAA9366	36	Soil	**43**	*1*	*0.33*
Benzo[b]fluoranthene	AAA9368	24	Soil	**3.7**	*1*	*0.33*
Benzo[g,h,i]perylene	AAA9362	42	Soil	2.8	*NC*	*0.33*
Benzo[g,h,i]perylene	AAA9364	36	Soil	2.5	*NC*	*0.33*
Benzo[g,h,i]perylene	AAA9366	36	Soil	4.3	*NC*	*0.33*
Benzo[g,h,i]perylene	AAA9368	24	Soil	2.1	*NC*	*0.33*
Benzo[k]fluoranthene	AAA9362	42	Soil	**12**	*1*	*0.33*
Benzo[k]fluoranthene	AAA9364	36	Soil	**7.1**	*1*	*0.33*
Benzo[k]fluoranthene	AAA9366	36	Soil	**47**	*1*	*0.33*
Benzo[k]fluoranthene	AAA9368	24	Soil	**4.8**	*1*	*0.33*
Bis(2-ethylhexyl)phthalate	AAA9362	42	Soil	2.6	*50*	*0.33*
Bis(2-ethylhexyl)phthalate	AAA9364	36	Soil	0.48	*50*	*0.33*
Bis(2-ethylhexyl)phthalate	AAA9366	36	Soil	1.8	*50*	*0.33*
Bis(2-ethylhexyl)phthalate	AAA9368	24	Soil	0.97	*50*	*0.33*
Chrysene	AAA9362	42	Soil	14	*96*	*0.33*
Chrysene	AAA9364	36	Soil	7.5	*96*	*0.33*
Chrysene	AAA9366	36	Soil	58	*96*	*0.33*
Chrysene	AAA9368	24	Soil	5.1	*96*	*0.33*
Di-n-butyl phthalate	AAA9362	42	Soil	1.3	*8 000*	*0.33*
Di-n-butyl phthalate	AAA9366	36	Soil	0.72	*8 000*	*0.33*
Di-n-butyl phthalate	AAA9368	24	Soil	0.44	*8 000*	*0.33*

TABLE 4-5 (CONTINUED)

INORGANICS FOUND ABOVE LANL AND TA-33 BACKGROUND UTLs IN THE DRAIN FIELD AT SWMU 33-004(a)

ANALYTE	SAMPLE ID	DEPTH (in)	MEDIUM	RESULT (mg/kg)	SAL[a] (mg/kg)	EQL[b] (mg/kg)
Dibenzo[a,h]anthracene	AAA9362	42	Soil	**1.4**	*0.1*	*0.33*
Dibenzo[a,h]anthracene	AAA9364	36	Soil	**1.4**	*0.1*	*0.33*
Dibenzo[a,h]anthracene	AAA9366	36	Soil	**2.6**	*0.1*	*0.33*
Dibenzo[a,h]anthracene	AAA9368	24	Soil	**1.1**	*0.1*	*0.33*
Fluoranthene	AAA9362	42	Soil	37	*3 200*	*0.33*
Fluoranthene	AAA9364	36	Soil	20	*3 200*	*0.33*
Fluoranthene	AAA9366	36	Soil	120	*3 200*	*0.33*
Fluoranthene	AAA9368	24	Soil	9.7	*3 200*	*0.33*
Fluorene	AAA9362	42	Soil	1.1	*3 200*	*0.33*
Fluorene	AAA9366	36	Soil	0.4	*3 200*	*0.33*
Fluorene	AAA9368	24	Soil	2.2	*3 200*	*0.33*
Indeno[1,2,3-cd]pyrene	AAA9362	42	Soil	**4.5**	*1*	*0.33*
Indeno[1,2,3-cd]pyrene	AAA9364	36	Soil	**3.9**	*1*	*0.33*
Indeno[1,2,3-cd]pyrene	AAA9366	36	Soil	**56**	*1*	*0.33*
Indeno[1,2,3-cd]pyrene	AAA9368	24	Soil	**3.2**	*1*	*0.33*
Phenanthrene	AAA9362	42	Soil	8.6	*NC*	*0.33*
Phenanthrene	AAA9364	36	Soil	3.7	*NC*	*0.33*
Phenanthrene	AAA9366	36	Soil	25	*NC*	*0.33*
Phenanthrene	AAA9368	24	Soil	2.3	*NC*	*0.33*
Pyrene	AAA9362	42	Soil	31	*2 400*	*0.33*
Pyrene	AAA9364	36	Soil	17	*2 400*	*0.33*
Pyrene	AAA9366	36	Soil	100	*2 400*	*0.33*
Pyrene	AAA9368	24	Soil	8.1	*2 400*	*0.33*

[a] UTL = Upper tolerance limit.
[b] SAL = Screening action level.
[c] NA = Not available.
[d] ND = Not determined.

TABLE 4-6

INORGANICS DETECTED IN THE DRAIN FIELD AT SWMU 33-004(a)

ANALYTE	SAMPLE ID	DEPTH (ft)	MEDIUM	CONCEN-TRATION (mg/kg)	LANL UTL[a] (mg/kg)	TA-33 UTL (mg/kg)	SAL[b] (mg/kg)
Chromium	AAA9362	3.5	Soil	38.5	34.3	20.7	400
	AAA9368	2	Soil	40.7	34.3	20.7	400
Mercury	AAA9362	3.5	Soil	0.5	0.1	NA[c]	24
	AAA9364	3	Soil	0.86	0.1	NA	24
	AAA9366	3	Soil	0.5	0.1	NA	24
	AAA9368	2	Soil	1.4	0.1	NA	24
Lead	AAA9362	3.5	Soil	68	39	39	400
	AAA9364	3	Soil	59	39	39	400
	AAA9366	3	Soil	54	39	39	400
	AAA9362	3.5	Soil	467	39	39	400
Silver	AAA9362	3.5	Soil	10.3	ND[d]	ND	400
	AAA9364	3	Soil	8.3	ND	ND	400
	AAA9366	3	Soil	2.8	ND	ND	400
	AAA9362	3.5	Soil	15.4	ND	ND	400
Uranium	AAA9362	3.5	Soil	5	2.8	4.8	95
Zinc	AAA9362	3.5	Soil	146	101	62.3	24 000
	AAA9364	3	Soil	111	101	62.3	24 000
	AAA9368	2	Soil	226	101	62.3	24 000

[a] Upper tolerance limit.
[b] Screening action level.
[c] Not determined.

Drainage Inorganics detected above background in the three drainage samples are listed in Table 4-7. No organics were detected in these samples.

Low levels of tritium were found in all samples, all well below the soil SAL of 810 pCi/g. TICs were noted in 17 of the 36 samples. PCBs were listed as TICs in several surface samples. Analytical results as well as physical indications noted during sampling at the septic tank indicated that the tank or associated structures are leaking. All sampling points are shown in Fig. 4-2.

TABLE 4-7

INORGANIC CONTAMINANTS FOUND ABOVE LANL AND TA-33 BACKGROUND UTLs IN THE DRAINAGE AT SWMU 33-004(a)

ANALYTE	SAMPLE ID	DEPTH (in.)	MEDIUM	CONCEN-TRATION	LANL UTL[a] (mg/kg)	TA-33 UTL (mg/kg)	SAL[b] (mg/kg)
Nickel	AAA2052	0-6	Soil	87	26.7	17	1 600
	AAA2053	0-6	Soil	35	26.7	17	1 600
Lead	AAA2052	0-6	Soil	46	39	39	400
	AAA2053	0-6	Soil	98	39	39	400
Silver	AAA2053	0-6	Soil	8.8	ND[c]	ND	400
	AAA2054	0-6	Soil	46	ND	ND	400
Zinc	AAA2053	0-6	Soil	330	101	62.3	24 000
	AAA2054	0-6	Soil	350	101	62.3	24 000

[a] UTL = Upper tolerance limit.
[b] SAL = Screening action level.
[c] ND = Not determined.

4.2.3.2 Data Interpretation

Results of sampling and analysis indicate that the septic tank has received hazardous effluent in the form of organics. High concentrations of bis(2-ethylhexyl)phthalate (1 500 mg/kg) may be due to plastics in the sample or may be indication of plasticizing operations at Main Site at some time. PAHs in the sludge may come from several sources, including asphalt caulking.

PAH contamination in the drain field is due to tar paper used in construction, shown in engineering drawing ENG-C 11641. Although results from boreholes adjacent to the seepage pits do not indicate the spread of contamination, the contents of the pits could not be sampled, nor was the possibility of a plume beneath the pits explored.

4.2.3.3 Risk Assessment

No risk assessment was performed for this PRS.

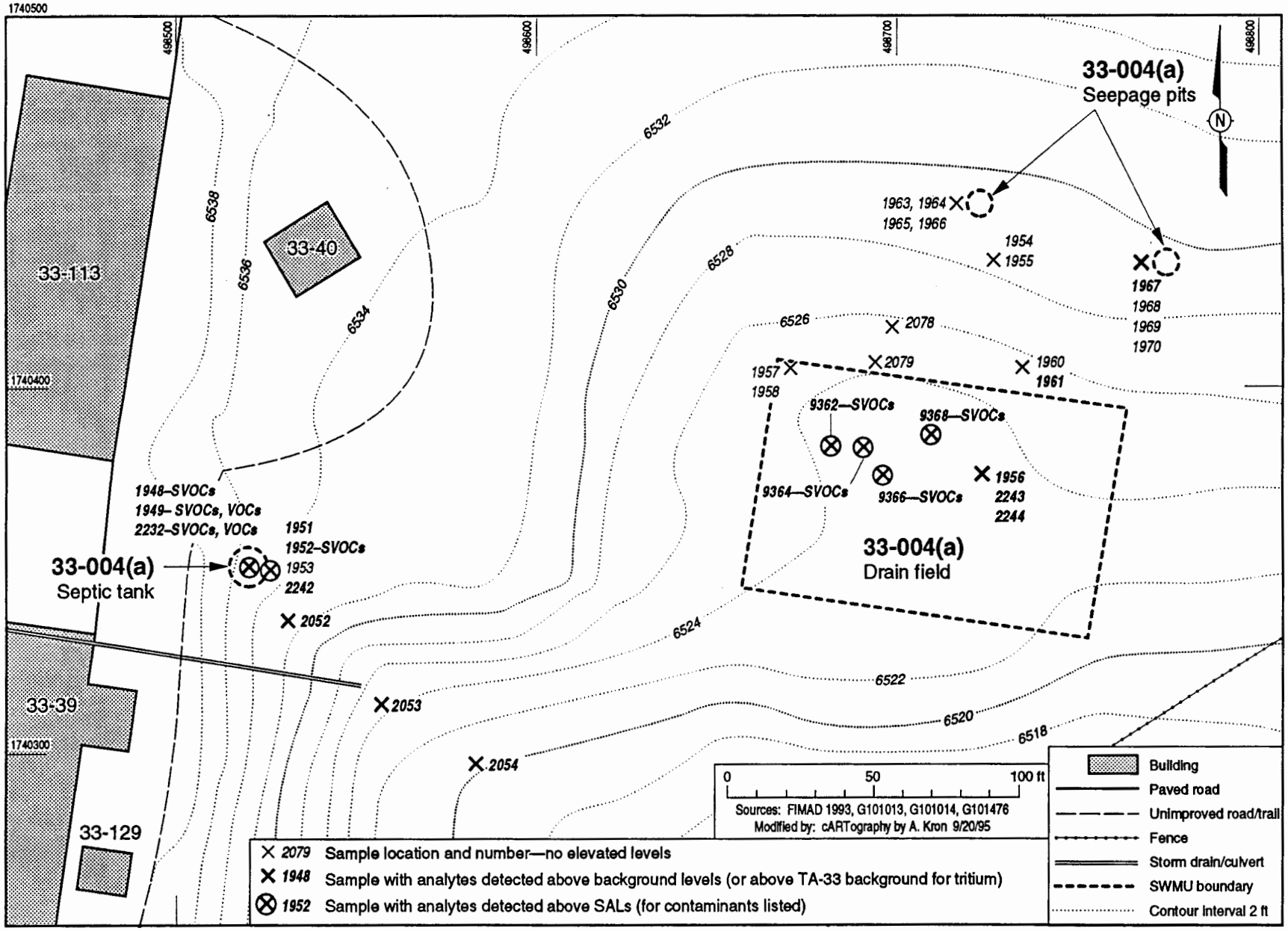

Fig. 4-2. Main Site: SWMU 33-004(a), septic system.

4.2.3.4 Ecotoxicological Screening Assessment

A global ecotoxicological assessment is presented in Subsection 3.2.3 of this RFI report.

4.2.4 Conclusion and Recommendation

The septic system is active and is expected to remain so for the foreseeable future because TA-33 sanitary waste streams will not be routed to the LANL sewage treatment plant. Most of the contamination is concentrated in the sludge, although low levels of SVOCs may be migrating from the tank. Physical evidence indicates that the tank is leaking. The leaking septic tank was reported to Johnson Controls, Inc. and the TA-33 operating group in 1994. Because the septic system is active and PAHs in the drain field have no viable pathway to receptors, no additional action is proposed until decommissioning.

PCBs were detected in surface samples from the drain field. These will be investigated in conjunction with Phase I sampling for C-33-001 discussed in Subsection 5.4 of this report.

4.3 SWMU 33-007(c) Firing Site Catcherboxes

SWMU 33-007(c) is the firing site at Area 6. The SWMU was discussed at length in RFI Report LA-UR-95-882, Subsection 4.11 submitted in January 1995 (LANL 1995, 1212). During 1994 trenching at the catcherboxes, subsurface uranium chunks were discovered. At the time of submittal of LA-UR-95-882, no results had been received for inorganic analyses of the 1994 soil samples. This subsection reports those analyses; it discusses only the catcherboxes in SWMU 33-007(c). An EC is proposed to remove uranium.

4.3.1 Previous Investigations

Results of sampling and analysis from SWMU 33-007(c) were discussed in detail in the January 1995 RFI report for TA-33. Because of incomplete data, no recommendation was made for the SWMU. During trenching, several intact experimental devices were unearthed. No external radiation was detected. Composition of the devices is unknown; casings appear to be steel. The devices are kept in locked storage at TA-33.

4.3.2 Field Investigation

Trenching during the 1994 sampling season uncovered chunks of corroded uranium metal oxidized to hydrated uranyl hydroxides. At that time, nine samples were collected and analyzed for uranium and inorganics.

4.3.2.1 Results of Field Surveys

All sampling points were surveyed. No other field surveys were associated with SWMU 33-007(c).

4.3.2.2 Results of Field Screening

During trenching in the catcherboxes, radiation was detected during routine field screening of soil in backhoe buckets. Radioactive soil was segregated during trenching and reburied during demobilization.

4.3.3 Screening Assessment

4.3.3.1 Comparison to Background/SALs

This comparison addresses only samples taken from the catcherboxes. Of inorganics, only uranium was found above SALs. Inorganics detected above LANL and TA-33 background UTLs are listed in Table 4-8, as are uranium results.

TABLE 4-8

INORGANICS DETECTED ABOVE LANL AND TA-33 BACKGROUND UTLS AT SWMU 33-007(c) CATCHERBOXES

ANALYTE	SAMPLE ID	DEPTH (ft)	MEDIUM	CONCEN-TRATION (mg/kg)	LANL UTL[a] (mg/kg)	TA-33 UTL (mg/kg)	SAL[b] (mg/kg)
Lead	AAA9846	4	Soil	160	39	39	400
Nickel	AAA9843	0-0.5	Soil	51.5	26.7	17	1 600
	AAA9844	0-0.5	Soil	31.8	26.7	17	1 600
	AAA9848	0-0.5	Soil	104	26.7	17	1 600
	AAA9916	2	Soil	48	26.7	17	1 600
Silver	AAA9846	4	Soil	1	ND[c]	ND	400
	AAA9847	4	Soil	2	ND	ND	400
Uranium	AAA9844	0-0.5	Soil	**6 770**	2.8	4.8	95
	AAA9848	0-0.5	Soil	**218**	2.8	4.8	95
Zinc	AAA9846	4	Soil	1 200	101	62.3	24 000

[a] UTL = Upper tolerance limit.
[b] SAL = Screening action level.
[c] ND = Not determined.

Because several inorganics were detected within a small volume of material, a multiconstituent analysis is presented in Table 4-9 using the highest result detected in any sample. The contaminant fraction is determined by dividing the concentration of an analyte by its SAL. If the sum of contaminant fractions is less than one, then the multiple contamination does not pose a hazard. This analysis is intended to determine if soil should be cleaned of contamination other than uranium. Lead is included in the multiconstituent analysis, although its toxicological effect, neurological damage to young children, is distinct from the systemic effects of the other contaminants.

TABLE 4-9

MULTICONSTITUENT ANALYSIS OF INORGANICS AT SWMU 33-007(c) CATCHERBOXES, EXCLUDING URANIUM

ANALYTE	SAMPLE ID	CONCENTRATION (mg/kg)	SAL[a] (mg/kg)	CONTAMINANT FRACTION
Lead	AAA9846	160	400	0.15
Nickel	AAA9848	104	1 600	0.065
Silver	AAA9846	2	400	0.005
Zinc	AAA9846	1 600	24 000	0.067
SUM	NA[b]	NA	NA	**0.287**

[a] SAL = Screening action level.
[b] NA = Not applicable.

4.3.3.2 Data Interpretation

At least one pocket of uranium contamination is known in the catcherboxes, both by visual observation and sampling and analysis. Multiconstituent analysis of inorganics was performed using the highest value of each contaminant found in the eight samples collected. The resulting sum of each fraction (0.287) is less than one, indicating that the estimated volume of 240 cu yd of soil does not contain sufficient contamination to present an inorganic hazard. As is noted in Subsection 3.2.2 of RFI Report LA-UR-95-882, which discusses derivation of TA-33 background UTLs, the grid sample set from the cinder cone at Area 6 contained several outliers with elevated lead, nickel, and zinc. These data imply that at least some of the elevated inorganic levels may be background related.

4.3.3.3 Risk Assessment

No risk assessment was performed for SWMU 33-007(c).

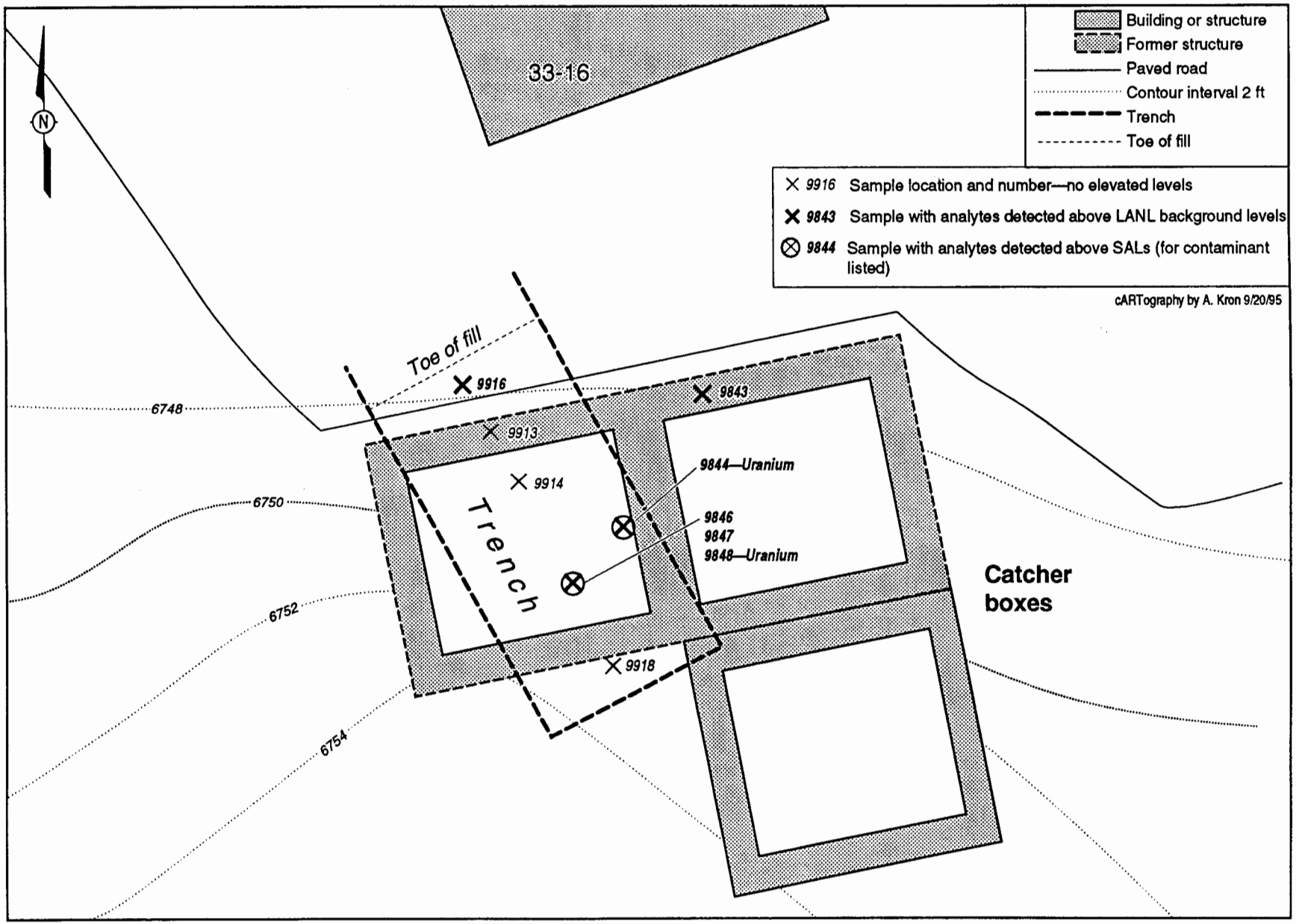

Fig. 4-3. Catcher boxes at SWMU 33-007(c).

4.3.3.4 Ecotoxicological Screening Assessment

A global ecotoxicological assessment is presented in Subsection 3.2.3 of this RFI report.

4.3.4 Conclusions and Recommendations

An EC is proposed for uranium in the catcherboxes at SWMU 33-007(c). Experimental debris will be removed. Options for uranium include drumming and removal, soil separation and cleaning of contaminated soil by an *in-situ* leaching technique, or offsite treatment and disposal. An EC plan will be prepared.

4.4 SWMU 33-009 Area 6 Surface Disposal

SWMU 33-009 is a surface disposal area at Area 6. It is discussed in the RFI Work Plan for OU 1122, Subsections 3.3.2.4 and 4.3.3.1 (LANL 1992, 0784). Sampling found low levels of PCBs over the surface of the SWMU. In one sample, PCBs were detected qualitatively as a TIC in an SVOC analysis. SWMU 33-009 is targeted for Phase II investigation.

The disposal area was created for two firing pads at Area 6. After the Area 6 firing site was abandoned, the level area and slope of the cinder cone were used for disposal of various materials, including uranium chips from the shops at Main Site, metal chunks, spent light bulbs, old tires, drums of unknown content, and like debris. The site was cleaned in 1974, although the cleanup did not remove all trash from the area. Debris, mostly broken glass and metal chunks, remains on the slope.

Between 1967 and 1974, defective capacitors from Project Sherwood were stored at the disposal site. Most capacitors were removed during the 1974 cleanup. In 1994 an empty capacitor was found partially buried in the cinders. Analyses indicated PCB contamination (140 and 195 mg/kg) in the small amounts of oil remaining in the capacitor, but only 2 mg/kg in the surrounding soil.

Potential contaminants listed for this SWMU were uranium, beryllium, other inorganics, and PCBs.

SWMU 33-009 includes the excavated area and adjacent slope of the basaltic cinder cone at Area 6. The leveled area in the cone is approximately 75 ft by 100 ft. Excavation has produced a vertical wall about 10 ft high at the eastern end. A moderately sloping area extends approximately 100 ft west, then becomes a steep, 80-ft slope of basaltic cinder pebbles descending into a tributary of Chaquehui Canyon at the western edge of Area 6. Shrubs,

primarily chamisa, grow at the top of the slope but much of the face consists of bare, loose pebbles. A drainage channel has formed at the south edge of the slope. At the north end is a natural drainage formed in tuff. Small, unconsolidated, basalt-cinder pebbles constitute the body of the slope. The site does not collect or retain water.

The cinder cone predates deposition of Bandelier Tuff units that form the mesas at TA-33. Based on drilling at MDA K, cone deposits extends approximately 300 ft below the surface and overlie a unit of "Pajarito Plateau" tholeiitic basalt, as shown in Fig. 5 of Reneau et al. (1994, 02-092). Observations indicate that there is no soil-tuff interface under most of the slope at SWMU 33-009. Cinder pebbles abut tuff in the drainage at the north end of the SWMU due to excavation when Area 6 was developed.

4.4.1 Previous Investigations

No previous investigations were conducted at this PRS.

4.4.2 Field Investigation

Of the surface samples collected at SWMU 33-009, seven samples, including one duplicate, were taken from the face of the slope at random locations. Four random samples from SWMU 33-007(c) are located within the sloping surface of the disposal area. Four additional samples were taken in the drainage leading from the base of the slope toward Chaquehui Canyon. The drainage channel of outfall SWMU 33-004(g), where five samples were collected, bounds the area to the north (Fig. 4-4). Results of these 20 samples were used in decisions for SWMU 33-009.

All samples were analyzed for SVOCs, inorganics, uranium, PCBs, and gamma emitters. Four samples were analyzed for HE, two were analyzed for herbicides, and one for pesticides.

4.4.2.1 Results of Field Surveys

All sampling points were surveyed. Because of a history of dumping metal objects at the SWMU, magnetic and electromagnetic geophysical surveys were performed at SWMU 33-009. No anomalies were detected that could not be attributed to known features at the site despite high background due to elevated iron concentrations in the basaltic cinders.

4.4.2.2 Results of Field Screening

No radiation was detected during routine field screening of sample locations at SWMU 33-009.

4.4.3 Screening Assessment

4.4.3.1 Comparison to Background/SALs

PCBs were detected in 15 samples relevant to SWMU 33-009. PCB-containing samples are discussed in Subsection 4.4.3.2. Table 4-10 lists concentrations of analytes other than PCBs detected above LANL or TA-33 background UTLs at SWMU 33-009. Sample AAA2145 was taken at the outfall from building TA-33-16. Inorganics found at that sampling point were collected for SWMU 33-004(g), as discussed in Subsection 4.2 of RFI Report LA-UR-95-882 submitted in January 1995 (LANL 1995, 1212). Sampling points are shown in Fig. 4-4.

TABLE 4-10

ANALYTES DETECTED ABOVE LANL AND TA-33 UTLs AT SWMU 33-009[a]

ANALYTE	SAMPLE ID	DEPTH (in.)	MEDIUM	CONCENTRATION (mg/kg)	LANL UTL[b] (mg/kg)	TA-33 UTL (mg/kg)	SAL[c] (mg/kg)
Nickel	AAA2147	0-6	Soil	46	26.7	17	1 600
	AAA2148	0-6	Soil	38	26.7	17	1 600
	AAA2149	0-6	Soil	52	26.7	17	1 600
	AAA2150	0-6	Soil	44	26.7	17	1 600
	AAA2152	0-6	Soil	60	26.7	17	1 600
	AAA2155	0-6	Soil	67	26.7	17	1 600
	AAA2166	0-6	Soil	46	26.7	17	1 600
	AAA2167	0-6	Soil	32	26.7	17	1 600
	AAA2168	0-6	Soil	45	26.7	17	1 600
	AAA2169	0-6	Soil	34	26.7	17	1 600
	AAA2171	0-6	Soil	33	26.7	17	1 600
	AAA2173	0-6	Soil	36	26.7	17	1 600
	AAA2174	0-6	Soil	28	26.7	17	1 600
	AAA2175	0-6	Soil	31	26.7	17	1 600
Uranium	AAA2168	0-6	Soil	5.5	2.8	4.8	95
Zinc	AAA2147	0-6	Soil	108	101	62.3	24 000
	AAA2168	0-6	Soil	130	101	62.3	24 000

[a] PCBs are excluded because they are discussed in Subsection 4.4.3.2.
[b] UTL = Upper tolerance limit.
[c] SAL = Screening action level.

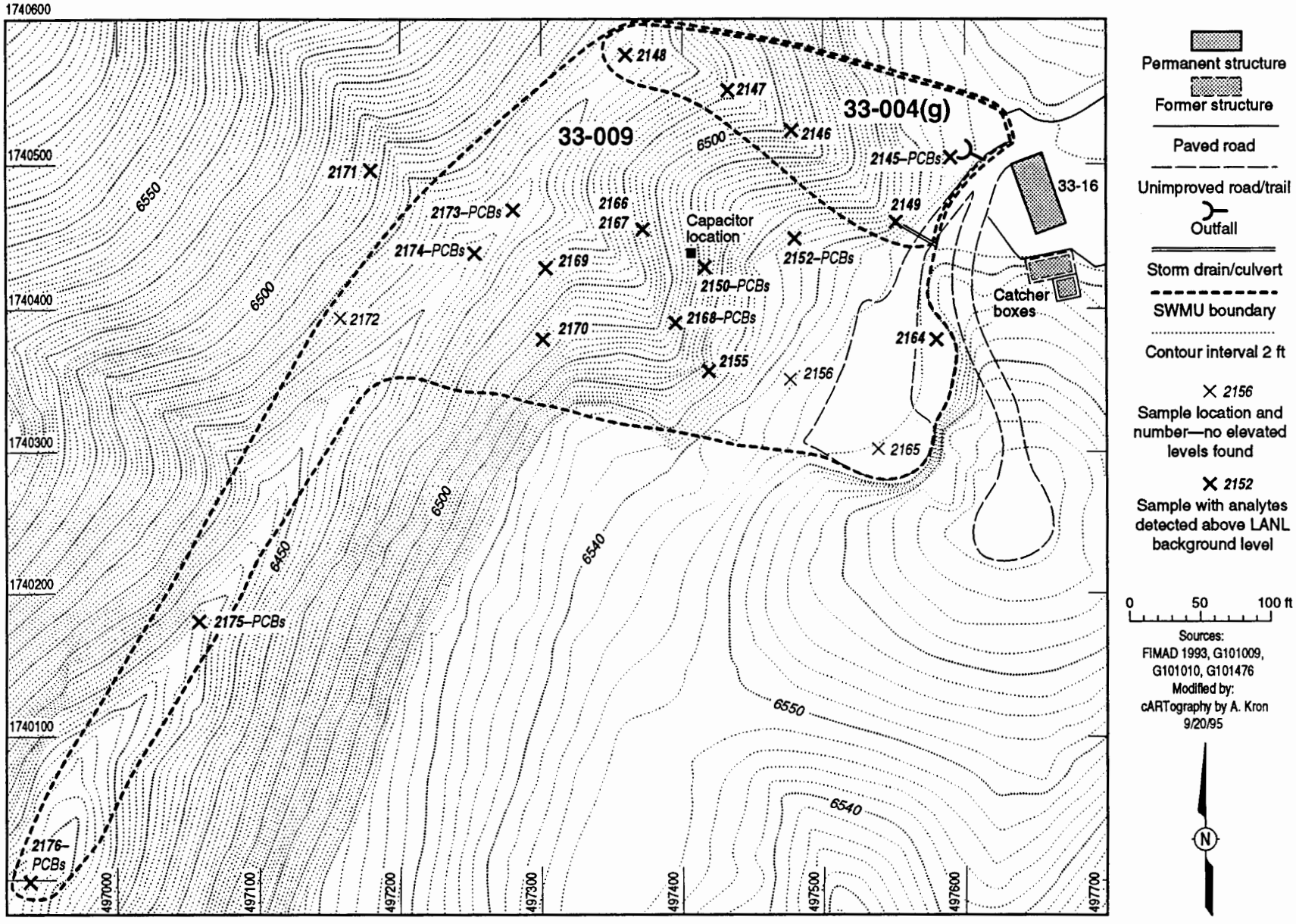

Fig. 4-4. Area 6: SWMU 33-009 showing overlapping SWMU 33-004(g).

4.4.3.2 Data Interpretation

The primary concern at PRS 33-009 is the low levels of PCBs (0.10 to 1.57 mg/kg) found in samples AAA2168, AAA2150, and AAA2152 collected at the top of the slope and in the four drainage samples, AAA2173 to AAA2176. No PCBs were found in samples from the lower half of the slope (samples AAA2167 to AAA2170). These analyses were performed using the SW-846 gas chromatography/electron capture method for PCBs and pesticides. Neither PCB nor SVOC analyses were requested for SWMU 33-007(c) samples that overlap SWMU 33-009, but PCB results were obtained for two samples, AAA2150 and AAA2152, submitted for pesticide analysis. PCBs were tentatively identified by SVOC analysis for sample AAA2145 from SWMU 33-004(g); results are qualitative only. This sample is located at the outfall from TA-33-16, which suggests that capacitors may have been stored as far north as this point along the rim of the level area.

4.4.3.2.1 Computations For PCBs at Area 6

PCB data are reported for: 11 Phase I samples from SWMU 33-009 (seven surface samples, including one collocated pair and four drainage samples), two surface samples from SWMU 33-007(c), and one surface sample taken at the SWMU 33-004(g) outfall. In addition, results are available for a surface soil sample collected at the site of the capacitor that was removed from the slope of SWMU 33-009.

The SWMU 33-004(g) samples were not analyzed for PCBs; the reported results are TICs from one SVOC analysis [no PCBs were identified in the remaining 33-004(g) samples], and are reported as a range of values for mixed Aroclors™. The remaining samples were analyzed following the standard procedure for PCBs. The primary PCB identified was Aroclor 1254™. Aroclor 1260™ was identified in one sample from PRS 33-007(c). No other specific Aroclors™ were identified above detection levels in any sample, but mixed Aroclors™ were also reported (generally at the level given for Aroclor 1254™) for the samples from SWMU 33-009. The data for Aroclor 1254™ and for mixed Aroclors™ are presented in Table 4-11. Also shown in the table are imputed values for mixed Aroclors™ for the two SWMU 33-007(c) samples and the 1994 result of analyzing under the capacitor.

Table 4-12 shows means and 95% upper confidence limits (UCLs) for the means of the data subsets in Table 4-11. Customarily, it is the UCL that is compared with regulatory standards. In computing these statistics, values less than the detection limit have been replaced by one-half the reported detection limit (DL), as recommended in EPA guidance documents (EPA 1989, 0305). The upper end of the reported range of TIC values is used for mixed Aroclors™ in AAA2145.

TABLE 4-11

PCB CONCENTRATIONS FOR AREA 6

PRS[a]	LOCATION	SAMPLE ID	AROCLOR™ (mg/kg)	
			1254	MIXED
33-004(g)	Outfall	AAA2145	None	0.57-2.5(TIC)[b]
33-007(c)	Surface	AAA2150	<0.0875	*0.0703*[c]
33-007(c)	Surface	AAA2152	0.0535	*0.0535*[c]
33-009	Surface	AAA2166	<0.0373	<0.0758
33-009	Surface	AAA2167[d]	<0.0370	<0.0370
33-009	Surface	AAA2168	1.3800	1.3800
33-009	Surface	AAA2169	<0.0381	<0.0381
33-009	Surface	AAA2170	<0.0370	<0.0370
33-009	Surface	AAA2171	<0.0365	<0.0365
33-009	Surface	AAA2172	<0.0368	<0.0368
33-009	Drainage	AAA2173	0.1000	0.1000
33-009	Drainage	AAA2174	1.5700	1.5700
33-009	Drainage	AAA2175	0.5200	0.5200
33-009	Drainage	AAA2176	0.1700	0.1700
33-009	Capacitor	94.00131	2.0000	*2.0000*

[a] PRS = Potential release site.
[b] Tentatively identified compound.
[c] Inputed values for mixed Aroclors™ for cases where only specific Aroclors™ were reported. In particular, the value for AAA2150 is the reported value for Aroclor 1260™ in this sample, which was the only Aroclor™ reported above detection limit (DL) for this sample.
[d] Sample colocated with sample AAA2166.

TABLE 4-12

MEANS AND 95% UPPER CONFIDENCE LIMITS FOR PCBS AT AREA 6

POPULATION	STATISTIC[a]	NO. SAMPLES	AROCLOR™ (mg/kg)	
			1254	MIXED
Surface	Mean	8	0.1963	0.2020
	95% UCL[b]		0.5389	0.5431
Surface with capacitor	Mean	9	0.3967	0.4018
	95% UCL		0.8895	0.8928
Drainage with outfall	Mean	4-5	0.5900	0.9720
	95% UCL		1.5121	2.0772
All	Mean	13-14	0.4562	0.6054
	95% UCL		0.8194	1.0320

[a] In computing means and UCLs, values less than DL are replaced by one-half the reported DL. All means and UCLs are computed without the collocated sample AAA2167. Means and UCLs for Aroclor 1254™ are computed without imputing any value to the SWMU 33-004(g) outfall sample AAA2145. However, means and UCLs for mixed Aroclors™ in drainages and overall are computed using the upper bound of the TIC values for AAA2145, i.e., 2.5 ppm.
[b] UCL = Upper confidence limit.

4.4.3.3 Risk Assessment

No risk assessment was performed for this PRS.

4.4.3.4 Ecotoxicological Screening Assessment

A global ecotoxicological assessment is presented in Subsection 3.2.3 of this report.

4.4.4 Conclusion and Recommendation

Phase II is proposed for SWMU 33-009, as discussed in Appendix B. Because PCBs were detected in one sample at outfall SWMU 33-004(g), the boundary of SWMU 33-009 has been extended to include the outfall and its drainage (Fig. 4-4). Although PCBs were not reported in samples from the lower part of the slope, a spent capacitor was discovered there in 1994. Therefore, metal-detecting geophysical studies are proposed for all parts of the site where cinder pebbles might cover additional buried capacitors. If found, such capacitors will be removed and the soil beneath them sampled to determine whether PCBs have been released to the environment.

4.5 SWMU 33-011(d) Storage at TA-33-20

SWMU 33-011(d) is the area used for storage south of warehouse TA-33-20. It is discussed in the RFI Work Plan for OU 1122 in Subsections 3.2.2.7 and 4.2.3.1 (LANL 1992, 0748). Lead, uranium, and tritium were detected above SAL in one asphalt sample and its duplicate. A radiological survey and cleanup is proposed for uranium. A Phase II sampling plan is presented to determine extent of lead contamination. The contaminated spot has been covered and posted.

SWMU 33-011(d) is located on the asphalt paving at warehouse TA-33-20. Site workers indicated that uranium and beryllium were stored in and around the warehouse until 1972. Scrap from recovered shots and material intended for recovery were also stored south of the building. All such material has been removed. The building is now used for storage and much of the surrounding paved area is used for parking. Potential contaminants included uranium, beryllium, and possibly other inorganics.

The site is within the developed area at Main Site. It is level and paved with asphalt.

4.5.1 Previous Investigations

No previous investigations were conducted at this PRS.

4.5.2 Field Investigation

Prior to sampling at TA-33, Main Site was surveyed for radiation on a grid as specified in the work plan. No radioactivity was detected. However, at the time of sample collection, radioactivity was detected on asphalt at SWMU 33-011(d). As specified in the work plan, two asphalt samples and three soil samples from below the asphalt were taken at three locations. Of these, one asphalt and one soil sample (AAA6866 and AAA6867) were taken at the radioactive point. All samples were analyzed for inorganics, uranium, and gamma emitters. Five of the samples (AAA6863, AAA6864, AAA6866, AAA6867, and AAA6868) were also analyzed for tritium and plutonium.

4.5.2.1 Results of Field Surveys

All sampling points were surveyed. No other field surveys were associated with SWMU 33-011(d).

4.5.2.2 Results of Field Screening

Radiation was detected during routine field screening. A sample was collected later by a sampler certified to collect radioactive samples. The entire area around the point was screened for radiation.

4.5.3 Screening Assessment

4.5.3.1 Comparison to Background/SALs

Samples AAA 6866 and AAA6867 taken from the radioactive spot contained uranium levels far above SAL. Lead was above background UTLs in most samples and above soil SAL in asphalt sample AAA6866. Other inorganics were found above background UTLs in this same asphalt sample. Tritium was above background UTL in samples AAA 6864 and AAA6868 and above the soil SAL in the asphalt sample AAA6863. Plutonium above the background UTL was detected at this location (Fig. 4-5). Table 4-13 is a summary of analytes detected above background UTLs. Neither UTLs nor SALs apply to asphalt; soil UTLs and SALs are listed in the table as a point of reference only.

4.5.3.2 Data Interpretation

Phase I sampling results suggest that contamination, both radioactive and inorganic, is patchy and not extensive. The highest levels of inorganic contamination were found in the same asphalt sample that contained over 3 200 mg/kg of uranium. High uranium, lead, and nickel concentrations were also found in the soil sample collected below the pavement at the same location.

4.5.3.3 Risk Assessment

No risk assessment was performed for this PRS.

4.5.3.4 Ecotoxicological Screening Assessment

A global ecotoxicological assessment is presented in Subsection 3.2.3 of this report.

4.5.4 Conclusion and Recommendation

Because the initial TA-33 grid for radioactive screening was too coarse to detect the radioactive spot at SWMU 33-011(d), the area around the warehouse is proposed for further investigation. A Phase II sampling and analysis plan is presented to investigate lead and uranium contamination (Appendix B).

TABLE 4-13

ANALYTES ABOVE LANL AND TA-33 BACKGROUND UTLs AND SALs AT SWMU 33-011(d)

ANALYTE	SAMPLE ID	DEPTH (in.)	MEDIUM	CONCENTRATION (mg/kg)	LANL UTL[a] (mg/kg)	TA-33 UTL (mg/kg)	SOIL SAL[b] (mg/kg)
Cadmium	AAA6866	0-6	Asphalt	4	2.7	2.7	80
Lead	AAA2028	0-6	Soil[c]	110	39	39	400
	AAA6863	0-6	Asphalt	45	39	39	400
	AAA6864	0-12	Soil	40	39	39	400
	AAA6866	0-6	Asphalt	**690**	39	39	400
	AAA6867	0-12	Soil	139	39	39	400
	AAA6868	0-12	Soil	40	39	39	400
Nickel	AAA6866	0-6	Asphalt	240	26.7	17	1 600
Uranium	AAA2028	0-6	Soil	6.8	2.8	4.8	95
	AAA2274	0-6	Soil	6.7	2.8	4.8	95
	AAA2275	0-6	Soil	6.3	2.8	4.8	95
	AAA6864	0-12	Soil	5.1	2.8	4.8	95
	AAA6866	0-6	Asphalt	**3 200**	2.8	4.8	95
	AAA6867	0-12	Soil	**899**	2.8	4.8	95
Zinc	AAA6866	0-6	Asphalt	470	101	62.3	24 000
	AAA6867	0-12	Soil	120	101	62.3	24 000
ANALYTE	**SAMPLE ID**	**DEPTH (in.)**	**MEDIUM**	**ACTIVITY (pCi/g)**	**LANL UTL (pCi/g)**	**TA-33 UTL (pCi/g)**	**SAL (pCi/g)**
Plutonium-238	AAA6863	0-6	Asphalt	0.055	0.01	0.01	27
	AAA6864	0-12	Soil	0.083	0.01	0.01	27
	AAA6866	0-6	Asphalt	0.405	0.01	0.01	27
	AAA6867	0-12	Soil	0.032	0.01	0.01	27
	AAA6868	0-12	Soil	0.04	0.01	0.01	27
Plutonium-239	AAA6866	0-6	Asphalt	0.083	0.01	0.058	24
	AAA6867	0-12	Soil	0.225	0.01	0.058	24
Tritium	AAA6863	0-6	Asphalt	**3 028** pCi/g	ND[d]	23.2	810
	AAA6864	0-12	Soil[c]	304 pCi/g	ND	23.2	810
	AAA6868	0-12	Soil[c]	472 pCi/g	ND	23.2	810

[a] UTL = Upper tolerance limit.
[b] SAL = Screening action level.
[c] Soil depth under 3-4 in. of asphalt.
[d] ND = Not determined.

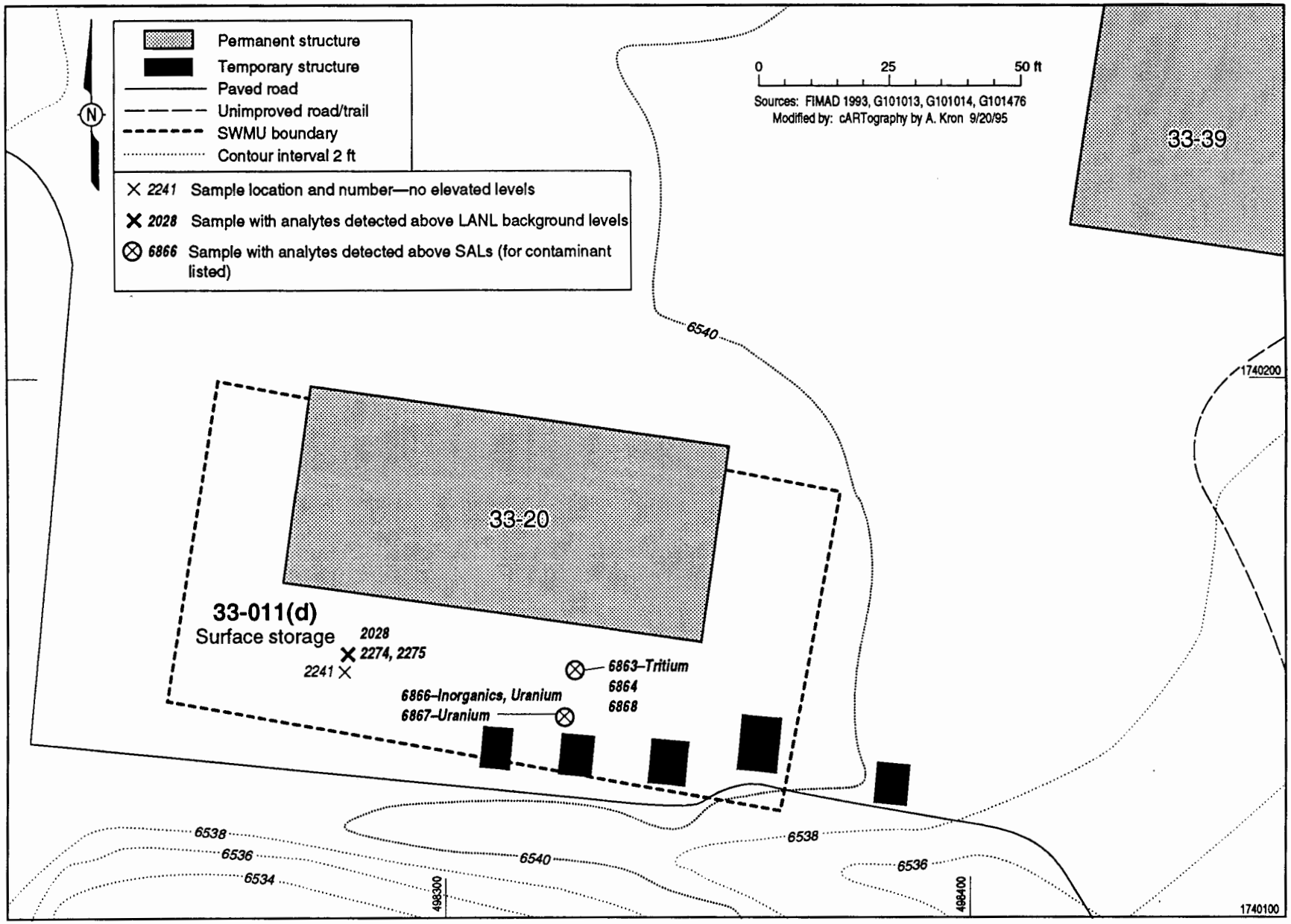

Fig. 4-5. Main Site: SWMU 33-011(d), surface storage.

4.6 SWMU 33-013 Liquid Waste Storage at the Tritium Facility

SWMU 33-013 is a surface disposal area on pavement east of the tritium facility TA-33-86. It is discussed in the RFI Work Plan for OU 1122, Subsections 3.2.2.8 and 4.3.4 (LANL 1992, 0784. Cadmium, chromium, and tritium were observed above SALs. Beryllium was measured above soil background levels. However, elevated inorganics were associated with problems in the QA/QC data. A Phase II sampling plan is presented to determine the extent of contamination.

SWMU 33-013 is an asphalt pad once used as a storage area for liquid waste. The SWMU is located northeast of TA-33-86 and lies within the fence surrounding the TA-33-86. Long-time employees describe the northeast section within the fence as a storage area for material awaiting disposal. Items for disposal included vacuum pumps from throughout LANL, barrels of waste oil, and dumpsters of miscellaneous wastes. No effort was made to cover the area. Many containers leaked and several containers remained in the area for years.

The area is level, about 50 ft square, paved with asphalt as an extension of the parking lot and driveway around the building. Weeds grow in the soil on three sides of the pad and in cracks in the pavement. Runoff from the area is to the east, toward the drainage leading to Chaquehui Canyon. East of the fence the ground slopes at a moderate grade without obvious channeling. There the surface material, soil with pumice, is sparsely vegetated; some of it may be fill from grading the site for building TA-33-86.

4.6.1 Previous Investigations

No previous investigations were conducted at this PRS.

4.6.2 Field Investigation

Three samples were taken at random locations 0-6 in. under the asphalt paving, which is 2 to 3 in. thick (Fig. 4-6). All SWMU 33-013 samples were analyzed for inorganics, gamma emitters and SVOCs. Two samples were analyzed for tritium and one for herbicides.

4.6.2.1 Results of Field Surveys

All sampling points were surveyed. No other field surveys were associated with SWMU 33-013.

4.6.2.2 Results of Field Screening

No radiation was detected during routine field screening of sampling locations at SWMU 33-0013.

4.6.3 Screening Assessment

4.6.3.1 Comparison to Background/SALs

One sample contained inorganics above background UTLs. Two elements, cadmium and chromium, were measured above their SALs in this sample. Both samples analyzed for tritium contained tritium above the TA-33 background UTL, with one concentration above SAL. Sample AAA2037 analyzed for SVOCs had trace levels of pyrene, benzo(b)fluoranthene, and fluoranthene. SVOC results were low enough so that a multiconstituent screening was deemed unnecessary. No herbicides were detected. Table 4-14 lists concentrations of contaminants found above LANL and TA-33 background UTLs.

TABLE 4-14

ANALYTES EXCEEDING UTLs AT SWMU 33-013

ANALYTE	SAMPLE ID	DEPTH (In.)	MEDIUM	CONCENTRATION (mg/kg)	LANL UTL[a] (mg/kg)	TA-33 UTL (mg/kg)	SAL[b] (mg/kg)
Beryllium	AAA2035	0-6	Soil under asphalt	7.8	3.31	1.51	None
Cadmium	AAA2035	0-6	Soil under asphalt	**620**	2.7	2.7	80
Chromium	AAA2035	0-6	Soil under asphalt	**670**	34.2	20.7	400
Nickel	AAA2035	0-6	Soil under asphalt	100	26.7	17	1 600
Silver	AAA2035	0-6	Soil under asphalt	10	ND[c]	ND	400
Tritium	AAA2036	0-6	Soil under asphalt	**3 342 pCi/g**	ND	23.2 pCi/g	810 pCi/g
Tritium	AAA2037	0-6	Soil under asphalt	27 pCi/g	ND	23.2 pCi/g	810 pCi/g

[a] UTL = Upper tolerance limit.
[b] SAL = Screening action level.
[c] ND = Not determined.

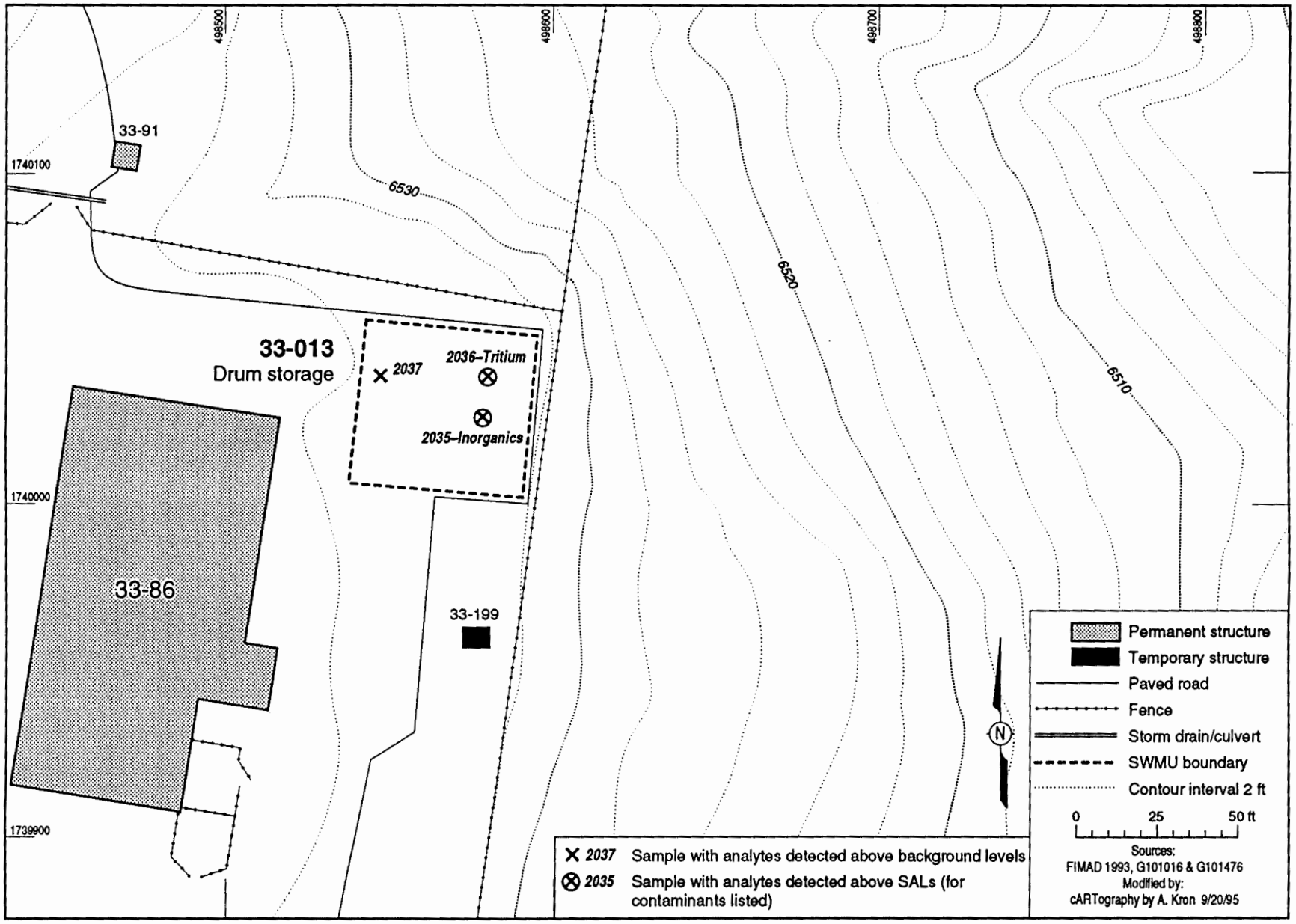

Fig. 4-6. Main Site: SWMU 33-013, drum storage.

4.6.3.2 Data Interpretation

The analytical request that included the three samples from SWMU 33-013 (request number 14594, report number 21424) also included two field blank samples and several grid samples. High levels of silver, cadmium, chromium and zinc were reported in field blank sample AAA2188 and in grid sample AAA2099. In addition, results for cadmium, chromium and zinc were biased high for one of two blind liquid QC samples included with this batch of samples. The result for nickel was biased low. The observations for field blank sample AAA2188 are anomalous. All other field blanks, which were splits of a single sample collected from an offsite location near Bandelier National Monument, were within TA-33 and LANL background ranges. Results from grid sample AAA2099 may be anomalous as well; this grid point lies just south of TA-33-86 and has tritium contamination within the TA-33 background range, but is not in an area that would have been affected by site activities other than stack releases. These anomalous observations could be the result of cross contamination either in the field or in the laboratory, or of an out-of-control laboratory process. All of these samples were collected May 12, 1993. According to the field logs, the samples from SWMU 33-013 were collected in the afternoon, while the grid sample and the field blank were collected in the morning, ruling out cross-contamination due to the field sample collection process. The data validation narrative associated with report number 21424 indicates that all of the run-time QC samples were statistically acceptable, which would preclude an out-of-control laboratory process. Cross-contamination in the laboratory, either from sample AAA2035 or from some other source, remains a possibility.

The QA/QC conditions lend uncertainty to the analytical results for inorganics obtained from the three samples. However, inorganics appear to be elevated above SALs at isolated points within PRS 33-013.

4.6.3.3 Risk Assessment

No risk assessment was performed for this SWMU.

4.6.3.4 Ecotoxicological Screening Assessment

A global ecotoxicological assessment is presented in Subsection 3.2.3 of this report.

4.6.4 Conclusion and Recommendation

High tritium in sample AAA2036 is expected because this storage pad is immediately adjacent to the tritium facility and fluids stored at the site were contaminated with tritium. Tritium is addressed in an RFI report for MDA K (in preparation). A risk assessment for tritium at Main

Site, discussed in the RFI report for MDA K, indicated a 1993 tritium exposure of 11.9 mrem/ year, well below the DOE effective dose equivalent of 30 mrem/year.

Because the source of high inorganic concentrations reported in one sample is uncertain, however, Phase II sampling will be conducted before further decisions are made (Appendix B).

4.7 SWMU 33-016 Sump at TA-33-23

SWMU 33-016 is a sump and outfall at bunker TA-33-23. It is discussed in the RFI Work Plan for OU 1122, Subsections 3.2.2.14 and 4.3.4 (LANL 1992, 0784). SVOCs above SALs were discovered in the sump sludge. A VCA of the sump was completed in 1995.

The sump served a sink and floor drain in TA-33-23, a trim building used in the early 1950s to prepare propellant charges for use at South Site. Until 1994 the bunker was used for storage by a LANL geological group, but is now empty. The sump is located west of the door to TA-33-23. Prior to the VCA, it was covered by a wooden lid.

At the time of construction, the area in front of TA-33-23 was graded and paved. One side of the sump is adjacent to the building. Two sides are surrounded by pavement and the fourth side is a tuff embankment, cut when the site was built. A pipe exits the sump and leads under the pavement to an outfall about 250 ft west of the building on the sloping side of Chaquehui Canyon. The slope is covered with pinyon and juniper trees and sparse grasses. Soil is thin with bedrock tuff outcrops. No drainage channel has formed at the outfall.

4.7.1 Previous Investigations

No previous investigations were conducted at this PRS.

4.7.2 Field Investigation

All sampling locations at SWMU 33-016 were selected to increase the chances of detecting contamination. Five samples were taken from the sump, two of fluid and two of sludge. A borehole adjacent to the sump yielded one surface sample, one sample at 3 to 5 ft, and one sample at 10 to 12 ft. Four surface samples were taken at the outfall (Fig. 4-7). All samples were analyzed for SVOCs and HE. Liquid and subsurface samples were also analyzed for VOCs.

4.7.2.1 Results of Field Surveys

All sampling points were surveyed. No other field surveys were associated with SWMU 33-016.

4.7.2.2 Results of Field Screening

No radiation was detected during routine field screening of sampling locations at SWMU 33-016.

4.7.3 Screening Assessment

4.7.3.1 Comparison to Background/SALs

No inorganic analyses were performed at SWMU 33-016. Table 4-15 lists organics detected in the sump sludge. Carcinogenic polycyclic aromatic hydrocarbons (cPAHs) were found. Although SALs are not relevant to sludge, soil SALs are listed as points of reference. QA comments indicate that these results are based on dry weight of sample. In addition, TICs were detected in the sludge samples. No analytes were reported in the water samples. Only trace levels of a plasticizer were found in samples from the outfall.

TABLE 4-15

ORGANICS DETECTED IN SUMP SLUDGE AT SWMU 33-016

ANALYTE	SAMPLE ID	DEPTH (in.)	MEDIUM	RESULT (mg/kg)	SAL[a] (mg/kg)	EQL[b] (mg/kg)
Acenaphthene	AAA2204	Tank	Sludge	8.4	*4 800*	*unknown*
Acetone	AAA2043	36	Tuff	0.024	*8 000*	*0.33*
Acetone	AAA2044	120	Tuff	0.031	*8 000*	*0.33*
Anthracene	AAA2041	Tank	Sludge	6	*24 000*	*0.33*
Anthracene	AAA2204	Tank	Sludge	11	*24 000*	*0.33*
Benzo[a]anthracene	AAA2041	Tank	Sludge	***23***	*1*	*0.33*
Benzo[a]anthracene	AAA2204	Tank	Sludge	***20***	*1*	*0.33*
Benzo[a]pyrene	AAA2041	Tank	Sludge	***16***	*0.1*	*0.33*
Benzo[a]pyrene	AAA2204	Tank	Sludge	***18***	*0.1*	*0.33*
Benzo[b]fluoranthene	AAA2041	Tank	Sludge	***13***	*1*	*0.33*
Benzo[b]fluoranthene	AAA2204	Tank	Sludge	***12***	*1*	*0.33*
Benzo[g,h,i]perylene	AAA2041	Tank	Sludge	8.8	*NC* [c]	*0.33*
Benzo[g,h,i]perylene	AAA2204	Tank	Sludge	15	*NC*	*0.33*
Benzo[k]fluoranthene	AAA2041	Tank	Sludge	***19***	*10*	*0.33*
Benzo[k]fluoranthene	AAA2204	Tank	Sludge	***19***	*10*	*0.33*
Bis(2-ethylhexyl)phthalate	AAA2041	Tank	Sludge	24	*50*	*0.33*
Bis(2-ethylhexyl)phthalate	AAA2047	0-6	Soil	0.42	*50*	*0.33*
Bis(2-ethylhexyl)phthalate	AAA2204	Tank	Sludge	***110***	*50*	*0.33*
Butylbenzene [sec-]	AAA2041	Tank	Sludge	1.6	*NC*	*0.005*
Butylbenzene [sec-]	AAA2204	Tank	Sludge	3.5	*NC*	*0.005*
Chrysene	AAA2041	Tank	Sludge	24	*96*	*0.33*
Chrysene	AAA2204	Tank	Sludge	24	*96*	*0.33*
Di-n-butyl phthalate	AAA2041	Tank	Sludge	60	*8 000*	*0.33*
Di-n-butyl phthalate	AAA2204	Tank	Sludge	65	*8 000*	*0.33*
Dibenzofuran	AAA2204	Tank	Sludge	9.3	*NC*	*0.33*
Dinitrobenzene [1,3-]	AAA2041	Tank	Sludge	6.1	*NC*	*0.33*
Dinitrotoluene [2,4-]	AAA2204	Tank	Sludge	***2.5***	*1*	*0.33*

TABLE 4-15 (CONTINUED)

ORGANICS DETECTED IN SUMP SLUDGE AT SWMU 33-016

ANALYTE	SAMPLE ID	DEPTH (in.)	MEDIUM	RESULT (mg/kg)	SAL[a] (mg/kg)	EQL[b] (mg/kg)
Ethylbenzene	AAA2041	Tank	Sludge	0.24	*3 100*	*0.005*
Ethylbenzene	AAA2204	Tank	Sludge	1.4	*3 100*	*0.005*
Fluoranthene	AAA2041	Tank	Sludge	35	*3 200*	*0.33*
Fluoranthene	AAA2204	Tank	Sludge	40	*3 200*	*0.33*
Fluorene	AAA2204	Tank	Sludge	11	*3 200*	*0.33*
Indeno[1,2,3-cd]pyrene	AAA2041	Tank	Sludge	***9.7***	*1*	*0.33*
Indeno[1,2,3-cd]pyrene	AAA2204	Tank	Sludge	***15***	*1*	*0.33*
Isopropylbenzene	AAA2041	Tank	Sludge	0.28	*3 200*	*0.33*
Isopropylbenzene	AAA2204	Tank	Sludge	1.2	*3 200*	*0.33*
Isopropyltoluene [4-]	AAA2041	Tank	Sludge	1.6	*NC*	*0.33*
Isopropyltoluene [4-]	AAA2204	Tank	Sludge	2.1	*NC*	*0.33*
Methylene chloride	AAA2041	Tank	Sludge	0.042	*5.6*	*0.005*
Methylnaphthalene [2-]	AAA2204	Tank	Sludge	31	*NC*	*0.33*
Naphthalene	AAA2204	Tank	Sludge	16	*3 200*	*0.33*
Phenanthrene	AAA2041	Tank	Sludge	19	*NC*	*0.33*
Phenanthrene	AAA2204	Tank	Sludge	47	*NC*	*0.33*
Propylbenzene	AAA2041	Tank	Sludge	0.75	*NC*	*0.005*
Propylbenzene	AAA2204	Tank	Sludge	6.9	*NC*	*0.005*
Pyrene	AAA2041	Tank	Sludge	25	*2 400*	*0.33*
Pyrene	AAA2204	Tank	Sludge	34	*2 400*	*0.33*
RDX[d]	AAA2041	Tank	Sludge	50	*64*	*Not listed*
Toluene	AAA2041	Tank	Sludge	0.18	*910*	*0.005*
Toluene	AAA2204	Tank	Sludge	2.9	*910*	*0.005*
Trimethylbenzene [1,2,4-]	AAA2041	Tank	Sludge	1.6	*40*	*0.005*
Trimethylbenzene [1,2,4-]	AAA2204	Tank	Sludge	7.3	*40*	*0.005*
Trimethylbenzene [1,3,5-]	AAA2041	Tank	Sludge	1.3	*32*	*0.005*
Trimethylbenzene [1,3,5-]	AAA2204	Tank	Sludge	8.6	*32*	*0.005*
Xylenes (o + m + p) [mixed-]	AAA2041	Tank	Sludge	0.31	*160 000*	*0.005*
Xylenes (o + m + p) [mixed-]	AAA2204	Tank	Sludge	1.9	*160 000*	*0.005*

[a] SAL = Screening action level.
[b] EQL = Estimated quatitation level.
[c] Not calculated due to insufficient toxicity data.
[d] RDX is the high explosive cyclonite.

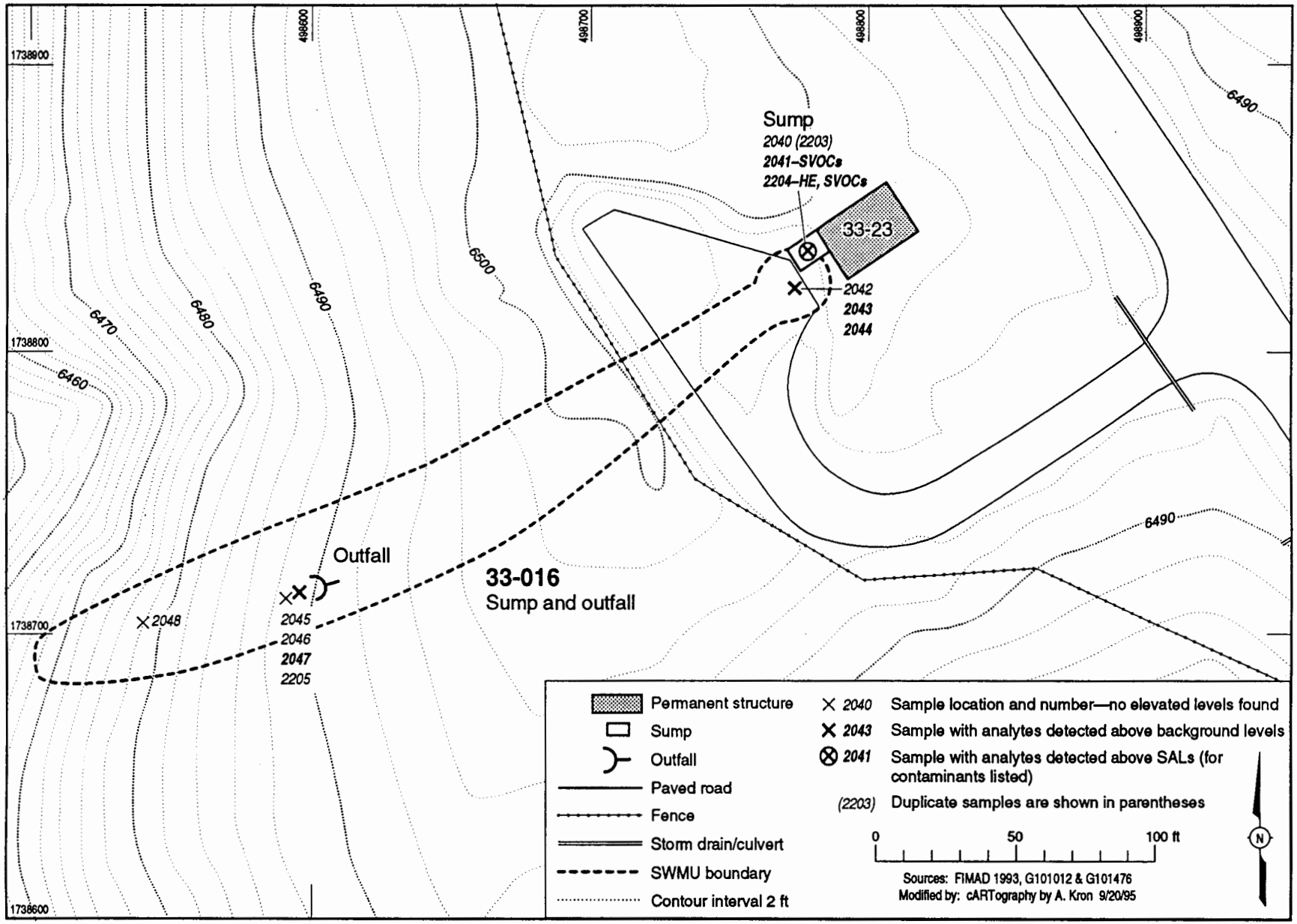

Fig. 4-7. Main Site: SWMU 33-016, sump.

4.7.3.2 Data Interpretation

The sludge at the TA-33-23 sump contains cPAHs above SALs. Analytical results from the borehole beside the sump and at the outfall indicate that contaminants found in the sump are not migrating from the sump.

4.7.3.3 Risk assessment

No risk assessment was performed for this PRS.

4.7.3.4 Ecotoxicological Screening Assessment

A global ecotoxicological assessment is presented in Subsection 3.2.3 of this report.

4.7.4 Conclusion and Recommendation

Sampling and analysis indicated that contamination was confined to the sump. Because the sump is no longer active, it was decommissioned in 1995 under a VCA plan. Approximately 250 gal. of liquid was removed from the sump. Approximately 45 gal. of sludge was vacuumed from the floor of the sump. The sump was filled with 3 yd^3 of sand and gravel, then capped with 1 ft of concrete. No confirmatory samples were taken. The sludge was analyzed for RCRA waste characteristics prior to disposal. Results indicated that 1,1-dichloroethylene and lead were present. A final report was submitted to EPA by October 1, 1995. A copy is attached as Addendum 1.

4.8 SWMU 33-017 Operational Releases/Vehicle Maintenance Area

SWMU 33-017 encompasses the eastern section of the fenced area at Main Site. It is discussed in the RFI Work Plan for OU 1122, Subsections 3.2.2.2 and 4.2.3.1 through 4.2.3.3 (LANL 1992, 0784). Elevated levels of lead and SVOCs are associated with samples from the small area east of shop TA-33-39 known as the vehicle maintenance area. A risk assessment for lead in this area was addressed in Subsection 4.4.4 of RFI Report LA-UR-95-882 (LANL 1995, 1212). The vehicle maintenance area is proposed for Phase II sampling to determine concentrations and extent of SVOC contamination. A sampling and analysis plan is included in Appendix B.

SWMU 33-017 addresses diverse activities at Main Site. Historic operating activities included the fumes from the uranium cut-off shack TA-33-40; air emissions from shop TA-33-39, tritium releases from the high-pressure tritium facility TA-33-86, stack emissions from shop TA-33-119 where uranium was processed, possible atmospheric release of plutonium from the spill in TA-33-21 [SWMUs 33-005(a,b,c)], and any other operations or releases that are not associated

with other known PRSs. One specific site, located east of shop TA-33-39 and used for vehicle maintenance, is included in SWMU 33-017.

The primary potential contaminants were identified as uranium, plutonium, tritium, SVOCs, and inorganics - specifically beryllium, cadmium, and lead. Pesticides, herbicides, and PCBs may also have been used in the area encompassed by this SWMU.

Most of SWMU 33-017 lies within the security fence at Main Site, where laboratory and office buildings are surrounded by asphalt pavement. The area is level with only a slight slope to the east. All runoff from Main Site converges on the east side of the site in a shallow tributary to Chaquehui Canyon. The eastern third of the site is unimproved. Construction of Main Site resulted in a steep bank about 20 ft high at the head of the drainage. Runoff and cooling water blowdown aided vigorous vegetation growth in this area. East of the Main Site fence, native pinyon-juniper woodland covers the drainage and surrounding land.

4.8.1 Previous Investigations

No previous investigations were conducted at this PRS.

4.8.2 Field Investigation

SWMU 33-017 is described as operational releases from Main Site. In the work plan, three separate sets of samples, a total of 82 surface samples, were identified to address SWMU 33-017: vehicle maintenance, airborne operational release, and drainage (LANL 1992, 0784).

- Fifty-six grid samples were taken from a wide area around Main Site and Area 6. Samples locations were selected by random offsets from the nodes of a 100-ft grid overlying Main Site and from four extensions radiating from Main Site as described in the work plan (LANL 1992, 0784).
- Twenty drainage samples were collected.
- Six samples were taken from the vehicle maintenance area east of shop TA-33-39. In addition to these six samples, ten samples were collected from two overlapping SWMUs, SWMU 33-004(i) and SWMU 33-012(a), embedded in the vehicle maintenance area.

All 82 SWMU 33-017 samples were analyzed for inorganics, 80 for radionuclides by gamma spectroscopy and SVOCs, 75 for plutonium, 74 for uranium and tritium, 14 for herbicides, 9 for pesticides, and 4 for PCBs.

4.8.2.1 Results of Field Surveys

All sampling points were surveyed. No other field surveys were associated with SWMU 33-017.

4.8.2.2 Results of Field Screening

The Main Site radiation survey, described in Subsection 4.2.1.3 of the work plan, did not detect any radioactivity (LANL 1992, 0784). No radiation was detected during routine field screening of sampling locations at SWMU 33-017.

4.8.3 Screening Assessment

4.8.3.1 Comparison to Background/SALs

Tritium Because the source of tritium is considered to be the high-pressure tritium facility, a detailed analysis of all surface tritium at Main Site is included in the RFI Report for MDA K (in preparation). In that report, a risk assessment for tritium indicates that levels of activity detected in samples collected at Main site and MDA K present an acceptable risk. Input to the model included an industrial worker exposure unit, an inhalation exposure pathway, a contaminated volume 200 ft by 300 ft by 155 ft deep, and a 1993 activity of 11 900 pCi/g. Calculations indicated that the effective dose equivalent to a worker at the site would be 11.9 mrem/year under these extremely conservative conditions. The DOE allowable effective dose equivalent is 30 mrem/year (LANL 1995, in preparation).

Grid Samples Most grid samples were used to calculate background UTLs specific to TA-33. Results are assessed in detail in Subsection 3.2 of the TA-33 RFI Report LA-UR-95-882 (LANL 1995, 1212). The grid sample set contained some anomalous results. Plutonium-239 (0.174 pCi/g) was detected in sample AAA2089 collected about 50 ft north of the site of TA-33-21 (SWMU 33-005). Inorganic anomalies in grid samples are listed in Table 4-16. Organic analytes above detection limits are listed in Table 4-17. Location of all grid samples are shown in Fig. 4-8.

TABLE 4-16

INORGANIC CONTAMINATION ABOVE LANL AND TA-33 BACKGROUND UTLs IN SWMU 33-017 GRID SAMPLES

ANALYTE	SAMPLE ID	DEPTH (in.)	MEDIUM	CONCENTRA-TION (mg/kg)	LANL UTL[a] (mg/kg)	TA-33 UTL (mg/kg)	SAL[b] (mg/kg)
Arsenic	AAA2067	0-6	Soil	13.8	11.6	4.36	None
Cadmium	AAA2099	0-6	Soil	5.2	2.7	2.7	80
Chromium	AAA2099	0-6	Soil	35	33.5	20.7	400
Nickel	AAA2061	0-6	Soil	46	26.7	17	1 600
	AAA2075	0-6	Soil	69	26.7	17	1 600
	AAA2077	0-6	Soil	460	26.7	17	1 600
Lead	AAA2067	0-6	Soil	**902**	39	39	400
	AAA2082	0-6	Soil	90	39	39	400
	AAA2097	0-6	Soil	61	39	39	400
	AAA2105	0-6	Soil	60	39	39	400
	AAA2053	0-6	Soil	98	39	39	400
	AAA2054	0-6	Soil	200	39	39	400
Silver	AAA2092	0-6	Soil	2.3	ND[c]	ND	400
	AAA2099	0-6	Soil	4.6	ND	ND	400
	AAA2053	0-6	Soil	8.8	ND	ND	400
	AAA2054	0-6	Soil	46	ND	ND	400
Uranium	AAA2075	0-6	Soil	41.6	2.8	4.8	95
Zinc	AAA2067	0-6	Soil	217	101	62.3	24 000

[a] Upper tolerance limit.
[b] Screening action level.
[c] Not determined.

TABLE 4-17

ORGANICS DETECTED IN SWMU 33-017 GRID SAMPLES

SVOCS	SAMPLE ID	DEPTH (in.)	MEDIUM	RESULT (mg/kg)	SAL[a] (mg/kg)	EQL[b] (mg/kg)
Acenaphthene	AAA2054	0-6	Soil	0.75	*4 800*	*Not listed*
Acenaphthene	AAA2097	0-6	Soil	0.69	*4 800*	*Not listed*
Aniline	AAA2123	0-6	Soil	0.41	*NC [c]*	*Not listed*
Anthracene	AAA2053	0-6	Soil	0.85	*24 000*	*0.33*
Anthracene	AAA2054	0-6	Soil	1.2	*24 000*	*0.33*
Anthracene	AAA2077	0-6	Soil	0.36	*24 000*	*0.33*
Anthracene	AAA2097	0-6	Soil	0.95	*24 000*	*0.33*
Benzo[a]anthracene	AAA2053	0-6	Soil	**4.1**	*1*	*0.33*
Benzo[a]anthracene	AAA2054	0-6	Soil	**3.5**	*1*	*0.33*
Benzo[a]anthracene	AAA2077	0-6	Soil	**1.3**	*1*	*0.33*
Benzo[a]anthracene	AAA2097	0-6	Soil	**2.1**	*1*	*0.33*
Benzo[a]pyrene	AAA2053	0-6	Soil	**4.7**	*0.1*	*0.33*
Benzo[a]pyrene	AAA2054	0-6	Soil	**4**	*0.1*	*0.33*
Benzo[a]pyrene	AAA2077	0-6	Soil	**1.4**	*0.1*	*0.33*
Benzo[b]fluoranthene	AAA2053	0-6	Soil	**6.2**	*1*	*0.33*
Benzo[b]fluoranthene	AAA2054	0-6	Soil	**5.2**	*1*	*0.33*
Benzo[b]fluoranthene	AAA2077	0-6	Soil	**1.8**	*1*	*0.33*
Benzo[b]fluoranthene	AAA2097	0-6	Soil	**3.8**	*1*	*0.33*
Benzo[g,h,i]perylene	AAA2053	0-6	Soil	1.7	*44*	*0.33*
Benzo[g,h,i]perylene	AAA2054	0-6	Soil	3.1	*44*	*0.33*
Benzo[g,h,i]perylene	AAA2077	0-6	Soil	0.66	*44*	*0.33*
Benzo[k]fluoranthene	AAA2053	0-6	Soil	**4.3**	*1*	*0.33*
Benzo[k]fluoranthene	AAA2054	0-6	Soil	**3.9**	*1*	*0.33*
Benzo[k]fluoranthene	AAA2077	0-6	Soil	**1.1**	*1*	*0.33*
Benzo[k]fluoranthene	AAA2097	0-6	Soil	**1.9**	*1*	*0.33*
BHC [beta-]	AAA2070	0-6	Soil	0.0023	*4*	*Not listed*
Bis(2-ethylhexyl)phthalate	AAA2053	0-6	Soil	1.1	*50*	*0.33*
Bis(2-ethylhexyl)phthalate	AAA2054	0-6	Soil	1.2	*50*	*0.33*
Bis(2-ethylhexyl)phthalate	AAA2097	0-6	Soil	1.9	*50*	*0.33*
Bis(2-ethylhexyl)phthalate	AAA2110	0-6	Soil	3.2	*50*	*0.33*
Chrysene	AAA2053	0-6	Soil	5.5	*96*	*0.33*
Chrysene	AAA2054	0-6	Soil	4.6	*96*	*0.33*
Chrysene	AAA2077	0-6	Soil	1.6	*96*	*0.33*
Chrysene	AAA2097	0-6	Soil	2.4	*96*	*0.33*
D [2,4-]	AAA2069	0-6	Soil	1.89	*NC*	*Not listed*
DDE [p,p'-]	AAA2071	0-6	Soil	0.0014	*NC*	*0.03*
Di-n-butyl phthalate	AAA2075	0-6	Soil	0.5	*8 000*	*0.33*
Dibenzofuran	AAA2097	0-6	Soil	0.44	*NC*	*0.33*
Dibenzo[a,h]anthracene	AAA2053	0-6	Soil	0.59	*0.086*	*0.33*
Dieldrin	AAA2071	0-6	Soil	0.00083	*NC*	*Not listed*
Diethylphthalate	AAA2069	0-6	Soil	30	*64 000*	*0.33*
Dinoseb	AAA2069	0-6	Soil	0.692	*NC*	*Not listed*
Endrin	AAA2070	0-6	Soil	0.0023	*NC*	*Not listed*
Endrin	AAA2071	0-6	Soil	0.0027	*NC*	*Not listed*

TABLE 4-17

ORGANICS DETECTED IN SWMU 33-017 GRID SAMPLES

SVOCS	SAMPLE ID	DEPTH (in.)	MEDIUM	RESULT (mg/kg)	SAL[a] (mg/kg)	EQL[b] (mg/kg)
Fluoranthene	AAA2053	0-6	Soil	1.6	*3 200*	*0.33*
Fluoranthene	AAA2054	0-6	Soil	5.2	*3 200*	*0.33*
Fluoranthene	AAA2077	0-6	Soil	2.5	*3 200*	*0.33*
Fluoranthene	AAA2097	0-6	Soil	2.8	*3 200*	*0.33*
Fluoranthene	AAA2098	0-6	Soil	0.61	*3 200*	*0.33*
Fluorene	AAA2054	0-6	Soil	0.59	*3 200*	*0.33*
Fluorene	AAA2097	0-6	Soil	0.58	*3 200*	*0.33*
Indeno[1,2,3-cd]pyrene	AAA2053	0-6	Soil	**2.2**	*1*	*0.33*
Indeno[1,2,3-cd]pyrene	AAA2054	0-6	Soil	**3.3**	*1*	*0.33*
Indeno[1,2,3-cd]pyrene	AAA2077	0-6	Soil	0.82	*1*	*0.33*
Naphthalene	AAA2054	0-6	Soil	0.39	*3 200*	*0.33*
Naphthalene	AAA2097	0-6	Soil	0.93	*3 200*	*0.33*
Phenanthrene	AAA2053	0-6	Soil	4.7	*NC*	*0.33*
Phenanthrene	AAA2054	0-6	Soil	5.9	*NC*	*0.33*
Phenanthrene	AAA2077	0-6	Soil	1.5	*NC*	*0.33*
Phenanthrene	AAA2097	0-6	Soil	2.8	*NC*	*0.33*
Phenanthrene	AAA2098	0-6	Soil	0.39	*NC*	*0.33*
Pyrene	AAA2053	0-6	Soil	19.6	*2 400*	*0.33*
Pyrene	AAA2054	0-6	Soil	27.4	*2 400*	*0.33*
Pyrene	AAA2068	0-6	Soil	0.49	*2 400*	*0.33*
Pyrene	AAA2070	0-6	Soil	0.38	*2 400*	*0.33*
Pyrene	AAA2077	0-6	Soil	2.6	*2 400*	*0.33*
Pyrene	AAA2097	0-6	Soil	3.3	*2 400*	*0.33*
Pyrene	AAA2098	0-6	Soil	0.53	*2 400*	*0.33*
Pyrene	AAA2221	0-6	Soil	0.69	*2 400*	*0.33*
Pyrene	AAA2222	0-6	Soil	0.44	*2 400*	*0.33*

[a] SAL = Screening action levels.
[b] EQL = Estimated quantitation limits.
[c] NC = Not calculated due to insufficient toxicity data.

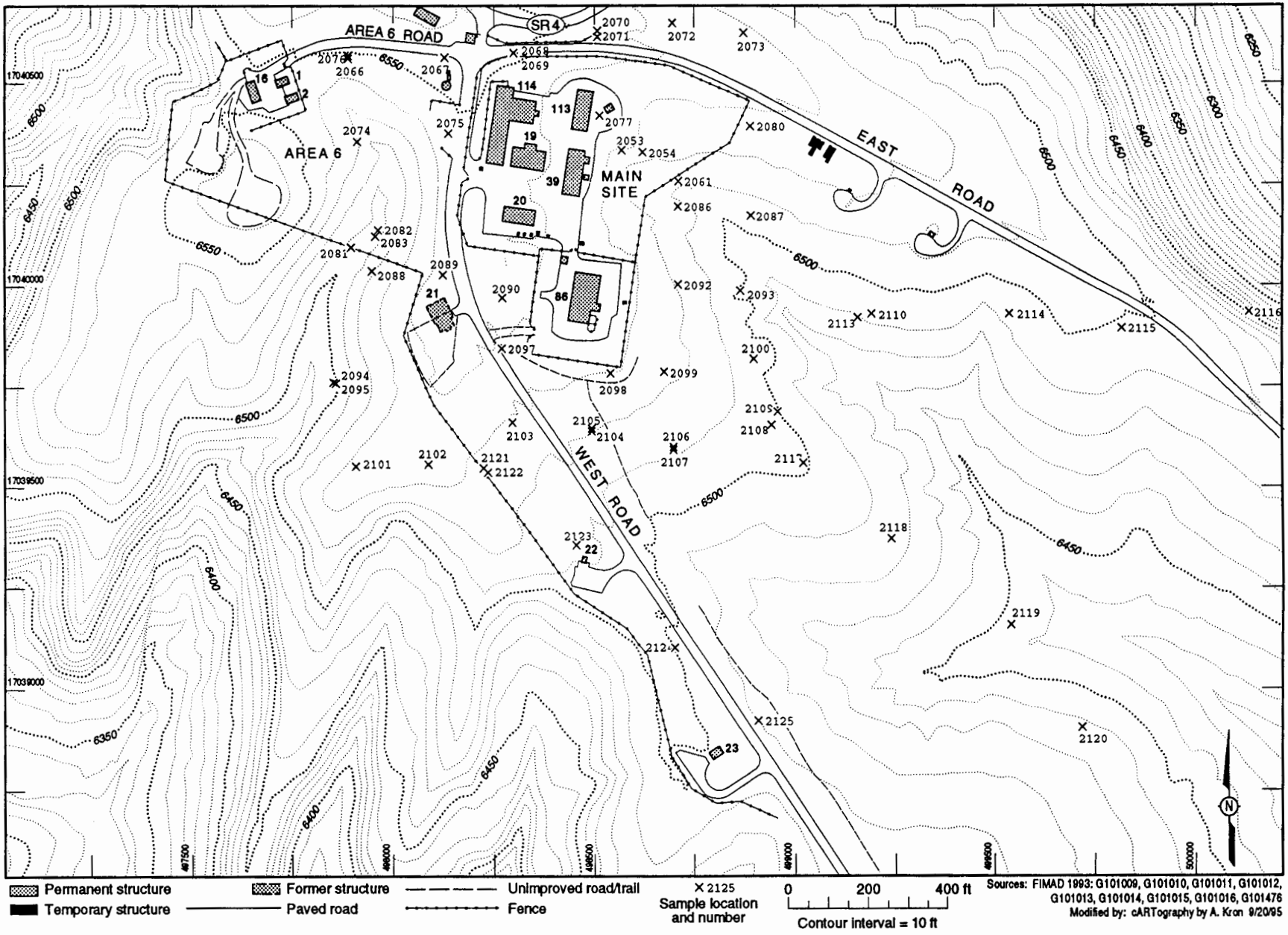

Fig. 4-8. Locations of grid samples assigned to SWMU 33-017.

Drainage Samples Four inorganics from the drainage samples exceeded LANL and TA-33 background UTLs (Table 4-18). Trace amounts of four organics were found above detection limits (Table 4-19). No other analyte concentrations were found above TA-33 and LANL background UTLs. No figure is given for these drainage samples.

TABLE 4-18

INORGANIC ANALYTES ABOVE LANL AND TA-33 BACKGROUND UTLs AT SWMU 33-017 DRAINAGES

ANALYTE	SAMPLE ID	DEPTH (in.)	MEDIUM	CONCENTRA-TION (mg/kg)	LANL UTL[a] (mg/kg)	TA-33 UTL (mg/kg)	SAL[b] (mg/kg)
Cadmium	AAA2061	0-6	Soil	3.3	2.7	2.7	80
Lead	AAA2055	0-6	Soil	40	39	39	400
	AAA2091	0-6	Soil	98	39	39	400
	AAA2195	0-6	Soil	100	39	39	400
Uranium	AAA2195	0-6	Soil	5.2	2.8	4.8	95
Zinc	AAA2056	0-6	Soil	110	101	62.3	24 000
	AAA2193	0-6	Soil	110	101	62.3	24 000
	AAA2061	0-6	Soil	750	101	62.3	24 000
	AAA2195	0-6	Soil	350	101	62.3	24 000

[a] Upper tolerance limit.
[b] Screening action level.

TABLE 4-19

ORGANIC ANALYTES ABOVE LANL AND TA-33 BACKGROUND UTLs AT SWMU 33-017 DRAINAGES

ANALYTE	SAMPLE ID	DEPTH (in.)	MEDIUM	CONCENTRA-TION (mg/kg)	EQL[a] (mg/kg)	SAL[b] (mg/kg)
Benzo(b)fluoranthene	AAA2055	0-6	Soil	0.44	0.33	1
Fluoranthene	AAA2056	0-6	Soil	0.41	0.33	3 200
	AAA2064	0-6	Soil	0.72	0.33	3 200
Phenanthrene	AAA2056	0-6	Soil	0.37	0.33	ND[c]
	AAA2064	0-6	Soil	0.59	0.33	ND[c]
Pyrene	AAA2055	0-6	Soil	0.71	0.33	2 400
	AAA2056	0-6	Soil	0.36	0.33	2 400
	AAA2064	0-6	Soil	0.66	0.33	2 400

[a] Estimated quantitation limit.
[b] Screening action level.
[c] Not determined.

Vehicle Maintenance Located within the vehicle maintenance area east of shop TA-33-39 are overlapping SWMUs 33-004(i) and 33-012(a). These SWMUs were discussed in depth in RFI Report LA-UR-95-882, Subsections 4.4 and 4.9 (LANL 1995, 1212). Elevated levels of lead were detected in most samples from the area east of the shop. As a means of dealing with the overlapping PRSs, all inorganic contamination was ascribed to SWMU 33-004(i), outfalls from the shop, because the shop contained a lead melting facility. Fig. 4-9 shows the relationship of these overlapping SWMUs.

Inorganics and SVOCs were detected in 14 of the 16 samples taken in the vehicle maintenance area. Seven samples contained PAHs above SAL. Because SVOCs are logically associated with maintenance activities, this contamination is ascribed to SWMU 33-017. Table 4-20 lists inorganics detected in the vehicle maintenance area. Table 4-21 lists the SVOCs. TICs were detected in all SVOC samples.

4.8.3.2 Data Interpretation

SVOCs, specifically cPAHs, were found in the vehicle maintenance area at levels that exceeded SALs. With the exception of lead, inorganics, radionuclides, herbicides, and pesticides were below SALs. SVOCs and PCBs are discussed in the Appendix B sampling and analysis plan for SWMU 33-017.

The area east of TA-33-39, represented by six samples from SWMU 33-004(i), four samples from SWMU 33-012(a), three samples from the vehicle maintenance area, and four samples from the main drainage, appears to have widespread above-background concentrations of lead and zinc, plus a few above-background observations of nickel and chromium. These analytes are addressed in a separate RFI report LA-UR-95-882 (LANL 1995, 1212). Three samples from SWMU 33-012(a) were analyzed for PCBs. Sample AAA2032 contained 2.3 mg/kg PCBs and sample AAA2034 contained 0.25 mg/kg. PCB migration at Main Site is addressed under area of concern (AOC) C-33-001 in Subsection 5.4 of this RFI report.

4.8.3.3 Risk Assessment

Lead results were included in the SWMU 33-004(i) preliminary risk assessment described in RFI Report LA-UR-95-882, Subsection 4.4. Results indicate that although lead contamination is widespread in the area east of TA-33-39, it would not pose a risk to the most sensitive population, children under seven years (LANL 1995, 1212). Because SWMU 33-004(i) is embedded SWMU 33-017, calculations for this risk assessment are repeated in Appendix D of this RFI report for completeness in dealing with SWMU 33-017. According to EPA, an acceptable risk for lead exposure is less than 5% of the population expected to have blood lead

TABLE 4-20

INORGANICS DETECTED ABOVE LANL AND TA-33 BACKGROUND UTLs AT SWMU 33-017 VEHICLE MAINTENANCE AREA

ANALYTE	SAMPLE ID	DEPTH (in.)	MEDIUM	RESULT (mg/kg)	LANL UTL[a] (mg/kg)	TA-33 UTL (mg/kg)	SAL[b] (mg/kg)
Chromium	AAA2051	0-6	Soil	84	34.2	20.7	*400*
Chromium	AAA1978	0-6	Soil	60	34.2	20.7	*400*
Lead	AAA2049	0-6	Soil	64	39	39	*1 600*
Lead	AAA2050	0-6	Soil	90	39	39	*400*
Lead	AAA2051	0-6	Soil	170	39	39	*400*
Lead	AAA2052	0-6	Soil	46	39	39	*400*
Lead	AAA2053	0-6	Soil	98	39	39	*400*
Lead	AAA2054	0-6	Soil	200	39	39	*400*
Lead	AAA1976	0-6	Soil	79	39	39	*400*
Lead	AAA1977	0-6	Soil	73	39	39	*400*
Lead	AAA1978	0-6	Soil	**800**	39	39	*400*
Lead	AAA1979	0-6	Soil	71	39	39	*400*
Lead	AAA1980	0-6	Soil	210	39	39	*400*
Lead	AAA2031	0-6	Soil	104	39	39	*400*
Lead	AAA2032	0-6	Soil	118	39	39	*400*
Lead	AAA2033	0-6	Soil	53	39	39	*400*
Nickel	AAA2051	0-6	Soil	73	26.7	17	*1 600*
Nickel	AAA2052	0-6	Soil	87	26.7	17	*1 600*
Nickel	AAA2053	0-6	Soil	35	26.7	17	*1 600*
Silver	AAA2053	0-6	Soil	8.8	NC[c]	NC	*400*
Silver	AAA2054	0-6	Soil	46	NC	NC	*400*
Uranium	AAA2052	0-6	Soil	3.6	2.82	4.84	*95*
Uranium	AAA2053	0-6	Soil	3.5	2.82	4.84	*95*
Uranium	AAA2054	0-6	Soil	4.2	2.82	4.84	*95*
Uranium	AAA1976	0-6	Soil	3.1	2.82	4.84	*95*
Uranium	AAA1977	0-6	Soil	3.9	2.82	4.84	*95*
Zinc	AAA2049	0-6	Soil	730	101	62.3	*24 000*
Zinc	AAA2050	0-6	Soil	530	101	62.3	*24 000*
Zinc	AAA2051	0-6	Soil	1 700	101	62.3	*24 000*
Zinc	AAA2053	0-6	Soil	330	101	62.3	*24 000*
Zinc	AAA2054	0-6	Soil	350	101	62.3	*24 000*
Zinc	AAA1976	0-6	Soil	210	101	62.3	*24 000*
Zinc	AAA1977	0-6	Soil	120	101	62.3	*24 000*
Zinc	AAA1980	0-6	Soil	130	101	62.3	*24 000*
Zinc	AAA2031	0-6	Soil	820	101	62.3	*24 000*
Zinc	AAA2032	0-6	Soil	610	101	62.3	*24 000*
Zinc	AAA2033	0-6	Soil	210	101	62.3	*24 000*

[a] UTL = Upper tolerance limit.
[b] SAL = Screening action level.
[c] NC = Not calculated due to insufficient data above detection limit.

TABLE 4-21

ORGANICS DETECTED AT SWMU 33-017 VEHICLE MAINTENANCE AREA

ANALYTE	SAMPLE ID	DEPTH (in.)	MEDIUM	RESULT (mg/kg)	SAL[a] (mg/kg)	EQL[b] (mg/kg)
Acenaphthene	AAA2051	0-6	Soil	0.47	*4 800*	*Not listed*
Acenaphthene	AAA2054	0-6	Soil	0.75	*4 800*	*Not listed*
Acenaphthene	AAA1976	0-6	Soil	0.63	*4 800*	*Not listed*
Acenaphthene	AAA1979	0-6	Soil	0.47	*4 800*	*Not listed*
Anthracene	AAA2051	0-6	Soil	2.3	*24 000*	*0.33*
Anthracene	AAA2053	0-6	Soil	0.85	*24 000*	*0.33*
Anthracene	AAA2054	0-6	Soil	1.2	*24 000*	*0.33*
Anthracene	AAA1976	0-6	Soil	0.94	*24 000*	*0.33*
Anthracene	AAA1978	0-6	Soil	0.69	*24 000*	*0.33*
Anthracene	AAA1979	0-6	Soil	0.92	*24 000*	*0.33*
Benzo[a]anthracene	AAA2051	0-6	Soil	***8.2***	*1*	*0.33*
Benzo[a]anthracene	AAA2053	0-6	Soil	***4.1***	*1*	*0.33*
Benzo[a]anthracene	AAA2054	0-6	Soil	***3.5***	*1*	*0.33*
Benzo[a]anthracene	AAA2032	0-6	Soil	0.51	*1*	*0.33*
Benzo[a]anthracene	AAA1976	0-6	Soil	***1.8***	*1*	*0.33*
Benzo[a]anthracene	AAA1977	0-6	Soil	0.39	*1*	*0.33*
Benzo[a]anthracene	AAA1978	0-6	Soil	***1.3***	*1*	*0.33*
Benzo[a]anthracene	AAA1979	0-6	Soil	***1.6***	*1*	*0.33*
Benzo[a]anthracene	AAA1980	0-6	Soil	0.6	*1*	*0.33*
Benzo[a]pyrene	AAA2051	0-6	Soil	***7.5***	*0.1*	*0.33*
Benzo[a]pyrene	AAA2053	0-6	Soil	***4.7***	*0.1*	*0.33*
Benzo[a]pyrene	AAA2054	0-6	Soil	***4***	*0.1*	*0.33*
Benzo[a]pyrene	AAA1976	0-6	Soil	***0.64***	*0.1*	*0.33*
Benzo[a]pyrene	AAA1978	0-6	Soil	***0.86***	*0.1*	*0.33*
Benzo[a]pyrene	AAA1979	0-6	Soil	***1.3***	*0.1*	*0.33*
Benzo[a]pyrene	AAA1980	0-6	Soil	***0.62***	*0.1*	*0.33*
Benzo[b]fluoranthene	AAA2049	0-6	Soil	0.34	*0.7*	*0.33*
Benzo[b]fluoranthene	AAA2051	0-6	Soil	***9.8***	*1*	*0.33*
Benzo[b]fluoranthene	AAA2053	0-6	Soil	***6.2***	*1*	*0.33*
Benzo[b]fluoranthene	AAA2054	0-6	Soil	***5.2***	*1*	*0.33*
Benzo[b]fluoranthene	AAA2032	0-6	Soil	0.43	*1*	*0.33*
Benzo[b]fluoranthene	AAA1976	0-6	Soil	***1.1***	*1*	*0.33*
Benzo[b]fluoranthene	AAA1977	0-6	Soil	0.45	*1*	*0.33*
Benzo[b]fluoranthene	AAA1978	0-6	Soil	***1.5***	*1*	*0.33*
Benzo[b]fluoranthene	AAA1979	0-6	Soil	***3.1***	*1*	*0.33*
Benzo[b]fluoranthene	AAA1980	0-6	Soil	***0.8***	*1*	*0.33*
Benzo[g,h,i]perylene	AAA2051	0-6	Soil	3.1	*NC* [c]	*0.33*
Benzo[g,h,i]perylene	AAA2053	0-6	Soil	1.7	*NC*	*0.33*
Benzo[g,h,i]perylene	AAA2054	0-6	Soil	3.1	*NC*	*0.33*
Benzo[k]fluoranthene	AAA2049	0-6	Soil	0.34	*1*	*0.33*
Benzo[k]fluoranthene	AAA2051	0-6	Soil	***7.1***	*1*	*0.33*
Benzo[k]fluoranthene	AAA2053	0-6	Soil	***4.3***	*1*	*0.33*

TABLE 4-21 (CONTINUED)

ORGANICS DETECTED AT SWMU 33-017 VEHICLE MAINTENANCE AREA

ANALYTE	SAMPLE ID	DEPTH (in.)	MEDIUM	RESULT (mg/kg)	SAL[a] (mg/kg)	EQL[b] (mg/kg)
Benzo[k]fluoranthene	AAA2054	0-6	Soil	***3.9***	*1*	*0.33*
Benzo[k]fluoranthene	AAA2032	0-6	Soil	0.52	*1*	*0.33*
Benzo[k]fluoranthene	AAA1978	0-6	Soil	0.36	*1*	*0.33*
Benzo[k]fluoranthene	AAA1980	0-6	Soil	0.57	*1*	*0.33*
Bis(2-ethylhexyl)phthalate	AAA2049	0-6	Soil	1.4	*50*	*0.33*
Bis(2-ethylhexyl)phthalate	AAA2051	0-6	Soil	0.92	*50*	*0.33*
Bis(2-ethylhexyl)phthalate	AAA2053	0-6	Soil	1.1	*50*	*0.33*
Bis(2-ethylhexyl)phthalate	AAA2054	0-6	Soil	1.2	*50*	*0.33*
Bis(2-ethylhexyl)phthalate	AAA2031	0-6	Soil	1.1	*50*	*0.33*
Bis(2-ethylhexyl)phthalate	AAA2032	0-6	Soil	1.3	*50*	*0.33*
Chrysene	AAA2049	0-6	Soil	0.35	*96*	*0.33*
Chrysene	AAA2051	0-6	Soil	9.2	*96*	*0.33*
Chrysene	AAA2053	0-6	Soil	5.5	*96*	*0.33*
Chrysene	AAA2054	0-6	Soil	4.6	*96*	*0.33*
Chrysene	AAA2032	0-6	Soil	0.54	*96*	*0.33*
Chrysene	AAA1976	0-6	Soil	2	*96*	*0.33*
Chrysene	AAA1977	0-6	Soil	0.54	*96*	*0.33*
Chrysene	AAA1978	0-6	Soil	1.5	*96*	*0.33*
Chrysene	AAA1979	0-6	Soil	1.5	*96*	*0.33*
Chrysene	AAA1980	0-6	Soil	0.64	*96*	*0.33*
Dibenzo[a,h]anthracene	AAA2053	0-6	Soil	***0.59***	*0.1*	*0.33*
Fluoranthene	AAA2049	0-6	Soil	0.65	*3 200*	*0.33*
Fluoranthene	AAA2051	0-6	Soil	20.1	*3 200*	*0.33*
Fluoranthene	AAA2053	0-6	Soil	1.6	*3 200*	*0.33*
Fluoranthene	AAA2054	0-6	Soil	5.2	*3 200*	*0.33*
Fluoranthene	AAA2032	0-6	Soil	0.68	*3 200*	*0.33*
Fluoranthene	AAA1975	0-6	Soil	0.44	*3 200*	*0.33*
Fluoranthene	AAA1976	0-6	Soil	2.7	*3 200*	*0.33*
Fluoranthene	AAA1977	0-6	Soil	0.54	*3 200*	*0.33*
Fluoranthene	AAA1978	0-6	Soil	1.4	*3 200*	*0.33*
Fluoranthene	AAA1980	0-6	Soil	1.3	*3 200*	*0.33*
Fluorene	AAA2054	0-6	Soil	0.59	*3 200*	*0.33*
Fluorene	AAA1976	0-6	Soil	0.38	*3 200*	*0.33*
Fluorene	AAA1979	0-6	Soil	0.33	*3 200*	*0.33*
Indeno[1,2,3-cd]pyrene	AAA2051	0-6	Soil	***4.2***	*1*	*0.33*
Indeno[1,2,3-cd]pyrene	AAA2053	0-6	Soil	***2.2***	*1*	*0.33*
Indeno[1,2,3-cd]pyrene	AAA2054	0-6	Soil	***3.3***	*1*	*0.33*
Naphthalene	AAA2054	0-6	Soil	0.39	*3 200*	*0.33*
Phenanthrene	AAA2051	0-6	Soil	12.6	*None*	*0.33*
Phenanthrene	AAA2052	0-6	Soil	0.34	*None*	*0.33*
Phenanthrene	AAA2053	0-6	Soil	4.7	*None*	*0.33*
Phenanthrene	AAA2054	0-6	Soil	5.9	*None*	*0.33*
Phenanthrene	AAA2032	0-6	Soil	0.96	*None*	*0.33*

TABLE 4-21 (CONTINUED)

ORGANICS DETECTED AT SWMU 33-017 VEHICLE MAINTENANCE AREA

ANALYTE	SAMPLE ID	DEPTH (in.)	MEDIUM	RESULT (mg/kg)	SAL[a] (mg/kg)	EQL[b] (mg/kg)
Phenanthrene	AAA1976	0-6	Soil	3.8	*None*	*0.33*
Phenanthrene	AAA1977	0-6	Soil	0.5	*None*	*0.33*
Phenanthrene	AAA1978	0-6	Soil	2.5	*None*	*0.33*
Phenanthrene	AAA1979	0-6	Soil	2.9	*None*	*0.33*
Phenanthrene	AAA1980	0-6	Soil	1.2	*None*	*0.33*
Pyrene	AAA2049	0-6	Soil	0.92	*2 400*	*0.33*
Pyrene	AAA2050	0-6	Soil	0.35	*2 400*	*0.33*
Pyrene	AAA2051	0-6	Soil	26.7	*2 400*	*0.33*
Pyrene	AAA2052	0-6	Soil	1.7	*2 400*	*0.33*
Pyrene	AAA2053	0-6	Soil	19.6	*2 400*	*0.33*
Pyrene	AAA2054	0-6	Soil	27.4	*2 400*	*0.33*
Pyrene	AAA2032	0-6	Soil	2.1	*2 400*	*0.33*
Pyrene	AAA1975	0-6	Soil	0.51	*2 400*	*0.33*
Pyrene	AAA1976	0-6	Soil	4.5	*2 400*	*0.33*
Pyrene	AAA1977	0-6	Soil	1.4	*2 400*	*0.33*
Pyrene	AAA1978	0-6	Soil	4.2	*2 400*	*0.33*
Pyrene	AAA1979	0-6	Soil	2.3	*2 400*	*0.33*
Pyrene	AAA1980	0-6	Soil	1.6	*2 400*	*0.33*

[a] SAL = Screening action level.
[b] EQL = Estimated quantitation limit.
[c] NC = Not calculated due to insufficient toxicity data.

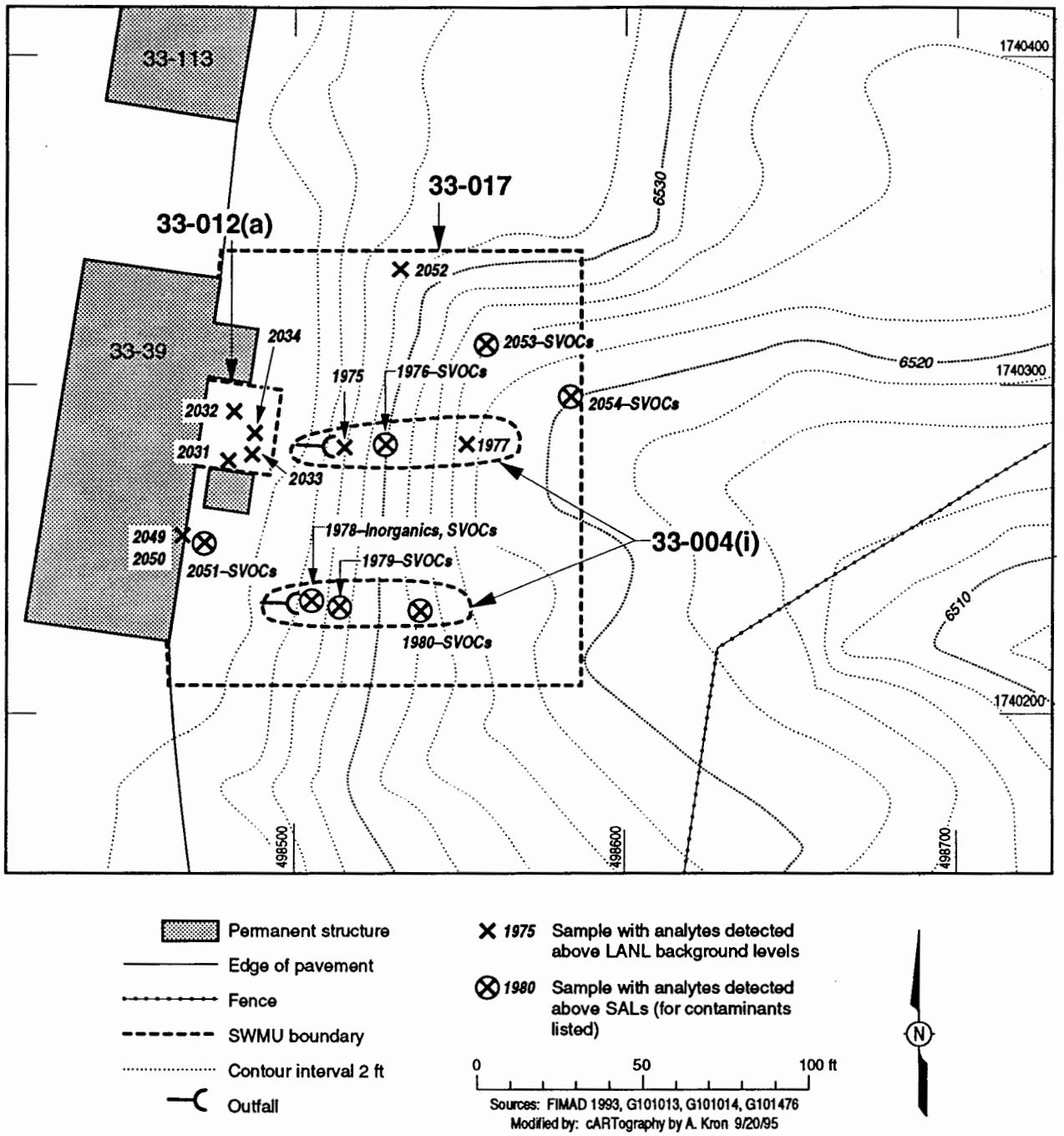

Fig. 4-9. Main Site: SWMU 33-017, vehicle maintenance area risk assessment exposure area showing overlapping SWMUs 33-004(i) and 33-012(a).

levels of greater than 10 µg/dL. Results of the modeling effort for TA-33 reveal that 1.66% of a hypothetical population of children exposed to 416.3 mg/kg of lead would exceed the standard value of 10 µg/dL, indicating that adverse health effects from lead exposure are unlikely at this site.

The same exposure unit used for lead, approximately 0.15 acres east of TA-33-39, was used for a preliminary risk assessment for the PAHs (Fig. 4-9). Risk assessment calculations for SWMU 33-017 are presented in Appendix D of this RFI report. Results show that the estimated carcinogenic risk to construction workers is low at both the mean and the 95% UCL concentrations: 2.7E-07 and 5.6E-07, respectively. Estimated risk to future residents based on the mean PAH concentration is 3.1E-06 and when based on all seven 95% UCLs, estimated risk rises to 2.1E-05.

4.8.3.4 Ecotoxicological Screening Assessment

A global ecotoxicological assessment is presented in Subsection 3.2.3 of this RFI report.

4.8.4 Conclusion and Recommendation

Based on results of this preliminary risk assessment for SVOCs, further study will be taken in this exposure unit, which includes the area extending approximately 130 ft east of shop TA-33-39. Phase II sampling will collect additional samples in the vicinity of the elevated SVOCs to refine level and extent of contamination (Appendix B).

5.0 REVISED PHASE I SAMPLING AND ANALYSIS PLANS

Information gathered since the RFI work plan LA-UR-92-925 was submitted in May 1992 indicates that six sampling plans are inadequate or inappropriate. Therefore, revised sampling plans for the PRSs listed in Table 5-1 are submitted in Section 5.0.

5.1 SWMU 33-003(b) MDA-D, East Site

SWMU 33-003(b) is underground experimental chamber TA-33-6 at MDA D. It is discussed in the RFI Work Plan for OU 1122, Subsections 3.5.2.1 and 4.5.3.1 (LANL 1992, 0784). No action is proposed for the chamber based on an assessment of exposure pathways. A Phase II sampling plan is presented for the surface and subsurface soil component of SWMU 33-003(b).

TABLE 5-1

PRSs WITH REVISED SAMPLING PLANS

PRS[a]	DESCRIPTION	REASON FOR REVISION
33-003(b)	MDA D subsurface	Possible PCB[b] contamination
33-004(k)	Outfall from TA-33-87	Outfall not located in 1994 campaign.
33-008(a)	Landfill at East Site	New information on contents
33-008(b)	Landfill at South Site	New information on contents
C-33-001	Transformer at Main Site	Phase I sampling plan for PCBs
C-33-002	Transformer at East Site	Phase I sampling plan for PCBs

[a] PRS = Potential release site.
[b] PCB = Polychlorinated biphenyl.

The chamber was constructed in 1948. It is an 18 ft by 18 ft octagonal, vault-like structure 11 ft high, buried with the roof approximately 30 ft below grade. Access was through a 4 ft by 6 ft elevator shaft at the side of the chamber. The elevator shaft, now filled, was approximately 46 ft deep. Remaining surface indications of the chamber include only an 8 ft by 12 ft concrete pad broken at the east end where the shaft was located. A 6 ft by 10 ft depression remains in the area of the shaft.

The chamber was used for initiator tests involving milligram quantities of beryllium. Polonium-210 (half-life 138 days) was used as a source of alpha particles. Chamber TA-33-6 was used twice, once in December 1948 and again in April 1952. The second test destroyed the chamber. Debris from the test was ejected through the elevator shaft and spread over the mesa. A 10-ft deep crater formed around the chamber (Blackwell 1952, 02-034). The crater was later filled with the ejected debris and covered with uncontaminated soil (Blackwell 1953, 02-035). In 1963 the depression was refilled (Zia Company 1963, 02-030).

MDA D is located at East Site. The mesa is level enough so that drainage patterns are not evident. The area is covered with weeds interspersed with a few chamisa shrubs. The chamber TA-33-6 concrete pad lies approximately 50 ft north of the East Site Road near septic tank TA-33-96 and approximately 350 ft south of the rim of Ancho Canyon.

5.1.1 Previous Investigation

Existing surface data for SWMU 33-003(b) at East Site includes 16 surface soil samples collected by LANL's Environmental Surveillance Program in 1977. The surveillance samples were analyzed for tritium, uranium, and cesium-137; all results were within background ranges. These data are summarized in the RFI Work Plan for OU 1122 (LANL 1992, 0784).

In 1989 Weston personnel conducted sampling at three boreholes at TA-33-6. Nine subsurface samples were collected. Seven were analyzed for uranium, six for inorganics, and seven for HE. Three samples were analyzed for VOCs. Results are discussed in Subsection 5.1.3.1 of this RFI report. Weston borehole logs indicate the following subsurface materials were encountered:

- LAN33-0023: This borehole was drilled into the elevator shaft to a total depth of 47 ft. Matrix consisted of fill material with gravel, sand, and tuff fragments. Wood was encountered between 8 and 23 ft. Gravel persisted to 28 ft. Rusty wire, metal clips, and chain fragments were encountered at 43 ft. Three samples were taken from the shaft.

- LAN33-0024: This borehole was drilled atop the chamber to a depth of 29 ft. Matrix consisted of tuff fill. The surface sample had numerous small, glass fragments. At 18 ft, the drill encountered a void. Below the void, sand and gravel were intermixed with tuff material. The concrete roof of the chamber was encountered at 29 ft. Two samples were taken from the borehole.

- LAN33-0025: This borehole was drilled adjacent to the chamber to a depth of 58 ft. The matrix consisted of fill material (sand and gravel) mixed with tuff. The upper 1.5 ft consisted of native soil. Four samples were taken from the borehole.

5.1.2 Field Investigation

In 1994 LANL ER Project sampling at East Site included five surface samples taken north of the chamber. Additional surface samples were taken in the drain field of SWMU 33-004(c). All samples were analyzed for inorganics, gamma emitters, and HE.

In 1994 an archival search was conducted to determine the probable contents of the chambers, with emphasis on the composition of the neutron counters. The search revealed the following: steel, copper, and aluminum were present in kilogram amounts; lead from solder was probably present in gram amounts. Capacitors used in the chamber may have contained less than 5 lb total of PCBs. No shielding material (lead, cadmium, paraffin) was used, nor were scintillation fluids or uranium (Morgan 1994, 02-088). Beryllium was present in milligram amounts. Polonium-210 (half-life 138 days) has decayed to undetectable levels.

5.1.2.1 Results of Field Surveys

All sampling points were surveyed. No other field surveys were associated with SWMU 33-003(b).

5.1.2.2 Results of Field Screening

No radiation was detected during routine field screening of sampling locations at SWMU 33-003(b).

5.1.3 Screening Assessment

5.1.3.1 Comparison to Background/SALs

Chamber Analytes above background UTLs were detected only in Weston samples from the LAN33-0023 borehole drilled into the elevator shaft. No analytes were detected above background UTLs in Weston boreholes LAN33-0024 and LAN33-0025. Results from borehole LAN33-0023 are presented in Table 5-2. Weston results have not received LANL ER QA/QC data validation and are presented for information purposes only.

TABLE 5-2

ANALYTES DETECTED ABOVE LANL AND TA-33 BACKGROUND UTLS IN THE TA-33-6 ELEVATOR SHAFT

ANALYTE	SAMPLE ID	DEPTH (ft)	MEDIUM	CONCENTRA-TION (mg/kg)	LANL UTL[a] (mg/kg)	TA-33 UTL (mg/kg)	SAL[b] (mg/kg)
Cadmium	33-0023-2	38-43	Fill	7.1	2.7	2.7	80
	33-0023-3	43-47	Fill	4.9	2.7	2.7	80
Mercury	33-0023-2	38-43	Fill	2.1	0.1	NA[c]	24
	33-0023-3	43-47	Fill	1.1	0.1	NA	24
Lead	33-0023-2	38-43	Fill	79	39	39	400
Zinc	33-0023-2	38-43	Fill	852	101	62.3	24 000
	33-0023-3	43-47	Fill	652	101	62.3	24 000

[a] Upper tolerance limit.
[b] Screening action level.

Surface Area In 1994 LANL ER personnel conducted surface sampling in the vicinity of the chamber. Analyses for gamma emitters and inorganics did not detect concentrations above LANL and TA-33 background UTLs, with the exception of a possibly anomalous mercury concentration of 0.02 mg/kg in sample AAA9608. A laboratory reanalysis of sample AAA9608 did not detect mercury. Location of Weston and ER sampling points is shown in Fig. 5-1.

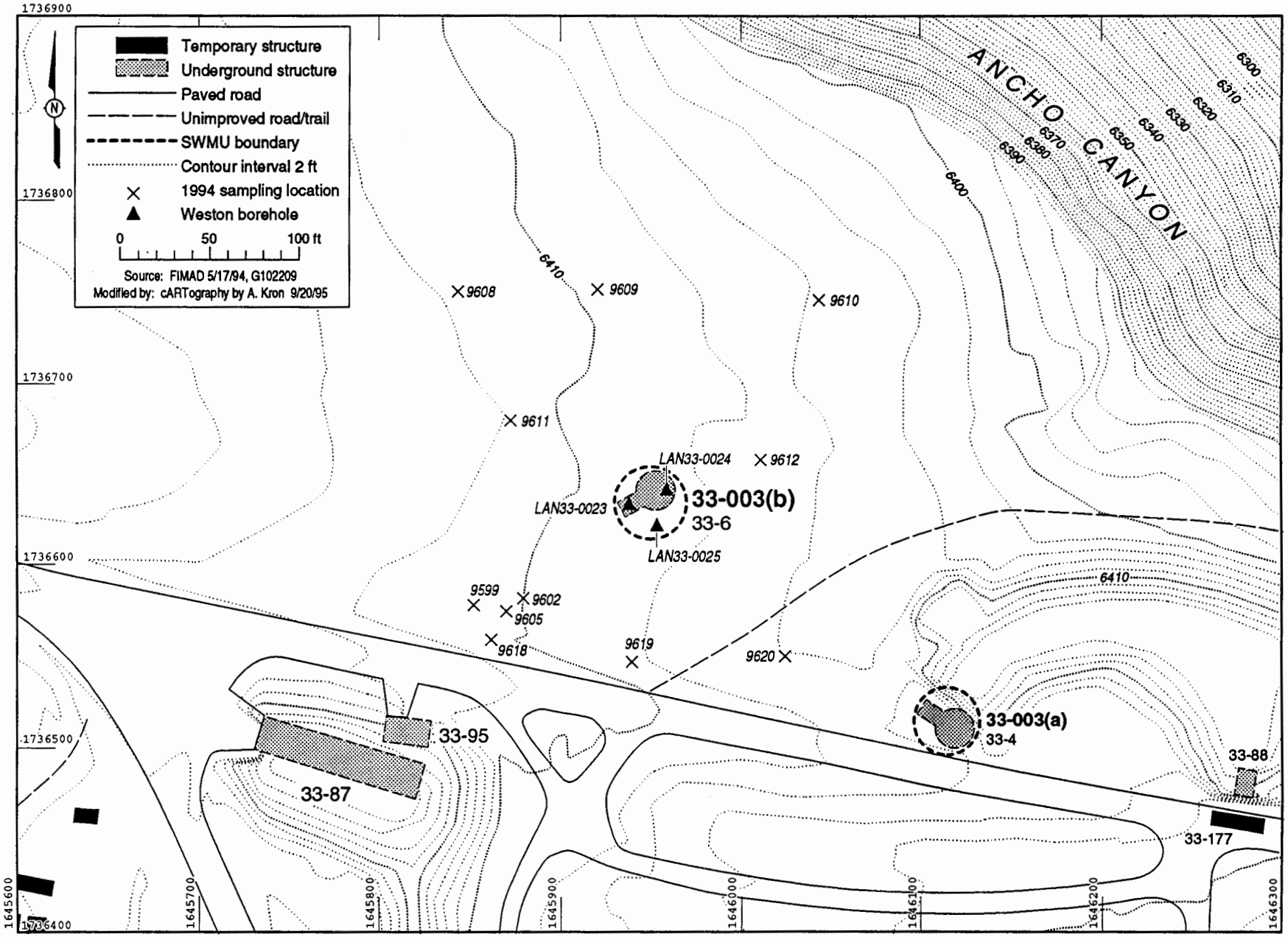

Fig. 5-1. East Site: SWMU 33-003(b) Weston boreholes and ER 1994 sampling campaign.

5.1.3.2 Data Interpretation

Results of sampling and analysis indicate that no inorganics or radionuclides are present at hazardous levels in the area surrounding the chamber. At the time of sampling, PCBs were not recognized as a potential contaminant.

5.1.3.3 Risk Assessment

No risk assessment was performed for SWMU 33-003(b). The following is a discussion of the pathway from the chamber to receptors. It does not address surface or subsurface contamination.

No remediation is recommended for chamber TA-33-6. This chamber is identical to chamber TA-33-4, described in Subsection 4.1. The rationale against further action is described in detail in Subsection 4.1.3.3 of this RFI report and is summarized here.

The source of contamination at the MDA D chambers is material within the underground chambers and possibly the elevator shafts. Based upon documentation of experiments conducted at MDA D, materials that may be present in the underground chambers include steel, copper, aluminum, PCBs, zinc, and milligram or gram amounts of beryllium and lead. The HE trinitrotoluene and its detonation products may also be present. Some electrical components of the tests may have contained PCBs and the chambers may contain PCBs in amounts estimated to be less than 5 lb (Morgan 1994, 02-088). No research data on the fate of PCBs under explosive conditions similar to those within the chamber can be found. It is not known what percentage of the PCBs remained intact and what percentage are present as combustion products.

For chamber TA-33-6, SWMU 33-003(b), the immediate transport mechanism was atmospheric dispersion. This mechanism potentially brought contaminants to the surface. This mechanism will be investigated in accordance with the sampling plan presented in Subsection 5.1.5 of this RFI report. The only current transport medium for any contaminants that remained in the chamber after detonation would be through soil sifting through cracks in the chamber or through the material used to backfill the elevator shaft. Migration is unlikely because these contaminants are most likely to bind to the subsurface fill material, the tuff walls of the shaft, and the concrete walls of the chamber. Any remaining PCBs, especially the more heavily chlorinated PCBs, will bind to organic material in the soil or to tuff rubble that may have entered the chamber.

The potential for future migration of PCBs and other contaminants from the chamber is negligible because of the minimum potential for migration discussed in the preceding paragraph and the inaccessibility of contaminated material in the chamber to potential receptors. Because the floor of the chamber is approximately 50 ft below grade, contaminants are not accessible to LANL workers or visitors. A potential future construction scenario is unlikely to expose workers to chamber contamination because a typical excavation would not occur at depths greater than 12 ft, the average depth of a basement. A residential scenario would not expose homeowners to contamination. For these reasons no remediation is recommended for the chamber.

The risk to groundwater is considered negligible. MDA D is located 660 ft above the nearest spring on the floor of Ancho Canyon. No springs have been located on the side of the canyon. No driving force exists in the chambers to force contaminants through cracks in both tuff and basalt layers to groundwater.

5.1.4 Conclusion and Recommendation

Based on the argument in Subsection 5.1.3.2 that no pathway exists for contamination to reach a receptor, no further investigation of chamber TA-33-6 will be carried out. However, sampling prescribed by the RFI work plan was not sufficient to characterize material bulldozed into the crater created by the 1952 test, nor were PCBs considered a potential contaminant. Therefore, additional Phase I surface and subsurface sampling are proposed for SWMU 33-003(b).

5.1.5 Phase I Revised Sampling and Analysis Plan

5.1.5.1 Phase I Sampling Objectives

Existing surface data for SWMU 33-003(b) at East Site includes 16 surface soil samples collected by LANL's Environmental Surveillance program, and 9 samples collected from 3 boreholes for the 1989 Weston investigation. The surveillance samples were analyzed for tritium, uranium, and cesium-137, and all results were within background ranges. The Weston borehole samples were analyzed for inorganics, HE, and radionuclides. Results were below detection limits or background UTLs. Surface sampling in 1994 did not detect inorganics above background UTLs.

Concerns that are inadequately addressed by the existing data are:

- Previous surface data are primarily from locations within approximately 50 ft of TA-33-6. However, following destruction of the chamber by a large experiment that ejected debris from the shaft, debris and soil were bulldozed back into the crater. It is possible that the area sampled in 1977 either had been scraped off, or consisted of uncontaminated soil used to cover the bulldozed material, while contaminants above background and possibly even above levels of concern may remain at greater distances from the elevator shaft.

- The Weston survey provided two samples from the refilled volume of the crater; that is, the debris and material for which above background field radioactivity measurements were reported in 1953.

Phase I sampling at PRS 33-003(b) is intended to address these concerns, to provide data for risk assessment, and (if appropriate) to provide information on the mobility of buried contaminants (Fig 5-2).

- **Surface samples** A 100 ft by 100 ft grid-stratified random sampling scheme will provide 9 surface samples out to a distance of 150 to 200 ft from the elevator shaft. One sample will be taken from each square, with the sample location randomly selected within each square. Sampling will be conducted north of the East Site road and will avoid other SWMUs when possible.

- **Subsurface samples** Two holes drilled near the shaft will provide six samples from depths of 2 ft to a minimum of 15 ft within the bulldozed debris.

All 15 samples will be field screened for PCBs using the PCB D TECH™ kit. PCB-screened samples exceeding 1 mg/kg will be submitted for fixed laboratory analysis. Subsurface samples will also be analyzed for inorganics. Results of inorganic analyses from the ER 1994 surface sampling points are adequate to address surface inorganic concerns. Toxicity characteristic leaching procedure (TCLP) analyses will be performed on subsurface samples if the total inorganics results (in mg/kg) exceed twenty times the TCLP limit (in mg/L).TCLP analyses will determine if buried constituents are leachable.

5.1.5.2 Sampling and Analysis

Phase I sampling will focus on determining the presence of inorganics and PCBs at SWMU 33-003(b). All samples will be field screened for radioactivity to identify gross concentrations of contaminants. Appropriate health and safety precautions will be undertaken according to the site-specific health and safety plan.

Sampling Techniques Surface soil samples will be collected with the spade and scoop technique (LANL-ER-SOP-06.09) to a depth of 6 in. Subsurface samples will be collected with a hollow-stem auger drill rig outfitted with a continuous sample collection system (LANL-ER-SOP-04.01) and will be advanced to a depth of 15 ft. The 15 ft depth is designed to ensure detection of contamination below the clean fill and/or scraped surface horizon.

The SWMU includes two target areas

- **Elevator shaft** Nine surface soil samples (0 to 6 in.) will be collected. The 9 grid-stratified random samples taken from a 100 ft by 100 ft grid will result in sampling to a distance of approximately 150 to 200 ft from the shaft (Fig. 5-2). These random samples will be field screened for PCBs.

- **Borehole samples** Two hollow-stem auger boreholes adjacent to the shaft will be drilled to a nominal depth of 15 ft. If soil texture or color indicates that the boreholes are not below the bottom of the former depression , the boreholes will be advanced below 15 ft until that interface is reached. These boreholes will be located within 8 ft of the shaft and will provide 3 analytical samples each. Analytical samples will be collected below the cover fill layer and above the bottom of the former depression. Selection of analytical sample intervals will be based upon observed changes in soil color and texture. Analytical samples will be a minimum depth interval of 6 in. each. See Fig. 5-2 for planned sample locations.

Laboratory Analysis Subsurface analytical samples will be field screened by X-ray fluorescence (XRF) or laser-induced breakdown spectroscopy (LIBS) for inorganics. All samples for which the inorganic concentration exceeds 20 times the TCLP limits will be submitted to the laboratory for TCLP analyses. Any sample measuring 1 mg/kg PCBs or above by field screening will be submitted for fixed-laboratory analysis.

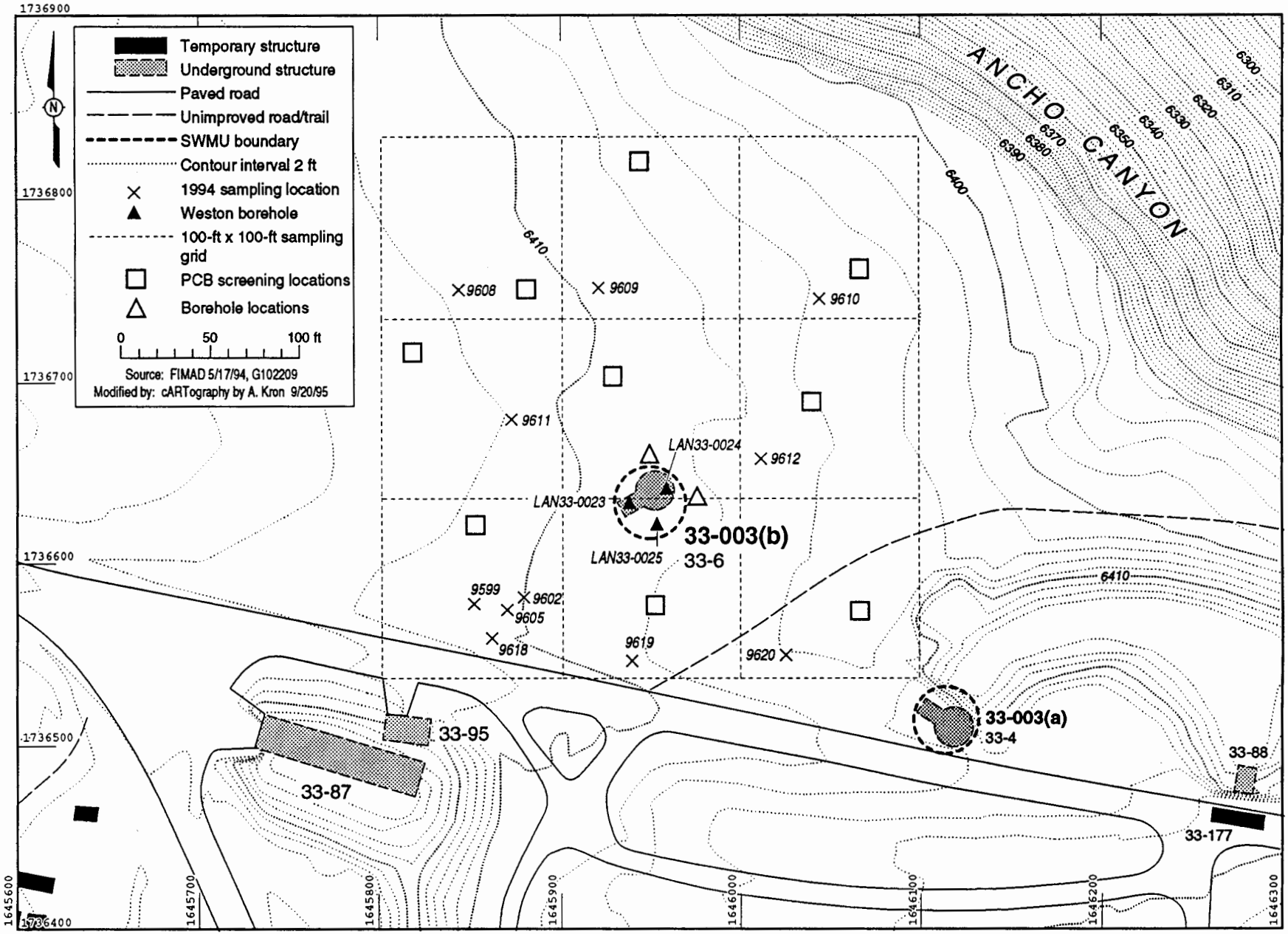

Fig. 5-2. East Site: SWMU 33-003(b) sampling locations.

5.2 SWMU 33-004(k) Outfall from TA-33-87, East Site

SWMU 33-004(k) is the outfall of a drain line from bunker TA-33-87. It is discussed in the RFI Work Plan for OU 1122, Subsection 3.5.2.3 and 4.5.3.2 (LANL 1992, 0784). Sampling during the 1994 campaign was inadequate to assess contamination from this SWMU because neither the outfall or the drain line was located.

SWMU 33-004(k) is the alleged outfall of a drain line from control bunker TA-33-87 at East Site. LANL engineering drawing C-3304 shows an 8-in cast iron. pipe extending 54 ft southeast of the building, then an 8-in. vitrified-clay pipe extending another 71 ft to an outfall. During the 1994 field campaign, neither pipe nor outfall was found. The outfall point of the clay pipe may be in the area excavated in 1984 for the SWMU 33-008(b) landfill. The point of discharge may have been destroyed during creation of the landfill.

Bunker TA-33-87 was completed in June 1955 to support shot tests at East Site. There is no record of radioactive materials being used or stored in the building. However, photoprocessing may have occurred.

TA-33-87 is covered by a berm and part of the alleged pipe is covered by this berm. The terrain southeast of the berm is level and covered with chamisa.

5.2.1 Previous Investigation

No previous investigations have been performed for this SWMU.

5.2.2 Field Investigation

Because the pipe was never found, no ER samples were collected during the 1994 field campaign that can be directly attributed to this outfall.

5.2.2.1 Results of Field Surveys

Magnetic and electromagnetic surveys failed to detect anomalies at the expected location of the pipe. Most of the area is buried under the berm covering bunker TA-33-87.

5.2.2.2 Results of Field Screening

No radiation screening was performed at SWMU 33-004(k).

5.2.3 Screening Assessment

No screening assessment can be performed for this SWMU.

5.2.4 Conclusion and Recommendation

To adequately assess release of potential contamination by this outfall, a second try at Phase I sampling is proposed in conjunction with sampling in landfill SWMU 33-008(b).

5.2.5 Sampling and Analysis Plan

During the Phase I sampling of landfill SWMU 33-008(b), described in Subsection 5.3 of this RFI report, an attempt will be made to locate the pipe. If the pipe is located, samples will be collected as follows: if the outfall lies within the boundaries of the landfill, a sample will be taken at the soil/tuff interface in the landfill at the point indicated on the engineering drawing as the location of the outfall (Fig. 5-3). If the outfall is located outside the boundaries of the landfill, a sample will be taken at that point. This sampling will be considered Phase I reconnaissance sampling. The sample will be analyzed in the laboratory for inorganics, VOCs, and SVOCs.

5.3 SWMU 33-008(a,b) Landfills at South Site and East Site

SWMUs 33-008(a,b) are landfills created at TA-33 during a 1984 cleanup of South and East Sites. SWMU 33-008(a) is discussed in the RFI Work Plan for OU 1122, Subsections 3.4.2.10 and 4.4.7 (LANL 1992, 0784). SWMU 33-008(b) is discussed in work plan Subsections 3.5.2.6 and 4.5.6. After the RFI work plan was submitted, evidence was discovered that the contents of the landfill made the proposed trenching sampling plan inappropriate to perform. A revised plan is presented here.

The SWMU 33-008(a) landfill was created in 1984 at South Site when many structures and experimental objects were dismantled. The cleanup was intended as an interim action pending stricter regulation of LANL cleanup activities. During cleanup, radioactive and salvageable material were removed; however, no sampling was done to identify RCRA hazardous wastes. Remaining material was buried in the landfill (Buhl 1984, 02-038).

The SWMU 33-008(b) landfill was created at East Site during the 1984 cleanup. Radioactive and salvageable material were removed. Remaining material was buried. The surface was leveled and the corners of the landfill marked with metal posts.

The RFI work plan for OU 1122, approved by EPA in 1993, proposed trenching through each landfill to determine if the contents include hazardous material (LANL 1992, 0784). Subsequent to submittal of the work plan, photos were discovered that were taken during the cleanup. Photos indicate that the buried debris included massive items such as telephone poles and railroad ties and that the material is tightly packed within the landfill. It became clear that trenching with a backhoe as described in the work plan could not produce the desired samples. This section presents an alternate sampling plan.

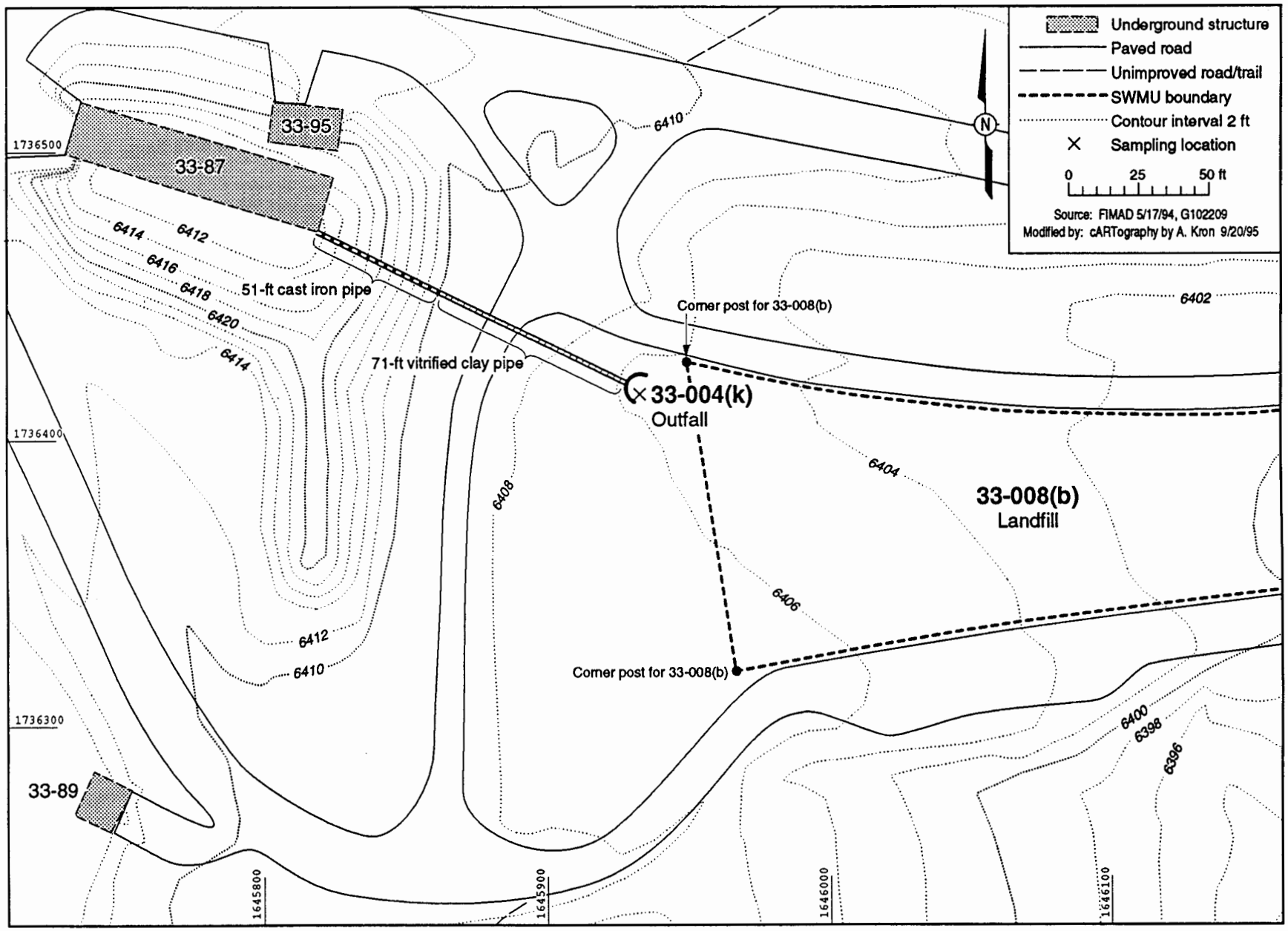

Fig. 5-3. East Site: SWMU 33-004(k), outfall from TA-33-87, shown in relation to SWMU 33-008(b), landfill.

SWMU 33-008(a) This landfill lies within a horseshoe-shaped berm, TA-33-43, at South Site. The floor of the berm appears to be on bedrock. At its highest point, the berm is about 15 ft high. The landfill grades from the floor to the inside curve of the berm and may be 8 ft at its deepest point. The four corners of the landfill are marked with metal pipe. Over the years, a thick stand of chamisa has grown on the landfill. Some of the buried material has been exposed through erosion.

SWMU 33-008(b) The landfill at East Site occupies the space between the firing pads east of bunker TA-33-87 and shack TA-33-151. According to LANL engineering drawing ENG-C 3304, this area may have originally been excavated to provide material for the nearby berms. The fill is well compacted and covered; there is no longer any surface indication of its existence. The four corners are marked with metal poles. The surface is level and covered with a sparse growth of weeds and grasses. Thick stands of chamisa grow along most of the perimeter.

5.3.1 Previous Investigations

Prior to 1994 ER sampling, no investigations had been performed for these landfills.

5.3.2 Field Investigations

SWMU 33-008(a) During the 1994 sampling campaign, four surface samples were collected at the South Site landfill. Three were taken at the lower edge of the landfill. The fourth was taken in the drainage leading from the bermed area (Fig. 5-4). All four samples were analyzed for inorganics, uranium, gamma emitters and HE. Two samples were analyzed for uranium.

SWMU 33-008(b) No samples were taken within the East Site landfill boundaries during the 1994 sampling campaign. Fig. 5-5 shows the extent of the landfill.

5.3.2.1 Results of Field Surveys

No field surveys were associated with SWMUs 33-008(a) or 33-008(b).

5.3.2.2 Results of Field Screening

No radiation was detected during routine field screening of sampling locations at SWMU 33-008(a).

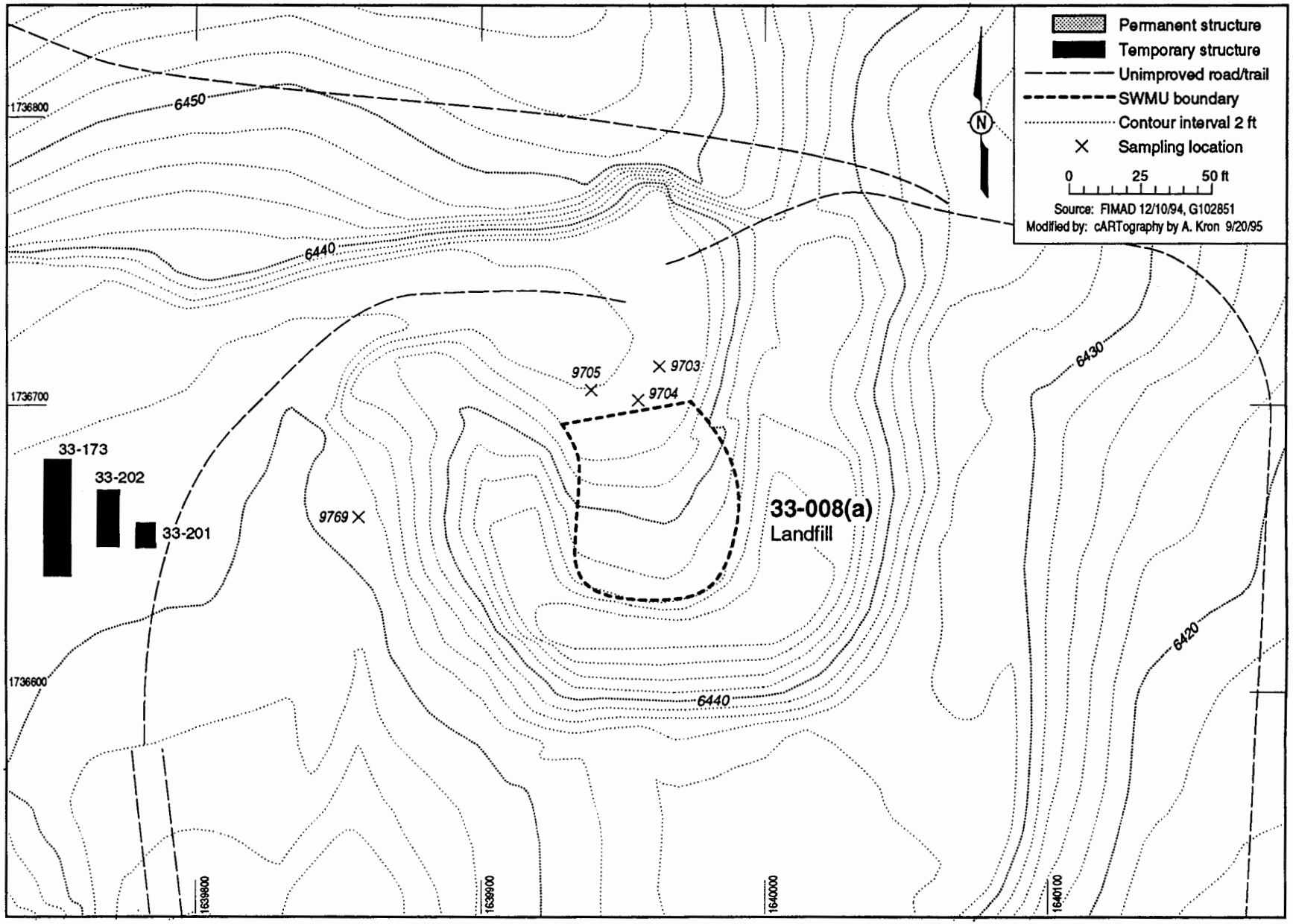

Fig. 5-4. South Site: SWMU 33-008(a), landfill, 1994 sampling campaign.

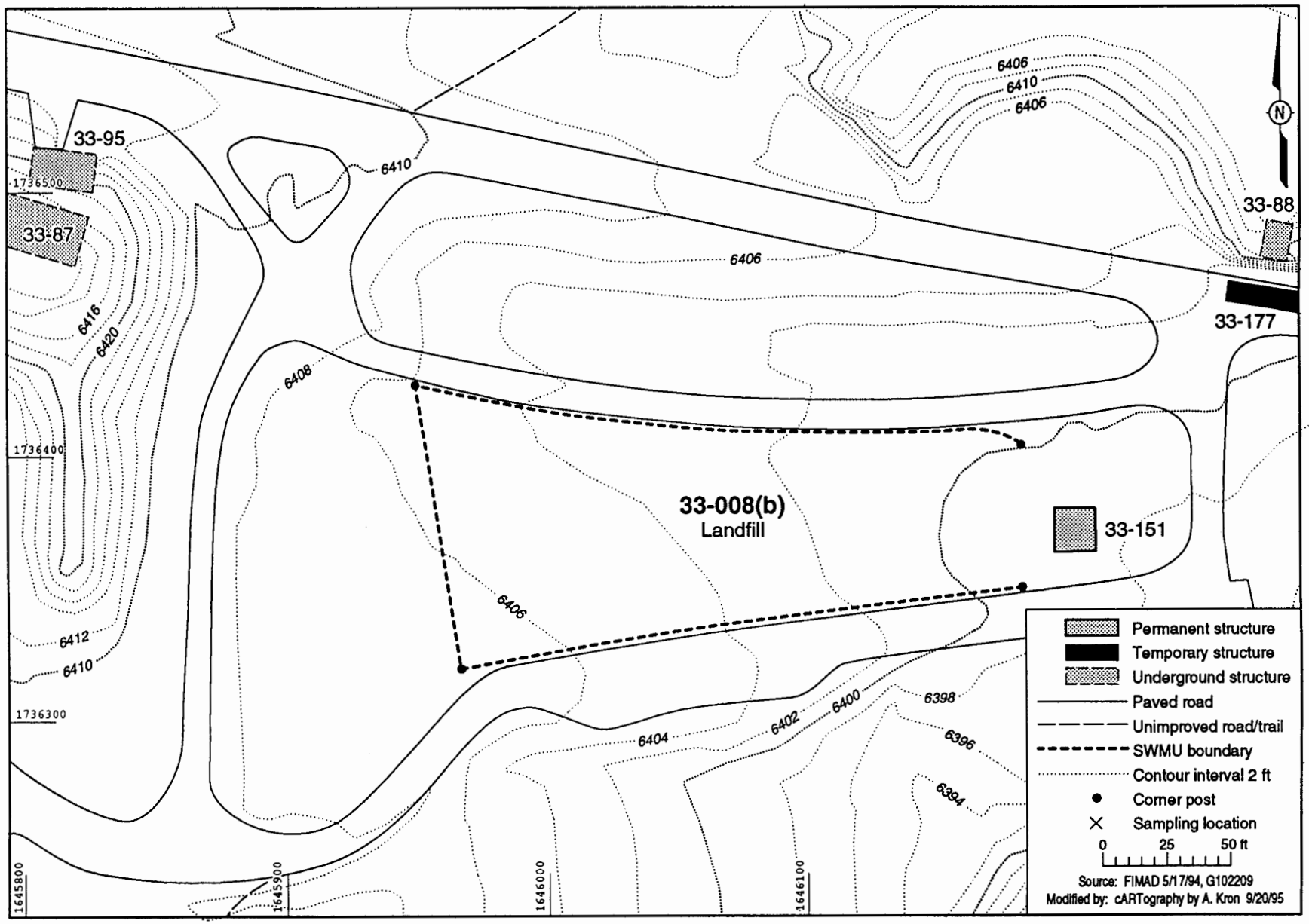

Fig. 5-5. East Site: SWMU 33-008(b), landfill.

5.3.3 Screening Assessment

5.3.3.1 Comparison to Background/SALs

SWMU 33-008(a) Two SVOCs were detected in one sample (Table 5-3). No inorganics, gamma emitters, or uranium were detected above LANL and TA-33 background UTLs.

TABLE 5-3

SVOCs DETECTED AT LANDFILL SWMU 33-008(a)

ANALYTE	SAMPLE ID	DEPTH (in.)	MEDIUM	CONCENTRATION (mg/kg)	SAL[a] (mg/kg)
Di-n-butylphthalate	AAA9675	0-6	Soil	4.1	8 000
Dinitrotoluene	AAA9675	0-6	Soil	2	1

[a] SAL = Screening action level.

5.3.3.2 Data Interpretation

The question of contamination within the landfills has not been addressed. Di-n-butylphthalate, a plasticizer, is a common analytical laboratory contaminant and may not be present. Dinitrotoluene is a propellant plasticizer.

5.3.4 Conclusions and Recommendations

Additional Phase I sampling is recommended for these landfills to assess the possibility of contamination. Based on sampling and analyses, recommendations will be developed for the disposition of the landfills.

5.3.5 Further Investigations

5.3.5.1 Sampling Objectives for SWMU 33-008(a,b)

Based on anecdotal evidence and reports of the 1984 activities that created these landfills, uranium, beryllium, and lead are likely to be present in small quantities in both landfills. HE or their byproducts may be present at the South Site landfill, SWMU 33-008(a). Field and/or laboratory analysis will characterize levels of radioactivity, inorganic hazardous constituents (both total and recoverable by TCLP), and HE.

The landfills are expected to be heterogeneous. Field information will provide information about this heterogeneity, including estimates of the volumes of metallic material such as cables, of wood material such as telephone poles and railroad ties, and of fill material, as well

as identify other types of buried material. Field investigations of the two shallow landfills will provide estimates of several parameters associated with these sites: the volumes of each landfill, the nature of the landfill contents, levels of radioactive and hazardous constituents, and whether or not such constituents, if present, are migrating into the underlying tuff. The depth of the fill/tuff interface will be observed in each borehole placed during Phase I sampling. The lateral extent of the landfills is known, and the depth will provide sufficient information to establish the total volume of the landfills.

Field crews will categorize all excavated material into at least three categories (metal, wood, soil/tuff fill), and more if desirable. Additional categories might be established for glass, rubber, or other materials if they are encountered. The volume of each type of material in the landfill will be estimated based on the relative amounts of each category encountered during drilling. This information will also be used to stratify the collection of samples for analysis.

Samples will be collected from the cored material, both within the landfill (i.e., above the fill/ tuff interface), at the interface, and in undisturbed tuff or material beneath the landfill. Analysis will determine whether hazardous constituents are present in any stratum at each landfill. The TCLP will be performed on one-half the randomly selected soil samples in preparation for possible removal of landfilled materials.

5.3.5.2 Phase I Sampling and Analysis

Phase I sampling will focus on determining: the volume of the landfills, the nature of the landfill contents, the levels of hazardous constituents within the landfills, and possible migration of hazardous constituents into underlying soil/tuff.

All samples will be field screened for radioactivity and organic vapors to identify gross concentrations of contaminants. Appropriate health and safety precautions will be undertaken according to the site-specific health and safety plan.

Sampling Techniques Subsurface core samples will be collected with an auger drill rig outfitted with a tungsten-carbide tipped core barrel. Although this drill rig would normally drive a hollow-stem auger drill string, in this case no augers will be used, only a specially-built tungsten carbide-tipped core barrel. This drill string will be cooled and lubricated with compressed air and is designed to slowly mill through the various types of landfill debris expected to be encountered. The boreholes will be advanced 2-ft into the underlying tuff to a nominal depth of 10 ft to ensure the detection of contaminants that may have leached from the landfill and migrated to the fill/tuff interface or below.

Sampling Summary, SWMU 33-008(a) Four cored boreholes will be drilled at the South Site landfill at random locations within a stratified 2 by 2 grid (four cells approximately 30 ft by 35 ft each) laid over the site as defined by the four posts. Alternate borehole locations will be selected within the same grid square if drilling into the underlying tuff is not possible because of bit refusal.

The boreholes will be cored through the landfill surface cover layer, the debris layer, and 2 ft into the tuff below. Four analytical samples will be collected from each borehole. Two borehole samples will consist of actual debris material, one soil sample at the bottom of the landfill material immediately above the tuff, and one tuff sample from between 12 in. to 24 in. beneath the fill/tuff interface. Debris samples will be selected from the entire landfill in the following proportions; one-third fill, one-third wood, one-third other material. Depth intervals of analytical samples will be 6 in. the case of tuff or soil and the thickness of the debris when the debris samples are being collected.

Sampling Summary, SWMU 33-008(b) Six cored boreholes will be drilled at the East Site landfill at random within a stratified grid of 2 by 3 (six cells approximately 40 ft by 60 ft each) laid over the site within the four corner posts. Alternate borehole locations will be selected within the same grid square if drilling into the underlying tuff is not possible because of bit refusal.

The boreholes will be cored through the landfill surface cover layer, the debris layer, and 2 ft into the tuff below. Four analytical samples will be collected from each borehole. Two samples will consist of actual debris materials, one soil sample at the bottom of the landfill material immediately above the tuff, and one tuff sample from between 12 in. to 24 in. beneath the fill/ tuff interface. Debris samples will be selected from the entire landfill in the following proportions; one-third fill, one-third wood, one-third other material. Depth intervals of analytical samples will be 6 in. the case of tuff or soil and the thickness of the debris when the debris samples are being collected.

Laboratory Analysis Debris samples of landfill material will be field screened for inorganics using XRF or LIBS. All soil samples will be analyzed in the laboratory for total inorganics and total uranium. TCLP analyses will be performed on samples exceeding 20 times SAL. HE analyses will be performed on all samples collected from the South Site landfill. Analysis for SVOCs will be performed on all fill samples, tuff/fill interface samples, and the samples taken 12 to 24 in. beneath the tuff/fill interface.

5.4 C-33-001, C-33-002 Power transformers

AOCs C-33-001 and C-33-002 are power transformers. C-33-001 is discussed in Subsection 3.2.2.15 and C-33-002 is discussed in Subsection 3.5.2.7 of the RFI Work Plan for OU 1122 (LANL 1992, 0784). Sampling is proposed to detect PCBs.

Two power transformers were installed at TA-33 in the 1950s. C-33-001, transformer TA-33-124, is located at Main Site on the east side of building TA-33-114. C-33-002, transformer TA-33-95, is in a vault at the TA-33-87 complex at East Site. Transformer oil in these transformers may have contained PCBs. When the RFI work plan was written, both transformers were scheduled for replacement. The transformers were replaced in 1992 under the Toxic Substances Control Act (EPA 1993, 1244). However, sampling after replacement was not adequate for ER objectives. This subsection proposes sampling and analysis to detect any PCB contamination and migration that may have resulted from historic operation of the transformers.

5.4.1 Objectives

The OU 1122 work plan depended upon sampling and cleaning to be performed during replacement of the transformers in 1992. Subsequent inquiry into the replacement operations at TA-33 indicate that the replacement crew only sampled where they had temporarily set down the old transformer. No site-wide sampling was performed to detect historic PCB releases. No cleanup was performed at either site.

The principal questions are:

- Were there historic releases of PCBs from either transformer?
- Have PCBs been released to the environment at either site?
- If PCBs are present, are they migrating to the environment?

Objectives for field screening at each site include:

- an estimate of the distribution of PCB contamination, if present,
- an estimate of the PCB concentration, and
- an indication of PCB migration and the direction of the plume.

Information expected from field screening includes:

- an estimate of PCB presence and extent,
- an estimate of potential and possible direction for migration,
- laboratory analysis, if field results warrant sampling.

C-33-001 Boundary of the Main Site transformer will be a 3-ft. radius around the perimeter of the fenced area (Fig. 5-6). If field screening locates PCBs at the perimeter, then screening will proceed outward until PCBs are no longer found. PCB sampling in the drainage at the vehicle maintenance area of SWMU 33-017 (Subsection 4.8 of this RFI report) will be considered when evaluating this AOC. In addition, field screening will be performed in the drain field at the points where PCBs were identified as TICs.

C-33-002 At East Site the boundary will be the concrete pad outside the vault door, an area approximately 10 ft by 20 ft, and 2 ft down the adjacent drainage (Fig. 5-7). The floor of the vault will not be sampled. The tolerable uncertainty is a 15% chance of missing contamination altogether even if half of the area is contaminated. Three samples will provide this margin of certainty.

5.4.2 Sampling Plan

Field screening will consist of D TECH™ immunoassay testing with a detection limit of 0.5 mg/kg of PCBs in soil (Appendix C). Because PCBs tend to absorb into asphalt or concrete, stained areas will be screened if present. If PCBs are detected, further testing will determine if a plume exists. If soil near either area appears stained, that soil will also be tested. If field screening indicates that PCBs may be present above 1 mg/kg, samples will be submitted for laboratory analysis.

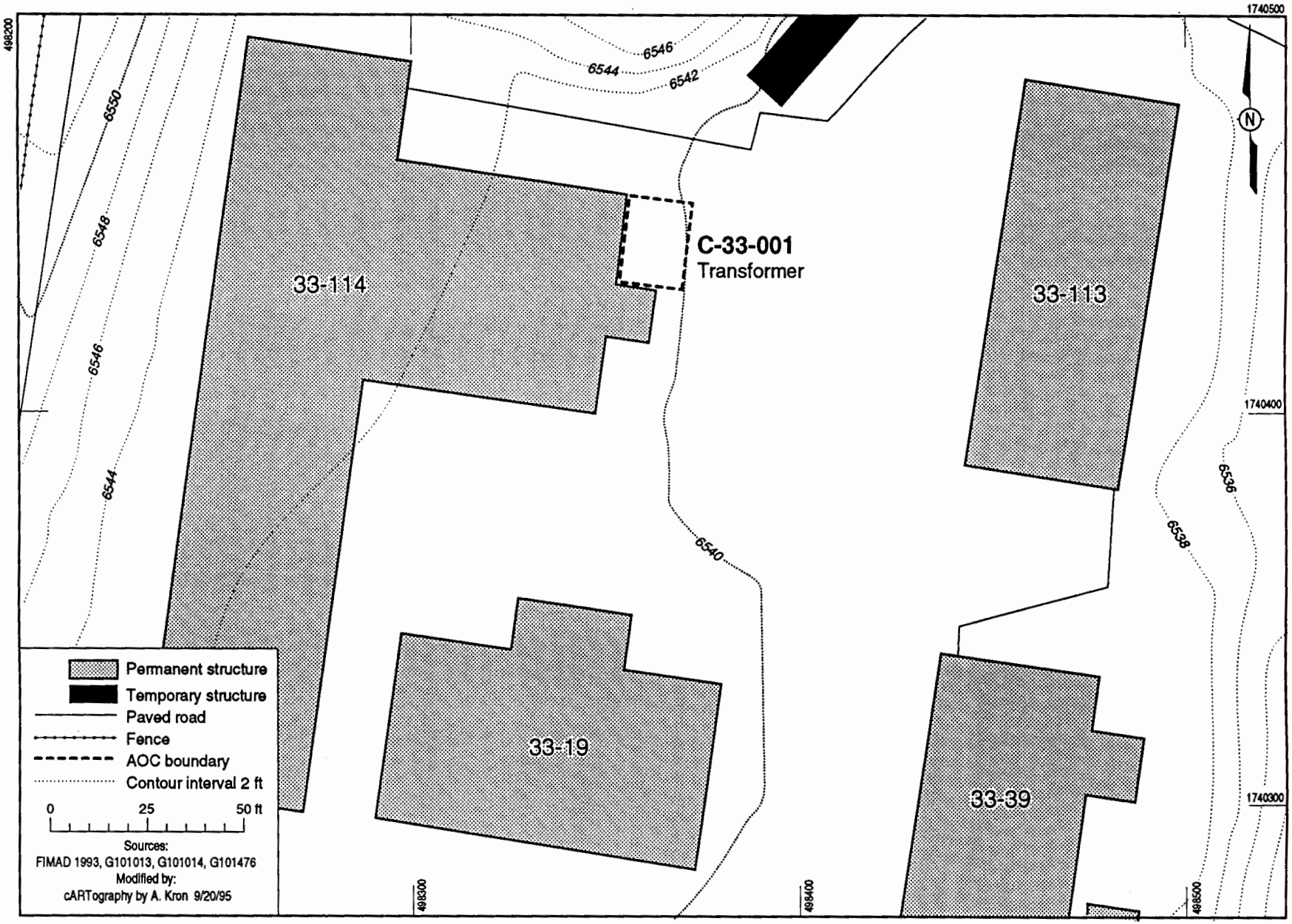

Fig. 5-6. Main Site: Area of concern (AOC) C-33-001, transformer.

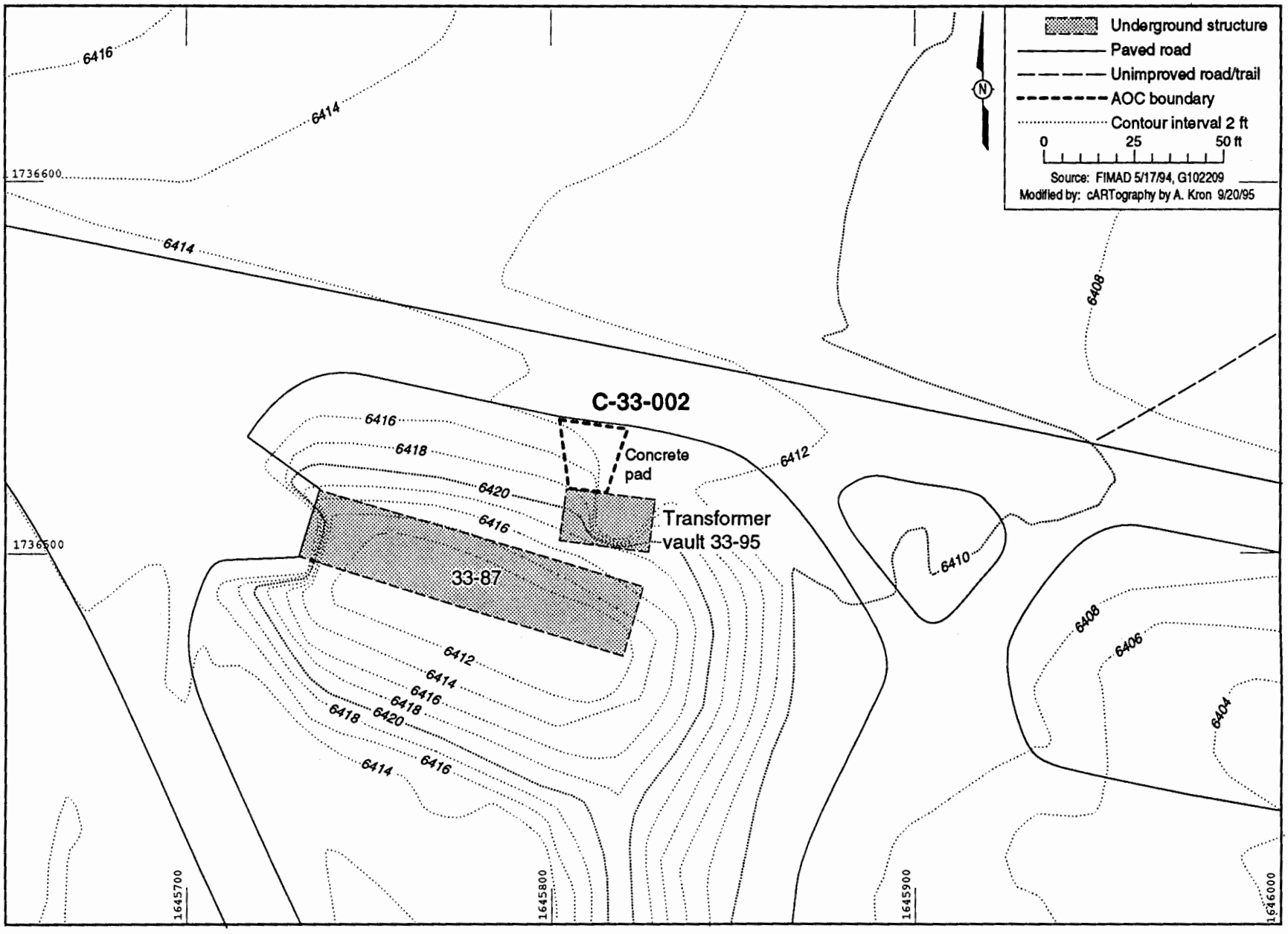

Fig. 5-7. East Site: Area of concern (AOC) C-33-002, transformer.

6.0 REFERENCES

Blackwell, C. D., April 23, 1952. "Excavation and Shot in Chamber #2 at 'Hot Point,' TA-33," Los Alamos Scientific Laboratory Memorandum to Dean D. Meyer (H-1) from Charles Blackwell (H-1), Los Alamos, New Mexico. **(Blackwell 1948, 02-034)**

Blackwell, C. D., October 28, 1953. "Radiation Survey of Old Hot Point, TA-33," Los Alamos Scientific Laboratory Memorandum H-1 to Henry Petrzilka (W-3) from Charles Blackwell (H-1), Los Alamos, New Mexico. **(Blackwell 1948, 02-035)**

Buckland, C., April 20, 1948. "TA-33," Los Alamos Scientific Laboratory Memorandum to Harriet L. Hardy, M. D. from Carl Buckland (H-1), Los Alamos, New Mexico. **(Buckland 1948, 02-048)**

Buhl, T. E., June 28, 1988. "Clean-up of Two Firing Sites at TA-33," unpublished draft of a report, Los Alamos National Laboratory, Los Alamos, New Mexico. **(Buhl 1984, 02-038)**

Environmental Restoration Project, January 1995. "Los Alamos National Laboratory Environmental Restoration Project - No Further Action (NFA) Criteria," ER Project Policy Paper, Los Alamos National Laboratory, Los Alamos, New Mexico. **(Environmental Restoration Project 1995, 1173)**

EPA (US Environmental Protection Agency), December 1989. "Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)," Interim Final, EPA 540/1-89/002, Office of Emergency and Remedial Response, Washington, DC. **(EPA 1989, 0305)**

EPA (US Environmental Protection Agency), April 10, 1990. Module VIII of RCRA Permit No. NM0890010515, EPA Region VI, issued to Los Alamos National Laboratory, Los Alamos, New Mexico, effective May 23, 1990, EPA Region VI, Hazardous Waste Management Division, Dallas, Texas. **(EPA 1990, 0306)**

EPA (US Environmental Protection Agency), February 1992. "Framework for Ecological Risk Assessment," EPA/630/R-92/001, Risk Assessment Forum, US Environmental Protection Agency, Washington, DC. **(EPA 1992, 0989)**

EPA (US Environmental Protection Agency), July 15, 1993. "RFI Work Plan for OU 1122, Approval," letter to Joseph Vozella, Los Alamos Area Office, DOE. from Jack Divits for Allyn Davis, EPA, Dallas, TX. **(EPA 1993, 02-090)**

EPA (US Environmental Protection Agency), July 1, 1993. "Toxic Substances Control Act," Title 40, Parts 700-789) Federal Register, Washington, DC. **(EPA 1993, 1244)**

ICF Kaiser, February 17, 1994. "Summary of 1993 Survey and Sampling Activities at TA-33 (Main Site and Area 6)," ICF Kaiser Engineers, Inc., Contract 9-XS2-X5348-1, Los Alamos, New Mexico. **(ICF Kaiser 1994, 02-095)**

ICF Kaiser February 1995. "Expedited Cleanup Plan for Operable Unite Solid Waste Management Unit (SWMU) 33-009," ICF Kaiser Engineers, Inc., Contract 9-XS2-X5348-1, Los Alamos, New Mexico. **(ICF Kaiser 1995, 02-105)**

LANL (Los Alamos National Laboratory), May 1991. "Generic Quality Assurance Project Plan for RCRA Facility Investigations for the Los Alamos National Laboratory Environmental Restoration Program," Rev. 0, Los Alamos National Laboratory Report Los Alamos, New Mexico. **(LANL 1991, 0412)**

LANL (Los Alamos National Laboratory), May 1992. RFI Work Plan for Operable Unit 1122, LA-UR-92-925. Los Alamos National Laboratory, Los Alamos, New Mexico. **(LANL 1992, 0784)**

LANL (Los Alamos National Laboratory), January 1993. "Los Alamos National Laboratory Environmental Restoration Program Standard Operating Procedures," Los Alamos National Laboratory Report, Los Alamos, New Mexico. **(LANL 1993, 0875)**

LANL (Los Alamos National Laboratory), November 1993. "Installation Work Plan for Environmental Restoration," Los Alamos National Laboratory Report LA-UR-93-3987, Los Alamos, New Mexico. **(LANL 1993, 1017)**

LANL (Los Alamos National Laboratory), June 16, 1994. "Environmental Restoration Program, Operable Unit (OU) 1122 Cultural Resource Survey Report" Cultural Resource Management Team Report No. 57, Volume 1, Survey No. 518. Environmental Protection Group (ESH-8), Los Alamos National Laboratory, Los Alamos, New Mexico. **(LANL 1994, 02-0103)**

LANL (Los Alamos National Laboratory), January 1995. "RFI Report for TA-33," Los Alamos National Laboratory Report LA-UR-95-882, Los Alamos, New Mexico. **(LANL 1995, 1212)**

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

Morgan, G. L., May 2, 1994. "Investigation of Material used in Underground Chambers at TA-33," Los Alamos National Laboratory Memorandum P-15-94-U-191 to Dorothy Hoard (CST-1) from George L. Morgan (P-15) Los Alamos, New Mexico. **(Morgan 1994, 02-088)**

Nyhan, J. W., L. W. Hacker, T. E. Calhoun, and D. L. Young, June 1978. "Soil Survey of Los Alamos County, New Mexico," Los Alamos Scientific Laboratory Report LA-6779-MS, Los Alamos, New Mexico. **(Nyhan et al. 1978, 0161)**

Reneau, S. L., D. P. Dethier, J. S. Carney, June 1995. "Landslides and Other Mass Movements Near Technical Area 33," Los Alamos National Laboratory Report LA-12955-MS, Los Alamos National Laboratory, Los Alamos, New Mexico. **(Reneau 1994, 02-092)**

Zia Company, May 1963. Zia Job Order 165991, Los Alamos, New Mexico. **(Zia Company 1963, 02-030)**

APPENDIX A

Environmental Restoration raw data are available from the Facility for Information Management, Analysis, and Display (FIMAD). If FIMAD is not accessible, data will be provided upon request.

THIS PAGE LEFT INTENTIONALLY BLANK

APPENDIX B PHASE II SAMPLING AND ANALYSIS PLANS

Table B-1 list the four sampling plans presented in Appendix B of this RFI report.

TABLE B-1

PHASE II SAMPLING AND ANALYSIS PLANS

SECTION	PRS[a]	OBJECTIVE
1.0	33-009	Determine levels and extent of PCBs[b]
2.0	33-011(d)	Locate and remove uranium contamination Determine levels and extent of lead
3.0	33-013	Investigate inorganic contamination
4.0	33-017	Determine levels and extent of PAHs[c]

a PRS = Potential release site.
b PCBs = Polychlorinated biphenyls.
c PAHs = Polycyclic aeromatic hydrocarbon.

1.0 PHASE II SAMPLING AND ANALYSIS PLAN FOR SWMU 33-009

1.1 Phase II Sampling Objectives

Phase II sampling is proposed for solid waste management unit (SWMU)-33-009. The objective of Phase II sampling is to determine the levels and extent of polychlorinated biphenyls (PCB) releases within and around the suspected storage site. In particular, it will seek to determine;

- whether PCBs are present at concentrations that could trigger cleanup,
- if so, the approximate lateral and vertical extent of volumes requiring cleanup, and
- the extent of PCB migration down the channel below the SWMU 33-004(g) outfall.

The study will be conducted primarily by means of field immunoassay measurements. Confirmatory laboratory analyses will be used to evaluate the method in the critical range (1 to 50 mg/kg) and to estimate the false negative rate, defined as reporting less than 1 mg/kg for samples greater than 5 mg/kg. If high field observations are made, waste characterization analyses will also be requested in anticipation of corrective action.

Four areas are targeted for the Phase II investigation.

- **Area most likely** The area most likely to have been used for storage of defective capacitors is the rim of Area 6 extending from north of TA-33-16 south to the west end of the excavated cinder cone. Ten augered boreholes about 25 ft apart (shown as circles in Fig. B-1) will provide two samples each, a surface sample and a sample from 12 to 18 in.

  Field immunoassays will be performed on all samples. If field results above 1 mg/kg are reported, an additional three augered boreholes will be placed around the location within a 4- to 10-ft radius to provide information for evaluating the extent of release. These conditional samples are not shown on Fig. B-1. Field observations above 1 mg/kg in 18 to 24 in. samples will also trigger the collection of deeper samples at those locations.

  A minimum of 10% of the field samples will be submitted for confirmatory laboratory analysis. Preference will be given to samples, if any, with immunoassay results in the range of 1 to 50 mg/kg. Some samples from below this range will also be included to provide data for evaluating the rate of false negatives produced by the field method. If there are samples with immunoassay results above 15 mg/kg, 5 samples from those locations and those in the 1 to 15 mg/kg range will be submitted for waste characterization analyses for toxicity characteristic leaching procedure (TCLP) inorganics, TCLP organics, and isotopic uranium.

- **Slope below** For the slope below the suspected capacitor storage area, Fig. B-1 indicates four augered boreholes (squares) that will provide both surface and subsurface samples to supplement information from Phase I samples AAA2150, AAA2152 and AAA2168. However, if any releases are located by sampling in the capacitor storage area, these augered boreholes may be moved or supplemented by other boreholes in order to sample downslope areas. As in the preceding paragraph, these holes will provide 0 to 6 in. and 18 to 24 in. samples, and immunoassay results above 1 mg/kg will trigger additional sampling. Samples will be selected for confirmatory laboratory PCB analysis as above, and three samples will be submitted for waste characterization if there are immunoassay results above 15 mg/kg.

- **Drainage** For the SWMU 33-004(g) drainage, at least five 0 to 6 in. sediment samples will be collected in the drainage to confirm results for AAA2145 and determine the extent of contamination in this drainage.

Sampling will begin at the location of AAA2145 and continue at 20-ft intervals at least 20 ft below the culvert (the location of AAA2149), and farther if the immunoassay results at that point exceed 1 mg/kg. The first five samples are shown as triangles in Fig. B-1.

- **Filled areas** Finally, Fig. B-1 indicates the maximum extent of the area that may have been covered by material excavated from the cinder cone. This area will be surveyed using metal-detecting instruments. Samples will be collected only if capacitors are found and after they are removed. Visibly stained soil will be removed together with the capacitor, as described in Subsection 1.2 of this appendix, and two samples will then be collected from 0 to 6 in. in the exposed surface. Further excavation and sampling will be required if an immunoassay result exceeds 1 mg/kg. One confirmatory sample will be submitted for laboratory analysis if all immunoassay results are below 1 mg/kg.

1.2 Geophysical Survey and Removal of Capacitors

A cleanup plan has been written to locate and remove any capacitors that may have been buried in the basaltic cinder groundmass. The plan specifies geophysical techniques to locate metallic objects followed by removal with hand digging. If capacitors are found, cleanup will follow appropriate guidance for removal, verification sampling, and disposal. Investigation will be coordinated with the LANL Toxic Substances Control Act (TSCA) Compliance Program (ICF Kaiser 1995, 02-105).

1.3 Sampling and Analysis at SWMU 33-009

Phase II sampling will focus on determining the levels and extent of PCBs at SWMU 33-009. All samples will be field screened for PCBs by means of the D TECH™ field PCB immunoassay screening. Appendix C contains a discussion of the use of a the field PCB immunoassay kit. Appropriate health and safety precautions will be undertaken according to the site-specific health and safety plans.

Sampling Techniques Because the groundmass contains basaltic cinders, samples will be collected by the spade and scoop technique (LANL-ER-SOP-06.09). Surface soil samples will be gathered to a depth of 6 in. The specific technique will be determined by the field team leader. Subsurface samples will be taken at a depth of 24 in. The 24 in. depth is designed to ensure detection of PCBs that may have migrated below the immediate surface through

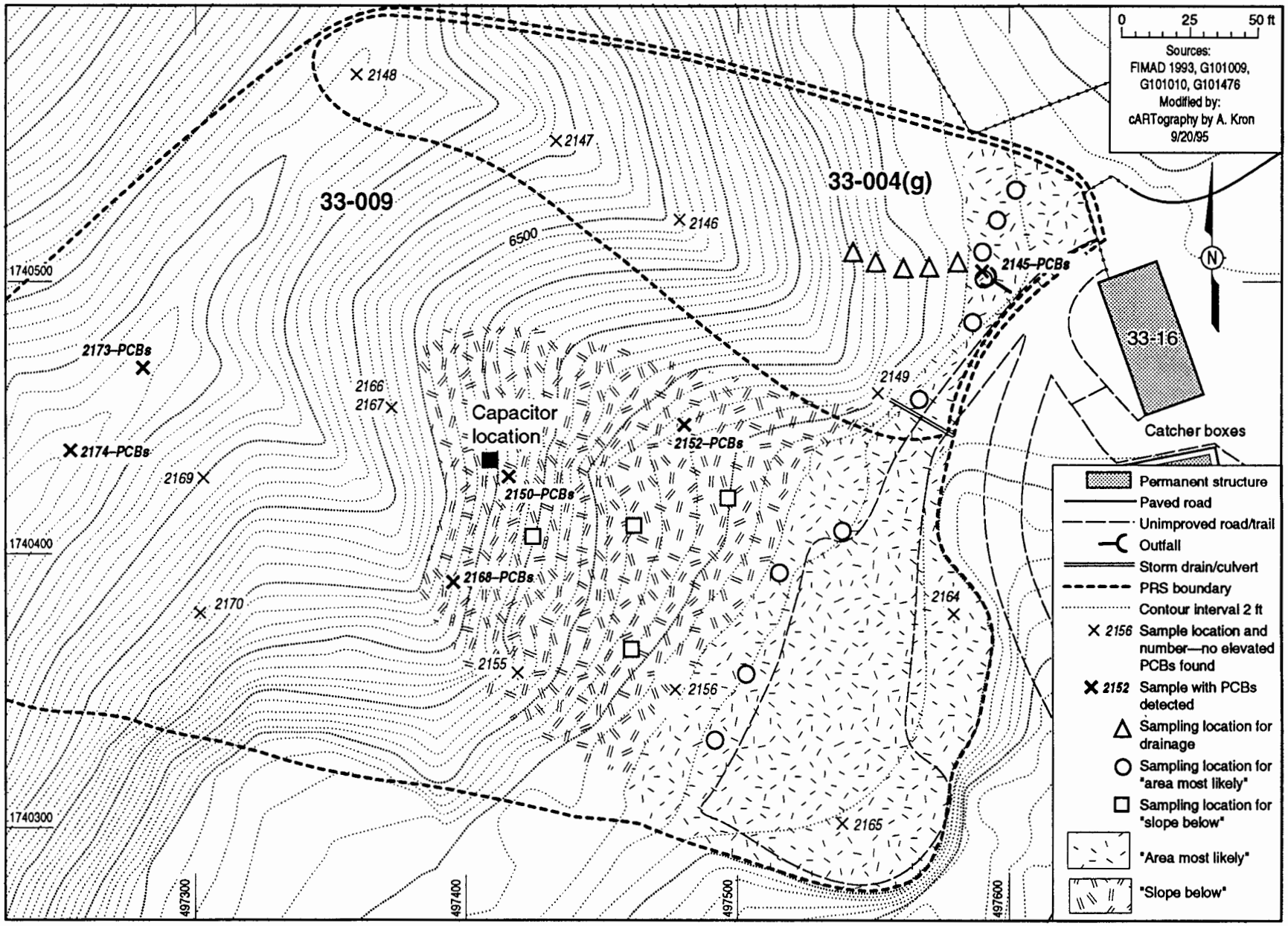

Fig. B-1. Area 6: SWMU 33-009 Phase II PCB sampling plan.

weathering. See Fig. B-1 for planned sample locations. Sampling locations may be moved at the discretion of the field team leader. Reasons for relocating samples will be documented in the field logs.

Sampling will proceed at the four target areas that will undergo Phase II sampling as described in Subsection 1.1 of this appendix.

- **Storage area** At the possible storage area for defective capacitors, sampling will consist of boring 10 hand-augered holes. The augered sample holes will be located on the north rim of Area 6 from north of TA-33-16 to the west end of the excavated cinder cone. Analytical samples will be removed at the surface (0 to 6 in.) and at the bottom of the hole (18 to 24 in.). If PCB field results above 1 mg/kg are detected, these 24-in.-deep augered boreholes will be advanced an additional 24 in. and tested for PCBs. The augered boreholes will be advanced in 24 in. increments until field testing indicates that PCBs are less than 1 mg/kg.

  In addition to deepening the original hand augered boreholes, where PCB readings are in excess of 1 mg/kg, three additional augered boreholes will be placed around the sample location at a 4- to 10-ft radius. As with the first augered boreholes, these will be advanced to a depth of 24 in. Analytical samples will be collected at the surface and bottom of the borehole.

- **Slope below** On the slope below the suspected capacitor storage area, sampling will consist of boring four augered boreholes below the suspected storage area and across the downslope area (Fig. B-1). Analytical sample intervals will be the same as for the first target area. Field screening results above 1 mg/kg will result in advancing the boreholes and possibly added new holes. The locations of these boreholes will also depend upon the upslope results in the suspect capacitor storage area .

- **Drainage** A minimum of five surface soil samples (0 to 6 in.) will be collected to determine the extent of contamination in the drainage. Sampling will began at AAA2145 and continue in 20 ft intervals at least 100 ft (Fig. B-1).

- **Filled Areas** Sampling will be performed only if capacitors are found and after they are removed. Two surface soil samples will be collected at the location of any removed capacitor. Additional sampling will be performed if field results indicate PCBs above 4 mg/kg.

Laboratory Analysis A minimum of 10% of field samples will be submitted for confirmatory laboratory analysis for PCBs. Preference will be given to samples with field PCB results in the 1 to 50 mg/kg range but some samples below this level may also be sent to the laboratory. Five samples with PCB levels of 1 to 15 mg/kg and five samples above 15 mg/kg, if found, will be submitted for waste characterization analyses (TCLP analyses and isotopic uranium).

2.0 PHASE II SAMPLING AND ANALYSIS PLAN FOR SWMU 33-011(d) STORAGE AT TA-33-20

2.1 Phase II Sampling Objectives

Phase I sampling results indicate that remediation may be required to remove high, but localized, levels of uranium contamination. Phase II investigations are proposed to locate radioactive spots for remediation. Continuous gamma scanning will be used to identify areas with elevated radioactivity within the survey area. The lateral and vertical extent of any hot spots thus identified, including the Phase I sampling location 33-1081, will be determined from field screening results. Vertical extent will be determined by gamma counting and by direct alpha and beta/gamma measurements.

Phase 1 sampling found lead above SAL in pavement sample AAA6866. Phase II sampling will enlarge the data set sufficiently to complete a risk assessment for lead. Pavement and soil/tuff samples will be collected from cores at all radioactive spots located and from six additional randomly selected sites. All samples will be analyzed for inorganics and total uranium. A fraction of the samples from radioactive spots will be analyzed for isotopic uranium.

2.2 Phase II Sampling and Analysis Plan for SWMU 33-011(d)

All samples will be field screened for radioactivity and organic vapors to identify gross concentrations of contaminants. Appropriate health and safety precautions will be undertaken according to the site-specific health and safety plans.

A field radioactivity survey will be performed to identify radioactive spots around building TA-33-20. The survey will extend to the fence that bounds the paved area south and west of the building and to a distance of 25 ft north and east of the building (Fig. B-2). The survey will also extend 10 ft beyond any radioactive spots detected. Gamma scanning will be performed by swinging a sodium-iodide detector in a pendulum manner as close to the paved surface as possible while progressing at the speed of a slow walk. The surveyor will be equipped with headphones.

Areas with count rates that are more than two times above the locally determined background level will be marked. One-minute alpha and beta/gamma direct measurements of the surface from each of these locations identified by gamma scanning will be recorded. Core samples will be taken at each location. The lateral dimensions of areas with above-background activity will be mapped, and the vertical extent of areas with above-background activity will be determined by making direct measurements along core samples collected at each area.

Sampling Techniques The pavement surface samples will be collected with a portable gasoline-powered impact drill outfitted with a continuous sampler. Subsurface samples will be collected according to the hand-auger and thin-walled tube sampler method (LANL-ER-SOP-06.10). All analytical samples will be a minimum depth interval of 6 in.

Sampling Summary The field radioactivity survey will identify any radioactive points in addition to the Phase I sampling location 33-1081 (samples AAA6866 and AAA6867). Cores will be taken from the center of each radioactive spot. The surface pavement sample will be collected with the portable impact drill. The hand auger will then be advanced 2 ft below the point at which field screening indicates a drop below background readings. Analytical samples will be collected at the surface and at each 18 in. interval until one sample is collected beneath the last field screening result that exceeds background.

In addition to the radioactive spots identified by field survey, six additional randomly selected hand-auger locations will be placed within the survey area. The hand-augered core will have analytical samples collected at the surface (a pavement sample) and at 2 ft 6 in. beneath the bottom of the pavement.

Laboratory Analysis All analytical samples will be analyzed for inorganics and total uranium. Three analytical samples from radioactive spots or 25% of radioactive samples, which ever is larger, will be analyzed for isotopic uranium. If the concentration of any analyte exceeds 20 times the TCLP limit, that analytical sample will be submitted to the laboratory for TCLP analyses.

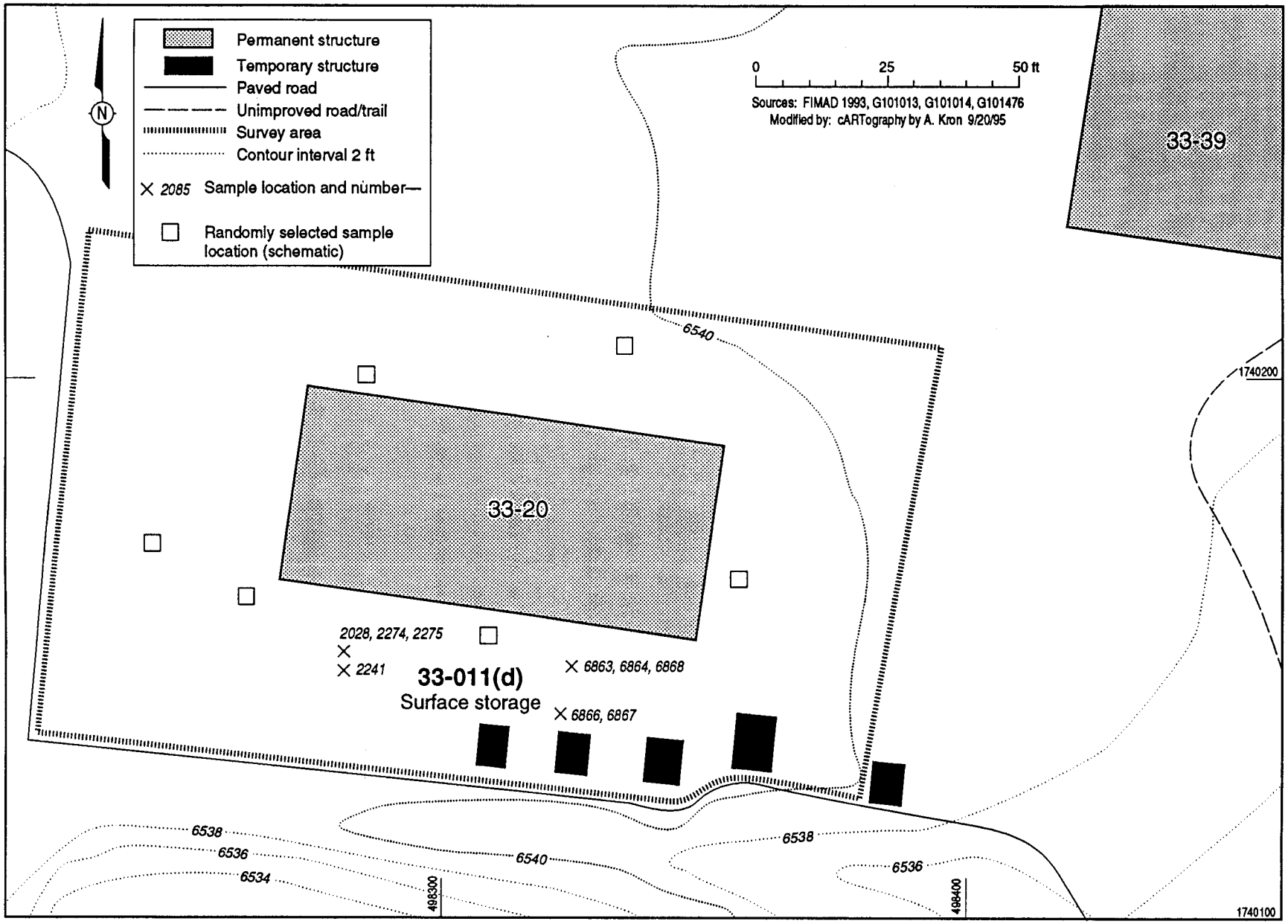

Fig. B-2. SWMU 33-011(d) sampling plan.

3.0 PHASE II SAMPLING AND ANALYSIS PLAN FOR SWMU 33-013 LIQUID WASTE STORAGE AT THE TRITIUM FACILITY

3.1 Phase II Objectives

The objective of resampling at PRS 33-013 is to determine whether the level and extent of inorganic contamination at this site warrants remediation. In particular, resampling will attempt to replicate the Phase I observations and to determine the horizontal and vertical extent of contamination within the storage area. Based on Phase I sampling results, the analytes of interest are inorganics, particularly chromium and cadmium but also silver, beryllium, and nickel. Uranium will be added to the analytical suite. Volatile organic compound (VOC) analyses will be performed on subsurface samples.

Resampling at 33-013 will be biased with field screening using x-ray fluorescence (XRF) or laser-induced breakdown spectroscopy (LIBS). XRF and LIBS detection limits for elements of interest are shown in Table B-2. Beryllium cannot be detected by XRF. Cadmium would easily be detected at the level at which it was reported in sample AAA2035 (620 mg/kg), but the XRF detection level is slightly above the SAL of 80 mg/kg. For the remaining analytes shown in Table B-2, the XRF detection limit is well below the SAL.

TABLE B-2

LOWER LIMITS OF DETECTION FOR THE SPECTRACE 9000™ X-RAY FLUORESCENCE ANALYZER AND LIBS FIELD INSTRUMENT

ANALYTE	XRF[a] (mg/kg)	LIBS[b] (mg/kg)	SAL[c] (mg/kg)
Beryllium	Not detectable	2	None
Cadmium	90	200	80
Chromium	78	10	400
Lead	15	30	400
Nickel	60	Not determined	1 600
Silver	55	20	400
Zinc	34	20	24 000

[a] X-ray fluorescence.
[b] Laser-induced breakdown spectroscopy.
[c] Screening action level.

The area targeted for resampling is shown in Fig. B-3. A 20-ft grid on a 60-ft by 60-ft area, measured south and west from the fence, will provide nine sampling locations. *In situ* field inorganic measurements will be made at each point selected within each grid square and also at the three Phase I sampling locations. If beryllium is found above background or if above-detection level observations of cadmium, chromium, nickel, or silver are found, an additional three locations will be randomly selected within a 4-ft to 10-ft radius and *in situ* measurements will be made.

Two samples will be collected for laboratory analysis from the location of sample AAA2035, and one sample collected from each location with high field measurements (i.e., above field instrument detection levels for analytes of interest or above 50 pCi/g tritium), if any such locations are identified. These will be surface (0 to 6 in.) samples if the location is unpaved, or soil samples within 2 ft beneath the pavement, if paved. If fewer than four samples are selected as a result of field measurements, the total number of samples submitted for laboratory analysis will be increased to four by random selection from the surveyed grid points.

3.2 Sampling and Analysis of SWMU 33-013 Liquid Waste Storage

All samples will be initially analyzed in the field for inorganics by means of XRF or LIBS. Appropriate health and safety precautions will be undertaken according to current versions of the site-specific health and safety plans.

Sampling Techniques Surface soil samples will be collected with either the spade and scoop or ring sampler technique (LANL-ER-SOP-06.09) to a depth of 6 in. The specific technique will be determined by the field team leader. Subsurface samples will be collected with the hand-auger and thin-walled tube sampler method (LANL-ER-SOP-06.10). See Fig. B-3 for planned sample locations.

Nine samples at the storage area will be collected randomly, one from within each 20-ft square of a 20 ft x 20 ft grid within the 60 ft x 60 ft area (Fig. B-3). *In situ* field measurements will be made with the XRF and LIBS at each grid point and also at the three Phase I sampling locations. An additional three sample locations will be selected if above-detection level field observations are made of cadmium, chromium, nickel, or silver. These three samples will be located at random within a 4-ft to 10-ft radius of the elevated readings.

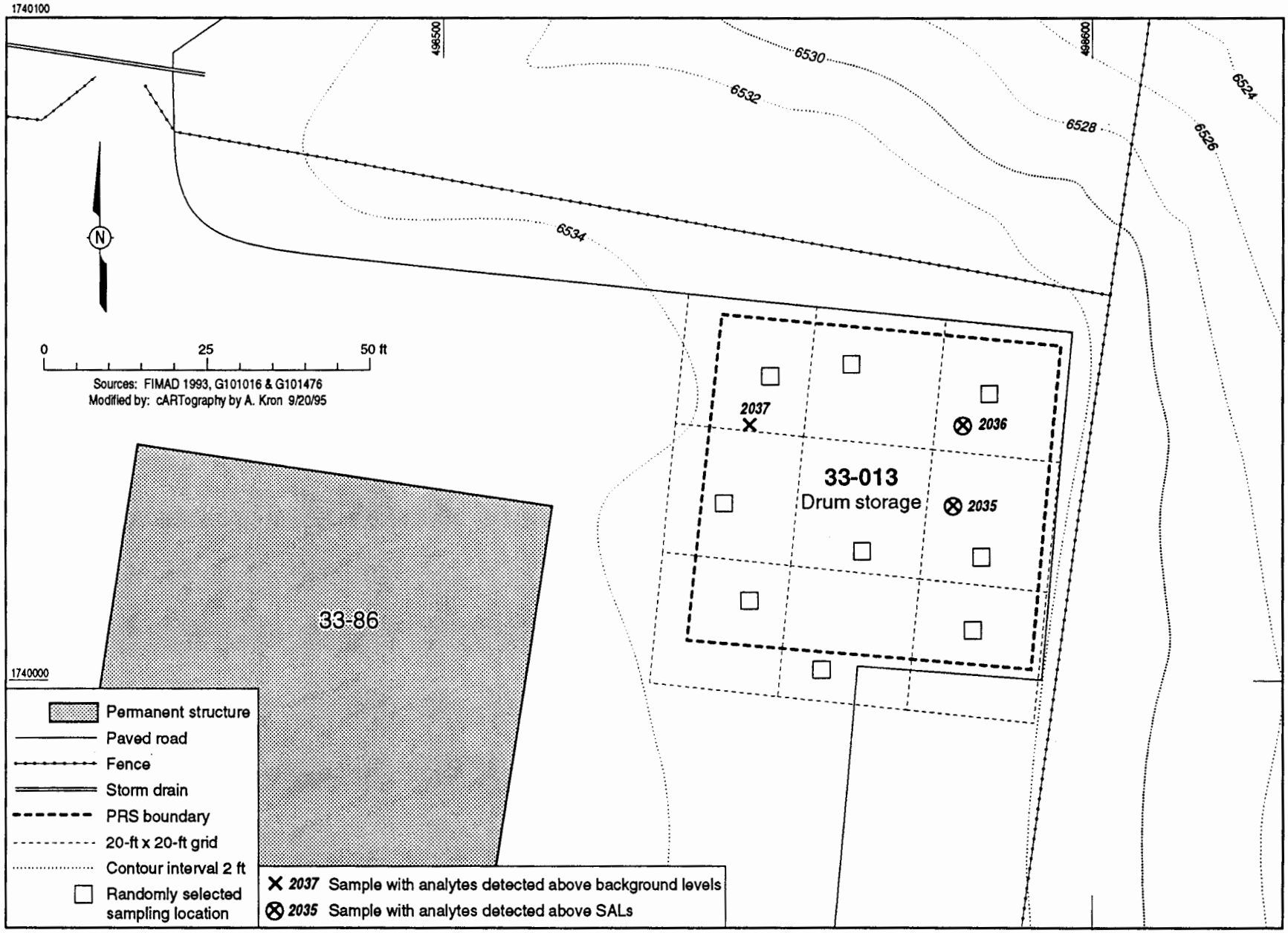

Fig. B-3. Main Site: SWMU 33-013 sampling locations.

One sample will be collected for off-site laboratory analysis from:

- each location characterized by measurements of cadmium, chromium, silver, or nickel above field instrument detection levels, lead or zinc above 200 ppm, or beryllium above background,
- the location of sample AAA2035, or
- a randomly selected subset of the remaining grid locations, if fewer than four samples are selected by the preceding criteria.

These samples will consist of surface soil (0 to 6 in.) if the grid location is unpaved, or collected within 2 ft beneath the pavement, if paved.

Laboratory Analysis The selected soil samples will be submitted for inorganic and total uranium analyses.

4.0 PHASE II SAMPLING AND ANALYSIS PLAN FOR SWMU 33-017 VEHICLE MAINTENANCE AREA

4.1 Phase II Sampling Objectives

Phase II sampling in the area to the east of shop TA-33-39 will address the following issues.

(1) The high estimates of polycyclic aromatic hydrocarbons (PAH) risk are driven by three Phase I samples.

- One sample, AAA2051, was collected from the southeast corner of TA-33-39.
- Two samples, AAA2053 and AAA2054, were collected above the point where runoff from activities behind TA-33-39 (the vehicle maintenance area, storage area, and outfalls) enters main drainage channel.

Samples AAA1978, AAA1979, and AAA1980 from the southern 33-004(i) outfall contained PAHs above 1 mg/kg, as did sample AAA1976 from the northern SWMU 33-004(i) outfall. No other sample in the vehicle maintenance area contained PAHs above 1 mg/kg.

These observations raise questions about whether these PAHs are associated with the activities behind the shop or with general runoff from the entire paved site. A number of additional biased samples will be collected in Phase II sampling to complete the assessment

of PAH concentrations in areas associated with activities behind TA-33-39 (Fig. B-4). Because of the history of TA-33-39 as a metals-handling facility, samples will be field screened for inorganics.

- Three Phase II sampling locations are designed to further assess the extent of high PAH contamination at the southeast corner of TA-33-39. Two additional samples will be collected across the gravel road from this area. These five points are shown as circles in Fig. B-4.
- Two samples will also be collected below the collapsed wooden platform east of TA-33-39. PAHs above 1 mg/kg were observed in sample AAA1976, the outfall sample closest to this platform. These points are shown as circles in Fig. B-4.
- Two additional samples will be collected in the main drainage, approximately 200 ft and 400 ft below sample AAA2054. These points are shown as circles in Fig. B-4.
- To address vertical extent of contamination, an 18 in. sample will be taken at points exhibiting soil staining.

These samples will be analyzed for SVOCs and field screened for inorganics.

All Phase I samples were biased and the Phase II samples specified above are also biased. In order to obtain a more representative sample for the purposes of risk assessment, an additional eight surface samples will be collected from within the exposure unit boundaries, east of the gravel road that runs east of TA-33-39, avoiding runoff channels and outfall drainages. Within these constraints, the sampling locations, shown as squares in Fig. B-4, will be selected randomly. These samples will be analyzed for semivolatile organic compounds (SVOCs).

Low level PCBs were observed in two of the three samples analyzed for PCBs. Additional PCB analyses are needed in the main drainage channel as well because this channel would have received runoff from the transformer adjacent to TA-33-114.

A field survey using the PCB D TECH™ field kit (Appendix C) will analyze five pavement samples from the northeast side of the shop, three samples from the adjacent unpaved gravel roadway, three samples from around and below the collapsed wooden platform just east of SWMU 33-012(a) which may have been used for vehicle maintenance, and four samples from

the main drainage. These samples are shown as triangles on Fig. B-4. Samples with field results greater than 1 mg/kg will be submitted for confirmatory analysis. The field crew may, at its discretion, collect additional samples near samples with high results to ascertain the extent of the apparent release. A sample will be taken at 18 in. below any sample exhibiting greater than 5 mg/kg PCBs as measured by field screening.

4.2 Phase II Sampling and Analysis Plan for SWMU 33-017

Phase II sampling will focus on determining the levels and extent of SVOCs and PCBs at SWMU 33-017. See Appendix C for a discussion of the use of the field PCB immunoassay kit. Appropriate health and safety precautions will be undertaken according to the site-specific health and safety plan. All samples will be field screened for radioactivity and organic vapors to identify gross concentrations of contaminants.

Sampling Techniques Surface soil samples will be collected with the spade and scoop technique (LANL-ER-SOP-06.09) to a depth of 6 in. The specific technique will be determined by the field team leader. See Fig. B-4 for planned sample locations.

Sampling Summary SWMU 33-017 includes three target areas that will undergo Phase II sampling (Fig. B-4).

- **East of Building TA-33-39** Nine Phase II surface soil samples (0 to 6 in.) will be collected immediately east of TA-33-39. These biased samples will be analyzed for SVOCs. Three of the samples will be located at the southeast corner of TA-33-39. Two additional samples will be located further to the east across the gravel road. Two samples will be taken below the collapsed wooden platform. An additional two samples will be collected in the main drainage, located approximately 200 ft and 400 ft southeast of the sample AAA2054 location. An additional sample will be taken at 18 in. at any point exhibiting visible soil staining.

- **Random Samples** Eight surface soil samples will be collected east of the gravel road at the rear of TA-33-39. The sample locations will be randomly selected with the constraint that they will not be collected from drainages. These samples will be analyzed for SVOCs.

- **PCB Samples** Fifteen surface soil samples will be collected at the pavement adjacent to TA-33-39 and in the main drainage channel. These samples will be tested in the field using a D TECH™ field PCB test kit. Five samples will be collected from the pavement area; three from the adjacent unpaved road; three samples from the area of the collapsed wooden platform east of SWMU 33-012(a); and four samples from the main drainage. Samples with PCB field results above 1 mg/kg will be submitted for confirmatory laboratory analysis. The field team may collect additional samples adjacent to locations with elevated readings to determine the extent of the apparent release. A sample will be collected at a depth of 18 in. at any location exhibiting greater than 5 mg/kg PCBs as measured by field screening.

Laboratory Analysis Samples from the first two target areas will be analyzed in the laboratory for SVOCs. Samples from the third target area with field PCB results above 1 mg/kg will be sent to the laboratory for further PCB analysis.

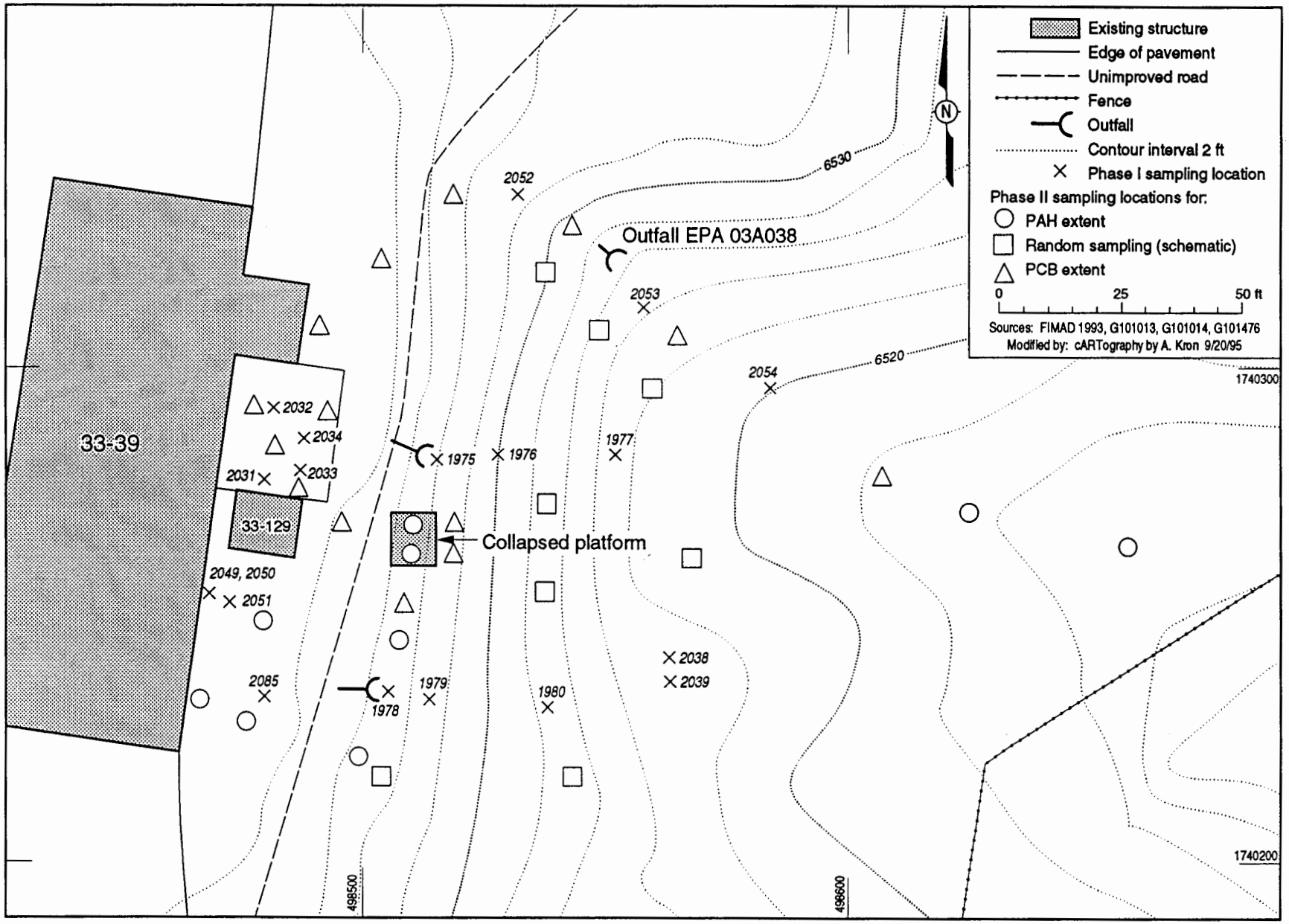

Fig. B-4. SWMU 33-017 Phase II sampling locations.

APPENDIX C PCB IMMUNOASSAY KIT

Field testing for polychlorinated biphenyls (PCBs) will be done using the D TECH™ PCB Field Test Kit, produced by EM Science/Strategic Diagnostics Inc. of Gibbstown, New Jersey. This kit can be used with a color comparison card in the range of 1 to 50 mg/kg, but it also comes with a hand-held reflectometer (the DTECHTOR™) for interpreting results of the tests. The reflectometer provides output in percentages, together with a suggested conversion to PCB equivalents (mg/kg) (Table C-1).

TABLE C-1

INTERPRETATION OF DETECHTOR™ READINGS (from D TECH™ Instruction Guide)

DTECHTOR™ READING (%)	PCB[a] EQUIVALENTS (mg/kg)
LO-10	<0.5
10-20	0.5-1.0
20-40	1.0-4.0
40-60	4.0-15.0
60-80	15.0-50
HI	>50

[a] PCB = Polychlorinated biphenyls.

Additional data on performance of the kit have been provided to LANL. These data are plotted in Fig. C-1, and show an approximately linear relationship between the DETECHTOR™ reading and the logarithm of the concentration as measured by SW-846 gas chromatography method 8080, for samples in the range of 0.1 to 120 mg/kg. The diagonal sequence of boxes shows how the samples would be classed by the algorithm of Table C-1. Samples within the boxes would be correctly classified; those above the boxes would be incorrectly classified into a lower category (8 samples out of 50), and those below would be incorrectly classified into a higher category (14 samples out of 50). As these error rates show, the algorithm is biased high, which is desirable for a screening procedure. This is also seen in Fig. C-1, where the regression line runs below the center of the boxes.

In these data, no sample above 10 mg/kg (as measured by gas chromatography) has a DETECHTOR™ reading of less than 44%. Tolerance bound calculations indicate that the probability of classifying a sample with true concentration of 10 mg/kg as "<4 mg/kg" is about

0.2, while half of samples at 10 mg/kg will be classified as ">15 mg/kg". The rules for collecting extra samples and for submitting waste characterization samples that are proposed in Appendix B Subsection 1.3 of this report are based on these results. Both DETECHTOR™ readings and classification results per Table C-1 will be reported, but the rules are stated in terms of the classification results, with cutoffs at 4 mg/kg (40% DETECHTOR™ reading) and 15 mg/kg (60% DETECHTOR™ reading).

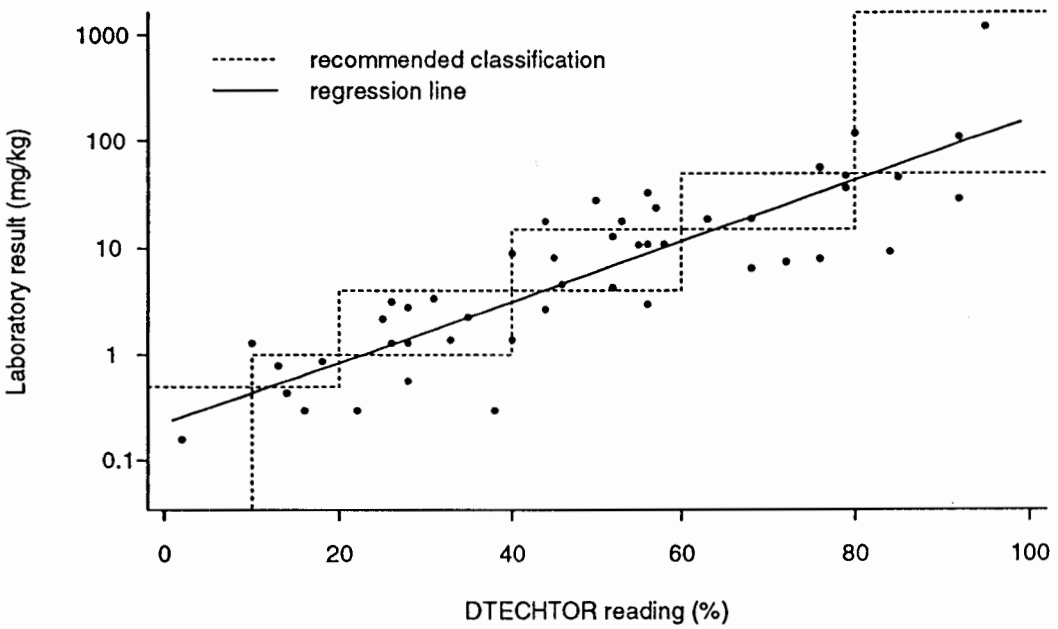

Fig. C-1. D-TECH plot.

THIS PAGE LEFT INTENTIONALLY BLANK

APPENDIX D RISK ASSESSMENT CALCULATIONS FOR SWMU 33-017

1.0 EXPOSURE ASSESSMENT

Exposure assessment requires identification of appropriate land use scenarios, exposure units, potential human receptors and exposure routes, and estimates of contaminant intake. For the risk assessments described in this report, it is assumed that all land may be used for future residential sites. For an exposure unit under the residential scenario, it is assumed that each residence will occupy approximately 0.15 acres (500 m2). The human exposure assumptions are that residents will be exposed to existing site contaminants for 20 hours/day, 350 days/year, for 30 years. The exposure pathways that are considered under the residential scenario include inhalation of vapors and wind-blown dust; ingestion of contaminated soil, water, and fruits or vegetables grown in contaminated soil; and contaminated soils or water coming into contact with the skin. Attachment 1 to Appendix K of the Installation Work Plan (IWP) provides additional detail about the intake assumptions used for each exposure pathway, under each land use scenario (LANL 1993, 1017).

2.0 TOXICITY ASSESSMENT

Toxicity assessment requires identifying appropriate toxicity values for contaminants of potential concern. Slope factors, which express the potential of a contaminant to cause cancer, are obtained from the Environmental Protection Agency's (EPA) Integrated Risk Information System, EPA's Health Effects Assessment Summary Tables, or the Superfund Health Risk Technical Support Center. Reference doses, which express non-carcinogenic toxicity of contaminants, are based on the most sensitive data set available for a given target organ or system (e.g., the liver or central nervous system).

Characterizing risk consists of two steps: calculating a quantified estimate of risk (e.g., exposure may result in a one in a million chance of developing cancer), and considering the uncertainties associated with the estimate to place risk in perspective. The numerical estimate of risk is calculated using methods found in EPA's Risk Assessment Guidance for Superfund (EPA 1989, 0305). The uncertainty analysis considers both the uncertainties inherent in the risk assessment process and the uncertainties specific to a particular site.

Appendix K of the IWP presents a detailed description of the risk assessment process adopted by LANL's Environmental Restoration ER Project (LANL 1993, 1017).

3.0 RISK CALCULATION FOR LEAD AT SWMU 33-017 VEHICLE MAINTENANCE AREA

Preliminary risk assessment results for the area east of TA-33-39 were discussed in Subsection 4.8.3.3 of this RFI report. This subsection discusses the calculations leading to these results. Analytical results for lead used in the calculations are given in Table D-1.

TABLE D-1

LEAD VALUES IN EXPOSURE UNIT EAST OF TA-33-39

PRS[a]	SITE ID	SAMPLE ID	LEAD (mg/kg)
33-004(i), north	33-1055	AAA1975	10
	33-1056	AAA1976	79
	33-1057	AAA1977	73
33-004(i), south	33-1058	AAA1978	800
	33-1059	AAA1979	71
	33-1060	AAA1980	210
33-012(a)	33-1086	AAA2031	104
	33-1087	AAA2032	118
	33-1088	AAA2033	53
	33-1089	AAA2034	9
33-017, vehicle maintenance area	33-1102	AAA2049	64
	33-1103	AAA2050	90
	33-1104	AAA2051	170
33-017, top of main drainage	33-1105	AAA2052	46
	33-1106	AAA2053	98
	33-1107	AAA2054	200

[a] PCB = Polychlorinated biphenyls.

3.1 Calculations for Lead at the SWMU 33-017 Exposure Unit

The calculation of the mean and upper confidence bound for lead contamination in the exposure unit east of TA-33-39 followed the method for minimum variance unbiased (MVU) estimation for lognormal populations described by Gilbert (1987, 0506), pp. 165-166. The data in Table D-1 are seen to be approximately lognormally distributed in the probability plot of Fig. D-1. (This is a probability plot, that is, the observed values have been sorted and plotted on a logarithmic scale against order statistics from the standard normal distribution. Data from a log-normal distribution should fall approximately along a straight line in such a plot. The departures from a straight line that occur at the low end in Fig. D-1 inflate the estimate of the variance and the estimates of the mean, see Equation 1 below, and especially of the upper confidence interval.)

The MVU estimate of the mean is

$$\hat{\mu} = [\exp(\bar{y})]\Psi_n\left(\frac{s_y^2}{2}\right) \qquad (1)$$

where is the sample mean of the logged data, is the sample variance, n is the sample size, and is a function tabled in Gilbert's book (although for our calculations we programmed this function using the series expansion given on p. 165 of that book and verified our program by comparing its results with Gilbert's Table A9.) An unbiased estimator of the variance of is given by

$$s^2(\hat{\mu}) = \exp(2\bar{y})\left\{\left[\Psi_n\left(\frac{s_y^2}{2}\right)\right]^2 - \Psi_n\left(\frac{s_y^2(n-2)}{n-1}\right)\right\} \qquad (2)$$

and thus a 95% upper confidence interval for the mean is computed finally as

$$\hat{\mu} + t_{n-1,0.95}s(\hat{\mu}) \qquad (3)$$

assuming approximate normality of the estimate (an application of the Central Limit Theorem of probability theory) with the usual number of degrees of freedom.

Risks were estimated using the EPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model, Version 0.99d (EPA 1994, 1178). This model considers exposure to lead from several pathways and correlates total exposure to a blood lead level, which is the standard descriptor of lead exposure. The IEUBK model applies to young children from birth to seven years because children are more sensitive to lead toxicity than adults. According to EPA, an acceptable risk for lead exposure is less than 5% of the population expected to have blood lead levels of greater than 10 µg/dL. Results of the modeling effort for TA-33 reveal that 1.66% of a hypothetical population of children exposed to 416.3 mg/kg of lead would exceed the standard value of 10 µg/dL, indicating that adverse health effects from lead exposure are unlikely at this site.

3.2 Results of the EPA Lead Model (version 0.99d) based on 95% UCL Lead Concentration in Soil at the SWMU 33-017 Exposure Unit

Results of the EPA Lead (Pb) Model (Version 0.99d) based on 95% Upper Confidence Limit (UCL)

AIR CONCENTRATION:		0.100 µg Pb/m^3 DEFAULT	
Indoor air Pb Concentration:		40.0 percent of outdoor	
OTHER AIR PARAMETERS			
Age	**Time Outdoors (hr)**	**Ventilation Rate (m^3/day)**	**Lung Absolute (%)**
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Concentration: 4.00 µg Pb/L DEFAULT
WATER Consumption: DEFAULT

SOIL AND DUST		
Soil: Constant concentration		
Dust: Multiple source analysis		
AGE	**SOIL (µg Pb/g)**	**HOUSE DUST (µg Pb/g)**
0-1	350.0	255.0
1-2	350.0	255.0
2-3	350.0	255.0
3-4	350.0	255.0
4-5	350.0	255.0
5-6	350.0	255.0
6-7	350.0	255.0
Additional dust source: None		DEFAULT
Soil contribution conversion factor: 0.70		
Air contribution conversion factor: 100.0		

PAINT INTAKE: 0.00 µg Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Contribution: 2.50 µg Pb/dl

CALCULATED BLOOD Pb and Pb UPTAKES			
YEAR	**BLOOD LEVEL (µg /dl)**	**TOTAL UPTAKE (µg /day)**	**SOIL + DUST UPTAKE (µg /day)**
0.5-1	5.2	9.66	6.80
1-2	5.8	14.12	10.64
2-3	5.5	14.71	10.80
3-4	5.2	14.85	10.97
4-5	4.3	12.27	8.35
5-6	3.7	11.80	7.59
6-7	3.4	11.76	7.21

YEAR	DIET UPTAKE (µg /day)	WATER UPTAKE (µg /day)	PAINT UPTAKE (µg /day)	AIR UPTAKE (µg /day)
0.5-1	2.48	0.36	0.00	0.03
1-2	2.55	0.88	0.00	0.04
2-3	2.91	0.93	0.00	0.08
3-4	2.84	0.96	0.00	0.08
4-5	2.81	1.03	0.00	0.08
5-6	2.99	1.10	0.00	0.11
6-7	3.32	1.12	0.00	0.11

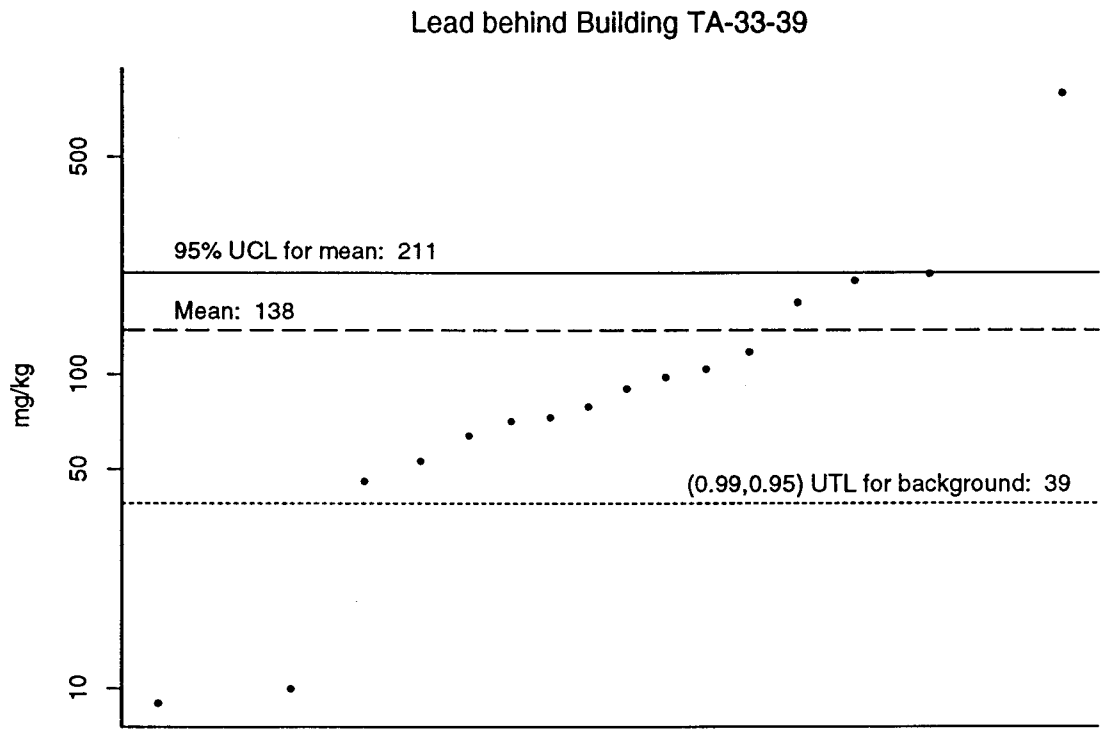

Fig. D-1. Probability plot of lead values.

4.0 RISK CALCULATION FOR PAHs AT SWMU 33-017 VEHICLE MAINTENANCE AREA

4.1 Risk Calculations for PAHs

The same formulas were used to calculate means and 95% UCLs for the seven PAHs shown in Table D-2. Below-detection-level observations were replaced by one-half the detection level. The approximate log-normality of the above-detection-level observations is illustrated in Fig. D-2 for benzo[a]anthracene, which is typical of the PAHs for which six to nine of the 16 observations are above the detection level (i.e., five of the seven constituents in Table D-2).

TABLE D-2

PAHs IN EXPOSURE UNIT EAST OF TA-33-39

	33-017: VEHICLE MAINTENANCE AREA			33-017: TOP OF MAIN DRAINAGE		
	AAA2049	AAA2050	AAA2051	AAA2052	AAA2053	AAA2054
Benzo[a]anthracene	<0.33	<0.33	8.20	<0.33	4.10	3.50
Benzo[a]pyrene	<0.33	<0.33	7.50	<0.33	4.70	4.00
Benzo[b]fluoranthene	0.34	<0.33	9.80	<0.33	6.20	5.20
Benzo[k]fluoranthene	0.34	<0.33	7.10	<0.33	4.30	3.90
Chrysene	0.35	<0.33	9.20	<0.33	5.50	4.60
Dibenzo[a,h]anthracene	<0.33	<0.33	<0.33	<0.33	0.59	<0.33
Indeno[1,2,3-cd]pyrene	<0.33	<0.33	4.20	<0.33	2.20	3.30
	33-004(i): NORTH OUTFALL			33-004(i): SOUTH OUTFALL		
	AAA1975	AAA1976	AAA1977	AAA1978	AAA1979	AAA1980
Benzo[a]anthracene	<0.33	1.80	0.39	1.30	1.60	0.60
Benzo[a]pyrene	<0.33	0.64	<0.33	0.86	1.30	0.62
Benzo[b]fluoranthene	<0.33	1.10	0.45	1.50	3.10	0.80
Benzo[k]fluoranthene	<0.33	<0.33	<0.33	0.36	<0.33	0.57
Chrysene	<0.33	2.00	0.54	1.50	1.50	0.64
Dibenzo[a,h]anthracene	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33
Indeno[1,2,3-cd]pyrene	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33

TABLE D-2 (CONTINUED)

PAHs IN EXPOSURE UNIT EAST OF TA-33-39

	33-012(a): STORAGE AREA			
	AAA2031	AAA2032	AAA2033	AAA2034
Benzo[a]anthracene	<0.33	0.51	<0.33	<0.33
Benzo[a]pyrene	<0.33	<0.33	<0.33	<0.33
Benzo[b]fluoranthene	<0.33	0.43	<0.33	<0.33
Benzo[k]fluoranthene	<0.33	0.52	<0.33	<0.33
Chrysene	<0.33	0.54	<0.33	<0.33
Dibenzo[a,h]anthracene	<0.33	<0.33	<0.33	<0.33
Indeno[1,2,3-cd]pyrene	<0.33	<0.33	<0.33	<0.33

Observations for seven PAHs detected in sixteen samples from this area are shown in Table D-3. Mean and 95% UCLs were computed for these seven cPAHs using the MVU lognormal estimators. Observations below detection level were replaced by one-half the detection level (EPA 1989, 0305). Calculated values are shown in Table D-3.

TABLE D-3

MEAN AND 95% UCLs FOR PAHs IN EXPOSURE UNIT EAST OF TA-33-39

PAH	MEAN (mg/kg)	95% UCL[a] (mg/kg)	SAL[b] (mg/kg)
Benzo[a]anthracene	1.35	2.28	1.0
Benzo[a]pyrene	1.11	1.89	0.10
Benzo[b]fluoranthene	1.74	3.03	1.0
Benzo[k]fluoranthene	0.88	1.45	1.0
Chrysene	1.61	2.74	22.0
Dibenzo[a,h]anthracene	0.19	0.21	0.1
Indeno[1,2,3-cd]pyrene	0.54	0.86	1.0

a UCL = Upper confidence limit.
b SAL = Screening action level.

Risks were estimated using the methodology outlined in Appendix K of the IWP for carcinogenic, nonradioactive compounds (LANL 1993, 1017). Two different exposure scenarios were considered:

- construction, which assumes that the exposure unit would continue to be used by LANL and that construction workers working in the unit would have the highest exposure potential; and
- residential, which assumes that the exposure unit would ultimately be used for housing.

Results show that the estimated carcinogenic risk to construction workers is low at both the mean and the 95% UCL concentrations: 2.7E-07 and 5.6E-07, respectively. Estimated risk to future residents based on the mean PAH concentration is 3.1E-06 and when based on all seven 95% UCLs, estimated risk rises to 2.1E-05. Printouts showing results of the calculations are included in Attachment D-1 of this appendix

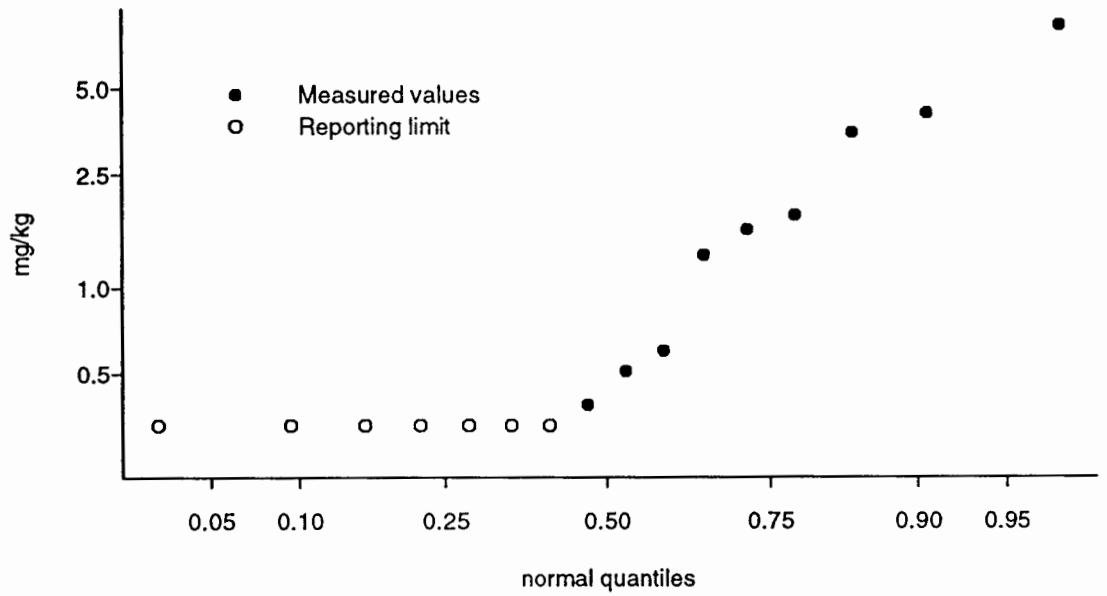

Fig. D-2. Distribution of benzo[a]anthracene in SWMU 33-017 exposure unit (lognormal plot).

5.0 REFERENCES

EPA (US Environmental Protection Agency), February 1994. "Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children," EPA 540-R-93-081, Office of Emergency and Remedial Response, Washington, DC. **(EPA 1994, 1178)**

Gilbert, R. O., 1987. Statistical Methods for Environmental Pollution Monitoring, Van Nostrand Reinhold, New York, New York. **(Gilbert 1987, 0506)**

LANL (Los Alamos National Laboratory), November 1993. "Installation Work Plan for Environmental Restoration," Los Alamos National Laboratory Report LA-UR-93-3987, Los Alamos, New Mexico. **(LANL 1993, 1017)**

THIS PAGE LEFT INTENTIONALLY BLANK

ATTACHMENT D-1

RESULTS OF RISK CALCULATIONS FOR PAHs AT THE SWMU 33-017 VEHICLE MAINTENANCE EXPOSURE UNIT

THIS PAGE LEFT INTENTIONALLY BLANK

TABLE C–C
STATISTICAL SUMMARY OF SOIL DATA
VEHICLE MAINTENANCE AREA
LANL, LOS ALAMOS, NEW MEXICO

COPCs	FOD	Minimum Detected Conc.	Maximum Detected Conc.	Arithmetic Mean	95% UCL	Lesser of Max. or 95% UCL
Semivolatiles						
Benzo(a)anthracene	9/16	< 0.33	8.2	1.352	2.282	2.282
Benzo(a)pyrene	7/16	< 0.33	7.5	1.114	1.891	1.891
Benzo(b)fluoranthene	10/16	< 0.33	9.6	1.744	3.034	3.034
Benzo(k)fluoranthene	7/16	< 0.33	7.1	0.875	1.454	1.454
Chrysene	10/16	< 0.33	9.2	1.607	2.745	2.745
Dibenzo(a,h) anthracene	1/16	< 0.33	0.59	0.187	0.214	0.590
Indeno(1,2,3–cd)pyrene	3/16	< 0.33	4.2	0.544	0.863	0.863
Inorganics						
Antimony	13/16	0.1	0.4	0.096	0.133	0.133
Arsenic	16/16	1.26	4.14	2.113	2.392	2.392
Barium	16/16	39	220	80.668	99.885	99.885
Beryllium	16/16	0.16	0.62	0.413	0.472	0.472
Cadmium	11/16	< 0.4	2.3	1.146	1.702	1.702
Chromium	16/16	4.2	84	18.412	25.800	25.800
Lead	16/16	9	800	138.22	210.958	210.958
Nickel	14/16	< 2.0	87	24.158	38.593	38.593
Selenium	3/16	< 0.2	1.2	0.096	0.133	0.133
Silver	2/16	< 1.0	46	1.69	2.782	2.782
Zinc	16/16	37	1700	385.144	608.07	608.070

COPCs = Chemicals of potential concern
FOD = Frequency of detection
Conc. = Concentration
UCL = Upper confidence limit
Max. = Maximum detected concentration
All concentrations are in units of mg/kg.

TABLE D-1
AIR CONCENTRATIONS OF CHEMICALS ADHERED ONTO DUSTS
VEHICLE MAINTENANCE AREA
LANL, LOS ALAMOS, NEW MEXICO

COPCs	RME EPC (Cs) (mg/kg)	RME EPC (Cp) (mg/m³)
Semivolatiles		
Benzo(a)anthracene	2.28E+00	2.05E-07
Benzo(a)pyrene	1.89E+00	1.70E-07
Benzo(b)fluoranthene	3.03E+00	2.73E-07
Benzo(k)fluoranthene	1.45E+00	1.31E-07
Chrysene	2.75E+00	2.47E-07
Dibenzo(a,h) anthracene	5.90E-01	5.31E-08
Indeno(1,2,3-cd)pyrene	8.63E-01	7.77E-08
Inorganics		
Antimony	1.33E-01	1.20E-08
Arsenic	2.39E+00	2.15E-07
Barium	9.99E+01	8.99E-06
Beryllium	4.72E-01	4.25E-08
Cadmium	1.70E+00	1.53E-07
Chromium	2.58E+01	2.32E-06
Lead	2.11E+02	1.90E-05
Nickel	3.86E+01	3.47E-06
Selenium	1.33E-01	1.20E-08
Silver	2.78E+00	2.50E-07
Zinc	6.08E+02	5.47E-05

COPCs = Chemicals of potential concern
RME EPC = Reasonable Maximum Exposure Exposure Point Concentration
Cs = Concentration in soil
Cp = Concentration in dust particles = Cs x PC
PC = Particulate Concentration in Air = 9×10^{-8} kg/m^3

TABLE T-1
TOXICITY CRITERIA FOR CHEMICALS OF POTENTIAL CONCERN
VEHICLE MAINTENANCE AREA
LANL, LOS ALAMOS, NEW MEXICO

COPCs	Inhalation CSF (mg/kg/day)$^{-1}$	Chronic Oral CSF (mg/kg/day)$^{-1}$	Chronic Inhalation RfD (mg/kg/day)	Chronic Oral RfD (mg/kg/day)	Oral Absorption Fraction	Adjusted Dermal CSF (mg/kg/day)$^{-1}$	Adjusted Dermal RfD (mg/kg/day)
Semivolatiles							
Benzo(a)anthracene	7.30E-01	7.30E-01	NA	NA	0.84	8.69E-01	NA
Benzo(a)pyrene	7.30E+00	7.30E+00	NA	NA	0.84	8.69E+00	NA
Benzo(b)fluoranthene	7.30E-01	7.30E-01	NA	NA	0.84	8.69E-01	NA
Benzo(k)fluoranthene	7.30E-02	7.30E-02	NA	NA	0.84	8.69E-02	NA
Chrysene	7.30E-03	7.30E-03	NA	NA	0.84	8.69E-03	NA
Dibenzo(a,h) anthracene	7.30E+00	7.30E+00	NA	NA	0.84	8.69E+00	NA
Indeno(1,2,3-cd)pyrene	7.30E-01	7.30E-01	NA	NA	0.84	8.69E-01	NA
Inorganics							
Antimony	NC	NC	NA	4.00E-04	0.1	NC	4.00E-05
Arsenic	1.50E+01	1.80E+00	NA	3.00E-04	1	1.80E+00	3.00E-04
Barium	NC	NC	1.40E-04	7.00E-02	0.05	NC	3.50E-03
Beryllium	8.40E+00	4.30E+00	NA	5.00E-03	0.005	8.60E+02	2.50E-05
Cadmium	6.30E+00	NA	NA	5.00E-04	0.07	NC	3.50E-05
Chromium	4.20E+01	NA	NA	5.00E-03	0.1	NC	5.00E-04
Lead	UBM	UBM	UBM	UBM	0.5	NA	NA
Nickel	NC	NC	NA	2.00E-02	0.1	NC	2.00E-03
Selenium	NC	NC	NA	5.00E-03	0.97	NC	4.85E-03
Silver	NC	NC	NA	5.00E-03	1	NC	5.00E-03
Zinc	NC	NC	NA	3.00E-01	0.3	NC	9.00E-02

COPCs = Chemicals of potential concern
CSF = Cancer Slope Factor
RfD = Reference Dose
Adjusted Dermal CSF = Chronic Oral CSF / Oral Absorption Fraction
Adjusted Dermal RfD = Chronic Oral RfD x Oral Absorption Fraction
NA = No available data
NC = Not carcinogenic
UBM = Evaluated using the EPA Uptake Biokinetic Model

TABLE E-E
EXPOSURE PARAMETERS
VEHICLE MAINTENANCE AREA
LANL, LOS ALAMOS, NEW MEXICO

Exposure Parameter	Symbol	Units	Residents Adults	Residents Children	References
Inhalation Rate - indoor air	IRa	m^3/hr	0.83	0.66	
Inhalation Rate - outdoor air	IRa	m^3/hr	1.7	1.3	
Soil Ingestion Rate	IGs	mg/day	100	200	
Skin Surface Area Exposed	SA	cm^2/day	5000	2000	
Soil-skin Adherence Factor	SAF	mg/cm^2	1	1	
Exposure Time	ET	hr/day	20	20	
Exposure Frequency	EF	days/yr	350	350	
Exposure Duration	ED	year	30	6	
Fraction Ingested, Inhaled or Contacted from Site	FI or FC	unitless	1	1	
Conversion Factor	CF	kg/mg	1E-06	1E-06	Conversion Factor
Body Weight	BW	kg	70	15	
Averaging Time - Cancer	ATc	days	25550	25550	365 days/year x 70 years (lifetime)
Averaging Time - NonCancer	ATnc	days	10950	2190	365 days/year x ED

LADD/ADD = Lifetime Average Daily Dose/Average Daily Dose

Inhalation LADD Intake Rate Factors - outdoor air	2.00E-01	1.42E-01
Inhalation ADD Intake Rate Factors - outdoor air	4.66E-01	1.66E+00
Soil Ingestion LADD Intake Rate Factors	5.87E-07	1.10E-06
Soil Ingestion ADD Intake Rate Factors	1.37E-06	1.28E-05
Dermal Contact LADD Intake Rate Factors	2.94E-05	1.10E-05
Dermal Contact ADD Intake Rate Factors	6.85E-05	1.28E-04

TABLE I-1
CARCINOGENIC RISKS FROM SOIL INGESTION
FUTURE RESIDENT SCENARIO (CHILDREN)
VEHICLE MAINTENANCE AREA

COPCs	RME EPC (Cs) (mg/kg)	Child LADD (mg/kg/day)	Oral CSF $(mg/kg/day)^{-1}$	Child Cancer Risk
Semivolatiles				
Benzo(a)anthracene	2.28E+00	2.50E-06	7.30E-01	1.8E-06
Benzo(a)pyrene	1.89E+00	2.07E-06	7.30E+00	1.5E-05
Benzo(b)fluoranthene	3.03E+00	3.32E-06	7.30E-01	2.4E-06
Benzo(k)fluoranthene	1.45E+00	1.59E-06	7.30E-02	1.2E-07
Chrysene	2.75E+00	3.01E-06	7.30E-03	2.2E-08
Dibenzo(a,h) anthracene	5.90E-01	6.47E-07	7.30E+00	4.7E-06
Indeno(1,2,3-cd)pyrene	8.63E-01	9.46E-07	7.30E-01	6.9E-07
Inorganics				
Antimony	1.33E-01	1.46E-07	NC	NC
Arsenic	2.39E+00	2.62E-06	1.80E+00	4.7E-06
Barium	9.99E+01	1.09E-04	NC	NC
Beryllium	4.72E-01	5.17E-07	4.30E+00	2.2E-06
Cadmium	1.70E+00	1.87E-06	NA	NA
Chromium	2.58E+01	2.83E-05	NA	NA
Lead	2.11E+02	2.31E-04	NA	NA
Nickel	3.86E+01	4.23E-05	NC	NC
Selenium	1.33E-01	1.46E-07	NC	NC
Silver	2.78E+00	3.05E-06	NC	NC
Zinc	6.06E+02	6.66E-04	NC	NC
TOTAL RISK				3.2E-05

COPCs = Chemicals of potential concern
RME EPC = Reasonable Maximum Exposure Exposure Point Concentration in soil
LADD = Lifetime Average Daily Dose = Cs x LADD Factor
[Soil Ingestion Intake Rate LADD Factor = 1.10E-06]
CSF = Carcinogenic Slope Factor
NC = Noncarcinogen
NA = Not Applicable

TABLE I -2
NONCARCINOGENIC RISKS FROM SOIL INGESTION
FUTURE RESIDENT SCENARIO (CHILDREN)
VEHICLE MAINTENANCE AREA

COPCs	RME EPC (Cs) (mg/kg)	Child ADD (mg/kg/day)	Chronic Oral RfD (mg/kg/day)	Child HQ
Semivolatiles				
Benzo(a)anthracene	2.26E+00	2.92E-05	NA	NA
Benzo(a)pyrene	1.89E+00	2.42E-05	NA	NA
Benzo(b)fluoranthene	3.03E+00	3.88E-05	NA	NA
Benzo(k)fluoranthene	1.45E+00	1.86E-05	NA	NA
Chrysene	2.75E+00	3.51E-05	NA	NA
Dibenzo(a,h) anthracene	5.90E-01	7.54E-06	NA	NA
Indeno(1,2,3-cd)pyrene	8.63E-01	1.10E-05	NA	NA
Inorganics				
Antimony	1.33E-01	1.70E-06	4.00E-04	4.3E-03
Arsenic	2.39E+00	3.06E-05	3.00E-04	1.0E-01
Barium	9.99E+01	1.28E-03	7.00E-02	1.8E-02
Beryllium	4.72E-01	6.03E-06	5.00E-03	1.2E-03
Cadmium	1.70E+00	2.18E-05	5.00E-04	4.4E-02
Chromium	2.58E+01	3.30E-04	5.00E-03	6.6E-02
Lead	2.11E+02	2.70E-03	NA	NA
Nickel	3.86E+01	4.93E-04	2.00E-02	2.5E-02
Selenium	1.33E-01	1.70E-06	5.00E-03	3.4E-04
Silver	2.78E+00	3.56E-05	5.00E-03	7.1E-03
Zinc	6.08E+02	7.77E-03	3.00E-01	2.6E-02
TOTAL HAZARD INDEX				2.9E-01

RME EPC = Reasonable Maximum Exposure Exposure Point Concentration
ADD = Average Daily Dose = Cs x ADD Factor
Soil Ingestion Intake Rate ADD Factor = 1.28E-05
RfD = Reference Dose
HQ = Hazard Quotient
NC = Noncarcinogen
NA = Not Applicable

TABLE D-1
CARCINOGENIC RISKS FROM DERMAL CONTACT
FUTURE RESIDENT SCENARIO (CHILDREN)
VEHICLE MAINTENANCE AREA

COPCs	RME EPC (Ce) (mg/kg)	Dermal AF (unitless)	Child LADD (mg/kg/day)	Adjusted Dermal CSF (mg/kg/day)$^{-1}$	Child Cancer Risk
Semivolatiles					
Benzo(a)anthracene	2.28E+00	0.15	3.75E-06	8.89E-01	3.3E-06
Benzo(a)pyrene	1.89E+00	0.15	3.11E-06	8.69E+00	2.7E-05
Benzo(b)fluoranthene	3.03E+00	0.15	4.99E-06	8.69E-01	4.3E-06
Benzo(k)fluoranthene	1.45E+00	0.15	2.39E-06	8.69E-02	2.1E-07
Chrysene	2.75E+00	0.15	4.51E-06	8.69E-03	3.9E-08
Dibenzo(a,h) anthracene	5.90E-01	0.15	9.70E-07	8.69E+00	8.4E-06
Indeno(1,2,3-cd)pyrene	8.53E-01	0.15	1.42E-06	8.69E-01	1.2E-06
Inorganics					
Antimony	1.33E-01	0.01	1.46E-08	NC	NC
Arsenic	2.39E+00	0.01	2.62E-07	1.80E+00	4.7E-07
Barium	9.99E+01	0.01	1.09E-05	NC	NC
Beryllium	4.72E-01	0.01	5.17E-08	8.60E+02	4.4E-05
Cadmium	1.70E+00	0.01	1.87E-07	NA	NA
Chromium	2.55E+01	0.01	2.83E-06	NA	NA
Lead	2.11E+02	0.01	2.31E-05	NA	NA
Nickel	3.88E+01	0.01	4.23E-06	NC	NC
Selenium	1.33E-01	0.01	1.46E-08	NC	NC
Silver	2.78E+00	0.01	3.05E-07	NC	NC
Zinc	6.08E+02	0.01	6.66E-05	NC	NC
TOTAL RISK					8.9E-05

AF = Adherence Factor
RME EPC = Reasonable Maximum Exposure Exposure Point Concentration
LADD = Lifetime Average Daily Dose = Ce x LADD Factor
[Dermal Contact Intake Rate LADD Factor = 1.10E-05]
CSF = Carcinogenic Slope Factor
NC = Noncarcinogen
NA = Not Applicable

TABLE D-2
NONCARCINOGENIC RISKS FROM DERMAL CONTACT
FUTURE RESIDENT SCENARIO (CHILDREN)
VEHICLE MAINTENANCE AREA

COPCs	RME EPC (Cs) (mg/kg)	Dermal AF (unitless)	Child ADD (mg/kg/day)	Adjusted Dermal RfD (mg/kg/day)	Child HQ
Semivolatiles					
Benzo(a)anthracene	2.28E+00	0.15	4.38E-05	NA	NA
Benzo(a)pyrene	1.89E+00	0.15	3.63E-05	NA	NA
Benzo(b)fluoranthene	3.03E+00	0.15	5.82E-05	NA	NA
Benzo(k)fluoranthene	1.45E+00	0.15	2.79E-05	NA	NA
Chrysene	2.75E+00	0.15	5.28E-05	NA	NA
Dibenzo(a,h) anthracene	5.90E-01	0.15	1.13E-05	NA	NA
Indeno(1,2,3-cd)pyrene	8.63E-01	0.15	1.66E-05	NA	NA
Inorganics					
Antimony	1.33E-01	0.01	1.70E-07	4.00E-05	4.3E-03
Arsenic	2.39E+00	0.01	3.06E-06	3.00E-04	1.0E-02
Barium	9.89E+01	0.01	1.26E-04	3.50E-03	3.6E-02
Beryllium	4.72E-01	0.01	6.03E-07	2.50E-05	2.4E-02
Cadmium	1.70E+00	0.01	2.18E-06	3.50E-05	6.2E-02
Chromium	2.58E+01	0.01	3.30E-05	5.00E-04	6.6E-02
Lead	2.11E+02	0.01	2.70E-04	NA	NA
Nickel	3.86E+01	0.01	4.93E-05	2.00E-03	2.5E-02
Selenium	1.33E-01	0.01	1.70E-07	4.85E-03	3.5E-05
Silver	2.78E+00	0.01	3.56E-06	5.00E-03	7.1E-04
Zinc	6.08E+02	0.01	7.77E-04	9.00E-02	8.6E-03
TOTAL HAZARD INDEX					2.4E-01

RME EPC = Reasonable Maximum Exposure Exposure Point Concentration
ADD = Average Daily Dose = Cs x ADD Factor
[Dermal Contact Intake Rate ADD Factor = 1.28E-04]
RfD = Reference Dose
HQ = Hazard Quotient
NC = Noncarcinogen
NA = Not Applicable

TABLE R-R
SUMMARY OF CARCINOGENIC RISKS
FUTURE RESIDENT SCENARIO (CHILDREN)
VEHICLE MAINTENANCE AREA

COPCs	Soil Ingestion	Dermal Contact	Inhalation of Dusts	TOTAL CANCER RISK	Percent Contribution
Semivolatiles					
Benzo(a)anthracene	1.8E-08	3.3E-06	2.1E-08	5E-06	4%
Benzo(a)pyrene	1.5E-05	2.7E-05	1.8E-07	4E-05	31%
Benzo(b)fluoranthene	2.4E-06	4.3E-06	2.8E-08	7E-06	5%
Benzo(k)fluoranthene	1.2E-07	2.1E-07	1.4E -09	3E-07	0%
Chrysene	2.2E-08	3.9E-08	2.6E-10	6E-08	0%
Dibenzo(a,h) anthracene	4.7E-06	8.4E-06	5.5E-08	1E-05	10%
Indeno(1,2,3-cd)pyrene	6.9E-07	1.2E-06	8.1E-09	2E-06	1%
Inorganics					
Antimony	NC	NC	NC	NA	0%
Arsenic	4.7E-06	4.7E-07	4.6E-07	6E-06	4%
Barium	NC	NC	NC	NA	0%
Beryllium	2.2E-06	4.4E-05	5.1E-08	5E-05	34%
Cadmium	NA	NA	1.4E-07	1E-07	0%
Chromium	NA	NA	1.4E-05	1E-05	10%
Lead	NA	NA	NA	NA	0%
Nickel	NC	NC	NC	NA	0%
Selenium	NC	NC	NC	NA	0%
Silver	NC	NC	NC	NA	0%
Zinc	NC	NC	NC	NA	0%
TOTAL CANCER RISK	3E-05	9E-05	1E-05	1E-04	100%
Percent Contribution	23%	68%	11%	100%	

COPCS = Chemicals of potential concern
NC = Noncarcinogen
NA = Not Available

TABLE H-H
SUMMARY OF HAZARD INDICES
FUTURE RESIDENT SCENARIO (CHILDREN)
VEHICLE MAINTENANCE AREA

COPCs	Soil Ingestion	Dermal Contact	Inhalation of Dusts	TOTAL HAZARD INDEX	Percent Contribution
Semivolatiles					
Benzo(a)anthracene	NA	NA	NA	NA	0%
Benzo(a)pyrene	NA	NA	NA	NA	0%
Benzo(b)fluoranthene	NA	NA	NA	NA	0%
Benzo(k)fluoranthene	NA	NA	NA	NA	0%
Chrysene	NA	NA	NA	NA	0%
Dibenzo(a,h) anthracene	NA	NA	NA	NA	0%
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	0%
Inorganics					
Antimony	4.3E-03	4.3E-03	NA	9E-03	1%
Arsenic	1.0E-01	1.0E-02	NA	1E-01	18%
Barium	1.8E-02	3.6E-02	1.1E-01	2E-01	25%
Beryllium	1.2E-03	2.4E-02	NA	3E-02	4%
Cadmium	4.4E-02	6.2E-02	NA	1E-01	17%
Chromium	6.6E-02	6.6E-02	NA	1E-01	21%
Lead	NA	NA	NA	NA	0%
Nickel	2.5E-02	2.5E-02	NA	5E-02	8%
Selenium	3.4E-04	3.5E-05	NA	4E-04	0%
Silver	7.1E-03	7.1E-04	NA	8E-03	1%
Zinc	2.6E-02	8.6E-03	NA	3E-02	5%
HAZARD INDEX	3E-01	2E-01	1E-01	6E-01	100%
Percent Contribution	46%	37%	17%	100%	

COPCs = Chemicals of potential concern
NA = Not Available

ADDENDUM 1

VOLUNTARY CORRECTIVE ACTION PLAN COMPLETION REPORT FOR SOLID WASTE MANAGEMENT UNIT 33-016 SUMP WITH OUTFALL

SEPTEMBER 1995

THIS PAGE LEFT INTENTIONALLY BLANK

Voluntary Corrective Action Plan Completion Report
Potential Release Site 33-016
Sump with Outfall

DESCRIPTION

Potential Release Site 33-016 is a sump that once served the sink and floor drain in a bunker located south of main site, building TA-33-23 (Fig. 1). The bunker was used to prepare propellant charges for use at South Site in the 1950's and then as storage for EES-1. PRS 33-016 is listed in the Hazardous and Solid Waste Amendments (HSWA) Module of the Los Alamos National Laboratory's (LANL's) Resource Conservation and Recovery Act (RCRA) Permit.

The sump is on the west side of the building and is approximately 5 ft long by 2.5 ft wide by 7 ft deep. The sludge was analyzed during RFI sampling in 1993. This analysis indicated the presence of HE by-products, PAHs, and SVOCs above health-based levels. Analytical results are presented in Table 1. The soil at the outfall was sampled but revealed no contamination. The sludge was sampled again during the VCA cleanup and is addressed below.

CORRECTIVE ACTION

The proposed treatment for the site was to remove the sludge, abandon the concrete sump in-place, and backfill with gravel and sand. The cleanup followed the VCA Plan except in sampling. During sludge removal, there were elevated readings on the photoionization detector (PID). Because of the 10 to 20 ppm PID readings, additional sludge and liquid samples were collected and analyzed for lead, volatile, and semivolatile organics using EPA methods 6010, 8260 and 8270, respectively.

The initial cleanup involved pumping water from the sump into seven lined 55-gal barrels. During sludge removal it was decided to sample the sludge to examine the factor(s) contributing to the elevated PID readings. The analytical results were reviewed and determined to be non-RCRA by the ESH-19 hazardous waste regulator and

the Field Team leader. Analytical results are presented in Table 2 and are provided in Attachment A. The sludge was removed and placed in one, lined 55-gal. barrel. The sump was filled with gravel and sand and capped with 1 ft of concrete. The non-hazardous waste generated at this site is scheduled to be disposed of at the Liquid Waste Facility and a clean landfill.

All samples were collected for waste characterization and are compared to RCRA limits; any data associated with this PRS will be made available upon request.

This VCA was considered a final remedy to PRS 33-016, and this report serves as the formal request for regulator concurrence to remove PRS 33-016 from the HSWA module.

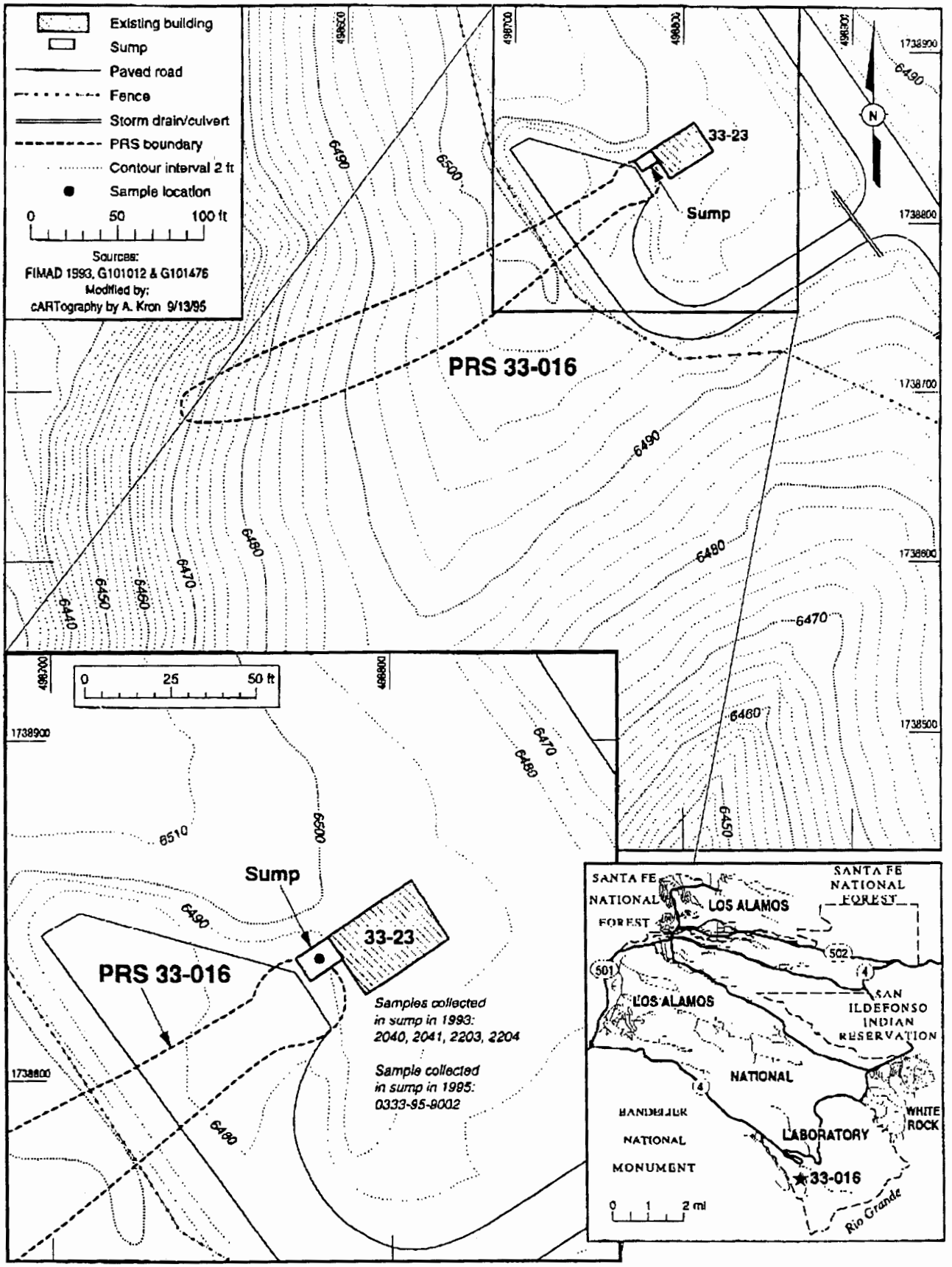

Figure 1. Location of PRS 33-016, proposed for VCA.

TABLE 1

SAMPLE RESULTS FOR SLUDGE SAMPLES AAA2041 AND AAA2204

ANALYTE	SAMPLE RESULT AAA2041 (ppm) [a]	SAMPLE RESULT AAA2204 (ppm)	SAL (ppm)
Benzo(a)pyrene	16.0	18	0.1
Benzo(a)anthracene	23.0	20	1
Benzo(b)fluoranthene	13.0	12	1
Benzo(k)fluoranthene	19.0	19	1
Chrysene	24	24	22
Indeno[1,2,3-cd]pyrene	9.7	15	1
2,4-Dinitrotoluene	nd	2.5	1
Bis(2-ethylhexyl)phthalate	24	111	50

[a] Only samples results above SALs are reported.

TABLE 2

SAMPLE RESULTS FOR SLUDGE AND LIQUID SAMPLES [a]

ANALYTE	0333-95-0002 (µg/g)	0333-95-0001 (µg/l)	0333-95-0003 (µg/l)	RCRA LIMIT [c] (mg/L)
1,1-Dichloroethylene	210			0.7
1,1-Dichloroethane		3.84	3.45	
Acetone		18.9	142	-
Methyl chloride			2.34	-
2-Methylnaphthalene	73.5			-
Di-n-butyl phthalate			15.2	-
Phenathrene	70.2			-
bis(2-Ethylhexyl)phthalate	244		24.6	-
Mercury	0.291			0.2
Silver	20.1			5.0
Aluminum	5 010	102	293	-
Arsenic	7.06			5.0
Barium	94.3	186	105	100.0
Calcium	4 750	68 600	73 300	-
Cadmium	1.76			1.0
Cobalt	4.47			-
Chromium	52.4			5.0
Copper	285		18.8	-
Iron	12 600	802	1310	-
Potassium	768	12 300	12 700	-
Magnesium	2 970	2 580	2 660	-
Manganese	112	199	114	-
Sodium	414	34 300	24 500	-
Nickel	88.5	29.9	35.2	-
Lead	293 [b]	14.5	17	5.0
Antimony	1.49			-
Selenium	0.972			1.0

TABLE 2 (CONTINUED)

SAMPLE RESULTS FOR SLUDGE AND LIQUID SAMPLES [a]

ANALYTE	0333-95-0002 (µg/g)	0333-95-0001 (µg/l)	0333-95-0003 (µg/l)	RCRA LIMIT
Vanadium	28.2			-
Zinc	458	69.3	87.6	-

[a] Only sample results above detection limits are reported.

[b] Lead was the only sludge component that resulted in a detectable value (245µg/l) during TCLP analysis.

c. Maximum Concentration of Contaminants for the Toxicity Characteristic, 40 CFR 261.24.

CERTIFICATION OF COMPLETION

I certify that all work pertaining to the voluntary corrective action (VCA) 33-016 has been completed in accordance with the Department of Energy approved VCA plan entitled **VCA Plan for PRS 33-016, Sump with Outfall.** Based on my personal involvement or inquiry of the person or persons who managed this clean up, a review of all data gathered and a visit to the site, to the best of my knowledge and belief, all criteria of the plan have been met or exceeded. I believe that the completion of the VCA is both protective to human health and the environment. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Brad Martin

Brad Martin
Field Unit 3 Project leader
Environmental Restoration Program
Los Alamos National Laboratory

9/6/95
Date Signed