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

U. S. Department of Energy
Los Alamos Area Office, MS A316
Environmental Restoration Program
Los Alamos, New Mexico 87544
505-667-7203/FAX 505-665-4504

NOV 1998
RECEIVED

Date: November 19, 1998
Refer to: EM/ER:98-453

Dr. Robert S. Dinwiddie
NMED-HRMB
P.O. Box 26110
Santa Fe, NM 87502

SUBJECT: SUMMITTAL OF REVISED VCA COMPLETION REPORT FOR PRS 0-016

Dear Dr. Dinwiddie:

In response to your July 1, 1998 letter, Los Alamos National Laboratory conducted a site visit of Potential Release Site 0-016 (former small arms range) for Ms. Kim Hill of the New Mexico Environment Department's Hazardous and Radioactive Materials Bureau (HRMB). This site visit occurred on July 22, 1998. At that meeting, it was agreed that the previously submitted Voluntary Corrective Action (VCA) report should be rewritten to incorporate HRMB comments and to clarify site activities which were conducted. To incorporate this rewrite approach, an additional 60 days were requested by the Los Alamos National Laboratory and granted by your office to generate a new VCA Completion Report. By granting the extension, the new delivery date of this report is November 20, 1998.

The Laboratory appreciates the opportunity to work closely with members of your staff to improve the quality of our documents and generate a product more readable by the public and reviewable by your office.

If you have any questions or comments regarding this report, please contact Dave McInroy at (505) 667-0819 or Joe Mose at (505) 667-5808.

Sincerely,

Julie A. Canepa, Program Manager
LANL/ER Project

Sincerely,

Theodore J. Taylor, Program Manager
DOE/LAAO

JC/TT/DM/bj

7041

Enclosure: Revised VCA Completion Report for PRS 0-016

Cy (w/ enc.):
M. Buksa, EM/ER, MS M992
G. Bayhurst, EM/ER, MS M992
J. Mose, LAAO, MS A316
W. Neff, CST-7, MS M992
D. Neleigh, EPA, R.6, 6PD-N
S. Rae, ESH-18, MS K497
T. Taylor, LAAO, MS A316
T. Trujillo, DOE-AL, MS A906
J. White, ESH-19, MS K490
B. Garcia, NMED-HRMB
J. Parker, NMED-HRMB
G. Saums, NMED-SWQB
S. Yanicak, NMED-AIP, MS J993
EM/ER File (CT#501), MS M992
RPF, MS M707

Information Only (w/o enc.):
T. Baca, EM, MS J591
A. Dorries, TSA-11, MS M992
T. George, EM/ER, MS M992
T. Longo, DOE-HQ, EM-453
D. McInroy, EM/ER, MS M992
G. Rael, AL-ERD, MS A906
P. Schumann, ESH-19, MS M992
J. Vozella, LAAO, MS A316
EM/ER File, MS M992
Tracker RM 604, MS M992

November 1998

Response to Rejection of VCA Report for Potential Release Site 0-016

and

Revised VCA Report for Potential Release Site 0-016

Environmental Restoration Project
A Department of Energy Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY
Los Alamos, NM 87545

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Response to the
Rejection of 0-016 VCA Report
Los Alamos National Laboratory
NM0890010515

This document responds to a letter titled, "Rejection of 0-016 VCA Report Los Alamos National Laboratory NM0890010515", dated July 1, 1998, for Los Alamos National Laboratory LA-UR-97-2745 from the New Mexico Environment Department (NMED) Hazardous and Radioactive Materials Bureau (HRMB) to Mr. Theodore Taylor, Project Manager, Los Alamos Area Office, Department of Energy to Mr. John Browne, Director, Los Alamos National Laboratory. To facilitate review of this response, NMED's comments are included verbatim. The comments are divided into general and specific categories as presented in the letter. Los Alamos National Laboratory's (LANL's) responses follow each NMED comment. Additionally, Table 4 following the comments correlates each comment to either LANL's response or the section of the revised report that addresses the comment.

General Comments

NMED Comment

1. *The VCA Report is difficult to read: it is unclear due to the complexity of the activities and processes conducted and its poor organization. Many of the report's sections are repetitive and/or incomplete. LANL should revise this report such that it presents the activities which occurred at the potential release site (PRS) in a clear and concise manner. RPMP is open to discussing and to providing guidance on an improved, more clear format for this submittal.*

LANL Response:

LANL has revised the VCA Report incorporating many aspects of the RFI report outline and suggestions from HRMB staff in order to make the presentation more clear and concise.

NMED Comment

2. *LANL should have written this VCA Report in a manner similar to a RFI Report (i.e., such that a final site decision could be made). The information collected during the VCA investigation and presented in this document do not adequately support a final decision: nature and horizontal and vertical extent of contamination are not adequately characterized.*

LANL Response:

LANL has re-written this VCA Report in a manner similar to the RFI Report such that a final site decision could be made. LANL believes the information collected during the VCA investigation adequately characterizes the nature and horizontal and vertical extent of contamination for the purposes of reaching a final site decision. This information is now clearly presented in the revised report in Section 3.4 Confirmatory Sampling and 3.6.1 Nature and Extent.

NMED Comment

3. *LANL should present both the screening and fixed laboratory analytical results for the samples obtained for each portion of the VCA investigation. The data should be presented in a clear and concise manner such that the samples, their locations, their results and their implications can be more easily correlated and understood.*

LANL Response:

LANL has presented both the screening and fixed laboratory analytical results for samples obtained for each portion of the VCA investigation in Appendix D, Tables D-2 and D-3 in the presentation style specified by the RFI outline.

NMED Comment

4. *LANL performed the VCA by removing contaminated soils which exceeded Screening Action Levels (SALs) or Preliminary Remediation Goals (PRGs). LANL should have first determined the horizontal and vertical extent of contamination relative to background values, determined if those concentrations exceeded SALs, and then determined a risk-based clean-up level specific to the PRS. This process is more clearly defined in LANL's RFI Report Annotated Outline.*

LANL Response:

For those cases where accelerated site characterization is occurring at the same time as remediation, extent of contamination is achieved during confirmation sampling. Section 3.6.1 Nature and Extent of Contamination in the revised report, discusses the determination of both vertical and horizontal extent at PRS 0-016. Section 3.2 Screening Methods Used To Guide Remediation explains the field screening techniques that were used to define remediation boundaries which was then followed up by confirmation sampling.

NMED Comment

5. *LANL performed a human health-based VCA. LANL must also consider the ecological impacts of the contaminants remaining at this PRS.*

LANL Response:

LANL has conducted an ecological screening assessment for PRS 0-016 to consider the ecological impacts of remaining contaminants. Details are in Section 3.7.3 Ecological Screening Assessment.

NMED Comment

6. *LANL states in Section 1.4 that "A VCA was determined to be the appropriate approach to address the time constraints placed on the LANL Environmental Restoration Project by a pending land exchange between the USDA Forest Service and a private land developer."*

RPMP questions the appropriateness of performing a VCA on sites such as this one based on criteria other than the following: potential remedy is obvious and can be readily applied, potential remedy will be a final resolution; sampling data are available that adequately identify the constituents of concern; adequate treatment, storage, and disposal capacity is available for anticipated wastes; cleanup levels are based on background concentrations, promulgated standards, or previously determined risk-based levels; estimated cost to complete the action is relatively small; and the estimated time to complete the field activities is relatively short. [no response required]

LANL Response:

Section 1.0 Introduction of the revised report addresses appropriateness of the VCA.

NMED Comment

7. *LANL failed to provide basic information regarding the various areas sampled. LANL should, at a minimum, provide the following information: the surficial area*
of the range floor, back area and drainage; the estimated volume of each of the berms; and the estimated volume of contaminated soil in the back area and range floor.

LANL Response:

LANL has provided estimated areas and volumes for each berm, range floor area, the back area and peripheral areas (access/parking area to the south, slash storage area to the east, and area between the back berms and the back area) that were included in the final cleanup in Section 2.2.1 Site Description of the revised report.

Specific Comments

NMED Comment

2.0 Site Characterization Before Removal

8. *LANL should present, at a minimum, a summary of the analytical results of the 1991 Forest Service study within the text to support the VCA investigation and decisions.*

LANL Response:

LANL has provided in Section 2.3.2 Previous Investigations, of the revised report, a table of the analytical results (Table 2.3-1) of the 1991 Forest Service study, as well as a map (Figure 2.0-2) of the sample locations.

NMED Comment

9. *LANL should include the USDA Forest Service Memorandum 7400 as a reference document for this report. Also, LANL should refrain from repeating inaccurate statements made within other reference materials. As an example, the text repeats the statement, "...because the TCLP test did not reproduce the essentially pH-neutral soil conditions at the site, the lead-contaminated soil does not constitute a release of a hazardous substance under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)." This statement is not founded or applicable based on the following reasons:*
   - *a. CERCLA does not utilize TCLP to determine nature and extent of contamination; CERCLA utilizes TCLP for waste characterization and disposal purposes.*
   - *b. This site is regulated by RCRA not CERCLA.*
   - *c. The lead-contaminated soil would be considered a source under CERCLA.*

LANL Response:

LANL has included the USDA Forest Service Memorandum 7400 as a reference document for this report in Appendix G-2.0. LANL repeated the information

provided in the Memorandum in the original VCA Completion Report to provide the reader with background information available on the site, not as a regulatory decision reference. This information has been deleted from the revised VCA completion report.

NMED Comment

2.2 Nature and Extent of Contamination

10. *The third paragraph of this section states, "Based on the results of the survey above, a correlation was established between the number of number of metal detector responses and the total lead concentration in the soil." LANL should clarify (perhaps most clearly using a table) how correlating XRF results with metal detector responses establishes a correlation between metal detector responses and total lead concentrations.*

LANL Response:

LANL has provided Table 3.2-1 and text (Section 3.2 Screening Methods Used to Guide Remediation) interpolating XRF lead results with metal detector responses. A discussion of the comparison of XRF lead results with fixed-site laboratory lead results is presented in Section 3.2 Screening Methods Used to Guide Remediation.

NMED Comment

11. *LANL failed to perform full suite analyses for target analyte list (TAL). LANL should have obtained and analyzed a subset of confirmatory samples to ensure adequate characterization and remediation of all metals for both human health and ecological risk.*

LANL Response:

LANL followed the NMED and USEPA approved VCA plan (LANL 1993, ER ID 29724.0, p.4) which stated: "All samples will be analyzed for total lead. Ten percent of the samples collected will also be analyzed for copper and zinc, found in small-arms ranges." Additionally, a number of samples of processed soil were collected and analyzed for TAL metals. The results are presented in Table 1 below. It is important to note that the four samples labeled "Un-Processed Soil Berm" in Table 2 below are samples from the source (the berms) and that no other inorganic chemicals besides copper and lead were detected at concentrations greater than background values. These four samples confirm the accuracy of LANL's and the USDA Forest Service's process knowledge that the inorganics analyzed for (copper, lead, and zinc) are in fact, the only chemicals of potential concern. The detection limit for antimony (14 mg/kg) exceeded the background value for antimony (0.38 mg/kg) but not the antimony cleanup level (30 mg/kg).

TABLE 1

CHARACTERIZATION SAMPLES

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range (mg/kg)	All Soils Background Value (mg/kg)	Frequency of Detects Above Background Value
Aluminum	Soil	27	27	3440-10000	29200	0/27
Antimony	Soil	27	5	[0.65-11]*	0.83	3/27
Arsenic	Soil	27	12	[1.2]-4.4	8.17	0/27
Barium	Soil	27	27	34.5-111	295	0/27
Beryllium	Soil	27	27	0.57-0.95	1.83	0/27
Cadmium	Soil	27	0	[0.07-0.57]	0.4	0/27
Calcium	Soil	27	27	771-1950	6120	0/27
Chromium, Total	Soil	27	27	3.7-8.7	19.3	0/27
Cobalt	Soil	27	27	1.9-8.1	8.64	0/27
Copper	Soil	27	27	4.7-10	14.7	0/27
Iron	Soil	27	27	5570-11800	21500	0/27
Lead	Soil	27	27	28-340	22.3	27/27
Magnesium	Soil	27	27	491-1700	4610	0/27
Manganese	Soil	27	27	113-427	671	0/27
Mercury	Soil	27	12	[0.04-0.11]*	0.1	0/27
Nickel	Soil	27	27	4.8-9.2	15.4	0/27
Potassium	Soil	27	27	444-1200	3460	0/27
Selenium	Soil	27	11	[0.4]-1.4	1.52	0/27
Silver	Soil	27	0	[0.22-2.3]	1	0/27
Sodium	Soil	27	27	140-250	915	0/27
Thallium	Soil	27	2	[0.74-1.4]*	0.73	2/27
Vanadium	Soil	27	27	8.1-18.4	39.6	0/27
Zinc	Soil	27	27	18.8-38	48.8	0/27

* The minimum and the maximum are undetected and there are detected values within the range of the minimum and maximum.

TABLE 2
UN-PROCESSED SOIL BERM

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range (mg/kg)	All Soils Background Value (mg/kg)	Frequency of Detects Above Background Value
Aluminum	Soil	4	4	5500-6300	29200	0/4
Antimony	Soil	4	0	[14-14]	0.83	0/4
Arsenic	Soil	4	0	[2.3-2.4]	8.17	0/4
Barium	Soil	4	4	80-84	295	0/4
Beryllium	Soil	4	0	[1.1-1.2]	1.83	0/4
Cadmium	Soil	4	0	[1.1-1.2]	0.4	0/4
Calcium	Soil	4	4	1400-1700	6120	0/4
Chromium, Total	Soil	4	4	4.6-5.7	19.3	0/4
Cobalt	Soil	4	0	[11-12]	8.64	0/4
Copper	Soil	4	4	8-24	14.7	1/4
Iron	Soil	4	4	7600-8200	21500	0/4
Lead	Soil	4	4	45-620	22.3	4/4
Magnesium	Soil	4	1	[1100]-1400	4610	0/4
Manganese	Soil	4	4	240-280	671	0/4
Mercury	Soil	4	0	[0.11-0.12]	0.1	0/4
Nickel	Soil	3	0	[9.1-9.4]	15.4	0/3
Potassium	Soil	4	0	[1100-1200]	3460	0/4
Selenium	Soil	4	0	[1.1-1.2]	1.52	0/4
Silver	Soil	4	0	[2.3-2.4]	1	0/4
Sodium	Soil	4	0	[1100-1200]	915	0/4
Thallium	Soil	4	0	[2.3-2.4]	0.73	0/4
Vanadium	Soil	4	1	[11]-13	39.6	0/4
Zinc	Soil	4	4	32-38	48.8	0/4

NMED Comment

3.1 Basis for Cleanup Levels

12. *LANL inappropriately used PRGs as cleanup levels for this PRS, See General Comments*

LANL Response:

PRGs are not appropriate cleanup levels for all sites. However, the land use, receptors, pathways, and equations used to calculate the PRGs are identical to those that would have been used to calculate the site-specific cleanup levels at PRS 0-016. Therefore, use of the USEPA Region 9 residential PRGs was appropriate. However, site-specific cleanup levels are presented in Section 3.1 Cleanup Levels and Appendix F of the revised report.

NMED Comment

3.2.1 Soil Washing Operations

13. *LANL does not clearly describe the intended/final disposition of the fine sediment accumulations in the ponds which were "--periodically removed as needed." LANL should indicate the volume and the intended/final disposition of these recirculation pond sediments.*

LANL Response:

LANL has provided information indicating the volume and the intended/final disposition of the recirculation pond sediments in Section 3.3.1 Soil Washing Operations of the revised report.

NMED Comment

14. *LANL indicates that TCLP analyses were conducted on several washed soil samples to ensure that the "...soils were suitable for off-site transfer." LANL should clarify the volume and the intended/final disposition of these washed soils which were transported off-site.*

LANL Response:

LANL has provided information indicating the volume and the intended/final disposition of the washed soils that were transported off-site in Section 3.3.1 Soil Washing Operations of the revised report.

NMED Comment

3.2.2 Shaker Plant Operations

15. *LANL should clarify the disposition of the lead fines that were vacuumed off the crushed material which fell through the 1/2 inch sieve and was retained by the 3/16 inch).*

ok

LANL Response:

The material vacuumed off the gravel that passed the ½-in sieve and was retained on the 3/16-in sieve was gravel, not fines. The fines passed through the 3/16-in sieve and were sampled and managed in the same manner as all other fines. The gravel vacuumed off this fraction was stockpiled, sampled for analysis by TCLP for lead, and transferred to TA-72 or disposed of as hazardous waste, depending on the analytical results. This is discussed in Section 3.3.3 Shaker Plant Operations of the revised report.

NMED Comment

3.3.1 Back Area Confirmatory Sampling

16. *LANL should revise Table 3.3-1 to show the separate confirmatory sampling events that took place and how the concentrations compared to previous field screening results.*

ok

LANL Response:

LANL has replaced Table 3.3-1 with Table D-2 in Appendix D in the revised report showing the separate confirmation sampling events that took place. Table D-2 compares off-site laboratory results (lead by ICPES) to field screening results (lead by XRF) for sample locations where both types of analyses were conducted.

NMED Comment

3.3.2 Range Floor Confirmatory Sampling

17. *The VCA Report indicates that all 16 first-round confirmatory samples for lead were J-qualified and that 4 second-round confirmatory samples for copper were either UJ or J-qualified. Since lead and copper are contaminants of concern at this PRS, LANL should resample these areas.*

ok

LANL Response:

LANL has conducted a focused validation of these samples and concluded that according to USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA 1994, ER ID 48639.1) these data

are usable and resampling is not warranted. Appendix C of the revised report discusses the qualification of data.

NMED Comment

3.3.3 First Order Drainage Confirmatory Sampling

18. *LANL omitted Figure 3.3.3-1 and Table 3.3.3-1 from the VCA Report. LANL should provide this figure and table in the VCA Report. The format of Table 3.3.3-1 should follow the revised RFI annotated outline.*

LANL Response:

There is no mention of a Figure 3.3.3-1in Section 3.3.3 First Order Drainage Confirmatory Sampling, nor in the rest of the original report. The text in Section 3.3.3 references Figure 3.3-1. Figure 3.3-1 was included in the original report on page 16.

LANL concurs that Table 3.3.3-1 was inadvertently omitted from the original report. A table presenting the results of the first order drainage confirmation samples is included in the revised text as Table D-2 in Appendix D

NMED Comment

Appendix A

19. *LANL failed to provide information required in a comprehensive data set. LANL should submit a complete data set. See general comments.*

LANL Response:

LANL has included a comprehensive data set in the revised report in Appendix D.

NMED Comment

20. Table A-1 does not include the request number and the text fails to provide the sample location/identification numbers; therefore, the sample location/identification numbers cannot be correlated to the QA/QC problems presented in the text of the Appendix.

LANL Response:

The revised report provides request numbers and sample location/identification numbers in all tables presenting data that will enable the reader to correlate the sample location/identification numbers to the QA/QC information.

NMED Comment

Appendix D

21. *LANL fails to provide a meaningful presentation of the confirmatory sampling analytical results: a correlation between sample location/identification numbers and area being investigated cannot be made. LANL should revise this data presentation as directed in the general comments.*

LANL Response:

The revised report provides sample location numbers in both figures and tables such that the reader can make the correlation between the confirmatory sampling analytical results and the area investigated.

NMED Comment

Appendix F

22. *On Page F-15, the endnote for Table F-1 states that "S = Analyzed by Method of Standard Addition." LANL should clarify what is meant by this endnote indicator.*

LANL Response:

The Method of Standard Addition (MSA) is covered in EPA Method SW-846, and can be applied to most analytical techniques. The standard addition technique involves adding known amounts of standard to one or more aliquots of the processed sample solution. This technique compensates for a sample constituent that enhances or depresses the analytical signal, thus producing a different slope from that of the calibration standards. The Method of Standard Addition is used when matrix interference is a problem. For example, when samples are not passing control limits for the matrix spike sample, due to matrix interference the Method of Standard Addition can be used to overcome this problem. Some laboratories often employ the Method of Standard Addition as part of any work involving a delisting petition, or whenever a new sample matrix is being used. For a detailed explanation of how this method is implemented, refer to EPA Method 7000, Atomic Absorption Methods.

NMED Comment

23. *LANL does not discuss the number or location of the stockpiles for which analytical results are presented; therefore, the data presented is limited in value. LANL should revise this data presentation as directed in the general comments.*

LANL Response:

Due to space requirements at PRS 0-016, waste was stockpiled for short periods of time while samples were sent for analyses of TCLP lead on an expedited turn around. As soon as the TCLP lead results were available, stockpiles were

disposed of in the appropriate manner. Therefore samples were not given location IDs. Section 3.3.1 Soil Washing Opertations, discusses the sampling of the stockpiles under subheading Handling, Sampling and Disposition of Washed Soils.

NMED Comment

24. *This Appendix presents data for samples with similar descriptions. LANL should include a date of sampling or other unique identifier to distinguish between the many samples with similar location identifications in the "TCLP Analysis Comments" column.*

LANL Response:

Table F-1 of the original report does include the date of sampling. The "Sample Date" column is the second column in the table and the dates range from 1994 to 1997. While in a different column than the TCLP Analysis Column, Table F-1 Waste Characterization Data of the original report does include a sample date field Table F-2 of the original report presents the results of two pond water samples. A footnote at the bottom of Table F-2 states: "Samples collected on 10 October, 1996...". These data are presented in Table 3, Waste Characterization Data, below.

NMED Comment

25. *LANL provides a "**" qualifier in the endnotes; however the review was unable to identify any samples which were qualified with this flag. LANL should clarify which samples required the "**" endnote as indicated on page F-15.*

LANL Response:

LANL concurs that the data requiring the "**" footnote was inadvertently not marked. This data appropriately marked in Table 3, Waste Characterization Data, below.

NMED Comment

26. *LANL presents the waste characterization data with columns identified as "Total Analysis" and "TCLP Analysis." LANL should clarify the analytical methods for both of these columns.*

LANL Response:

The analytical methods have been added in Table 3, Waste Characterization Data, below.

NMED Comment

27. *LANL fails to provide the information necessary to determine the quality and applicability of the analytical data. LANL should provide the method detection limits for the analyses conducted.*

LANL Response:

The method detection limits have been added in Table 3, Waste Characterization Data, below.

TABLE 3

WASTE CHARACTERIZATION DATA

Due to limited space at PRS 0-016, the waste piles were stockpiled in 25 yd^3 and sampled for TCLP lead. The analytical samples were expedited at the fixed-site laboratory and the piles were moved to their final disposition as soon as the TCLP lead results were available.

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-95-0761	2-Aug-95	NR	NR	NR	NR	NA	NR	NA	NR	NA	2.17	0.03	Pine needles after segregation from soil	60 yd^3
0100-96-0111	21-Feb-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.252	0.03	Pine Needles	Included in the 60 yd^3 above
0100-96-0112	21-Feb-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.151	0.03	Pine Needles	Included in the 60 yd^3 above
0100-96-0113	21-Feb-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	302	0.03	Pine Needles	Included in the 60 yd^3 above
0100-96-0114	21-Feb-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	54.5	0.03	Pine Needles	Included in the 60 yd^3 above
0100-96-0115 *	21-Feb-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.11	0.03	Duplicate of 0100-96-0113	Included in the 60 yd^3 above

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-0813	2-May-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #1	25 yd^3
0100-96-0814	2-May-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #2	25 yd^3
0100-96-0815	2-May-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #3	25 yd^3
0100-96-0816	2-May-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #4	25 yd^3
0100-96-0817	2-May-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #5	25 yd^3
0100-96-0818	2-May-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #6	25 yd^3
0100-96-0819	3-May-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #7	25 yd^3
0100-96-0820	3-May-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #8	25 yd^3
0100-96-0821	3-May-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	3.0	0.03	Stockpile Fines #9	25 yd^3
0100-96-0822	3-May-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #10	25 yd^3
0100-96-0823	15-May-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #13	25 yd^3
0100-96-0824	15-May-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #14	25 yd^3
0100-96-0825	15-May-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #11	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-0849	7-May-96	NR	NR	NR	6.8	5	56	0.6	32	4	ND	0.03	Stockpile Fines #6	25 yd^3
0100-96-0850	7-May-96	NR	NR	NR	6.5	5	63	0.6	33	4	ND	0.03	Stockpile Fines #2	25 yd^3
0100-96-0851	7-May-96	NR	NR	NR	6.7	5	62	0.6	30	4	3.2	0.03	Stockpile Fines #3	25 yd^3
0100-96-0852	7-May-96	NR	NR	NR	6.5	5	75	0.6	30	4	ND	0.03	Stockpile Fines #4	25 yd^3
0100-96-0853	7-May-96	NR	NR	NR	10	5	120	0.6	34	4	ND	0.03	Stockpile Fines #5	25 yd^3
0100-96-0854	7-May-96	NR	NR	NR	7.6	5	70	0.6	38	4	ND	0.03	Stockpile Fines #1	25 yd^3
0100-96-0855	7-May-96	NR	NR	NR	6.3	5	1200	0.6	33	4	ND	0.03	Stockpile Fines #7	25 yd^3
0100-96-0856	7-May-96	NR	NR	NR	7.6	5	77	0.6	33	4	ND	0.03	Stockpile Fines #8	25 yd^3
0100-96-0857	8-May-96	NR	NR	NR	7.5	5	83	0.6	34	4	16	0.03	Stockpile Fines #9	25 yd^3
0100-96-0858	8-May-96	NR	NR	NR	7.5	5	180	0.6	36	4	ND	0.03	Stockpile Fines #10	25 yd^3
0100-96-0859	8-May-96	NR	NR	NR	7.1	5	69	0.6	35	4	ND	0.03	Stockpile Fines #11	25 yd^3
0100-96-0860	8-May-96	NR	NR	NR	9.3	5	82	0.6	36	4	3	0.03	Stockpile Fines #12	25 yd^3
0100-96-0861	8-May-96	NR	NR	NR	8.1	5	340	0.6	35	4	ND	0.03	Stockpile Fines #13	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-0862	8-May-96	NR	NR	NR	7.8	5	75	0.6	38	4	ND	0.03	Stockpile Fines #14	25 yd^3
0100-96-0863	8-May-96	NR	NR	NR	7.5	5	65	0.6	35	4	8	0.03	Stockpile Fines #15	25 yd^3
0100-96-0864	15-May-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #12	25 yd^3
0100-96-0865	15-May-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #15	25 yd^3
0100-96-0876	6-Jun-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Sample from soil on liner after removal	25 yd^3
0100-96-1651	1-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.24	0.03	Stockpile Fines #16	25 yd^3
0100-96-1652	6-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.04	0.03	Stockpile Fines #17	25 yd^3
0100-96-1653	6-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.09	0.03	Stockpile Fines #18	25 yd^3
0100-96-1654	6-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.05	0.03	Stockpile Fines #19	25 yd^3
0100-96-1655	6-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.06	0.03	Stockpile Fines #20	25 yd^3
0100-96-1656	6-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.07	0.03	Stockpile Fines #21	25 yd^3
0100-96-1657	6-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.17	0.03	Stockpile Fines #22	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-1658	7-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.03	0.03	Stockpile Fines #23	25 yd^3
0100-96-1659	7-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.2	0.03	Stockpile Fines #24	25 yd^3
0100-96-1660	7-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.16	0.03	Stockpile Fines #25	25 yd^3
0100-96-1661	7-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	3	0.03	Stockpile Fines #26	25 yd^3
0100-96-1662	7-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.06	0.03	Sediment from W. end of S. pond	25 yd^3
0100-96-1663	8-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.04	0.03	Stockpile Fines #27	25 yd^3
0100-96-1664	8-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.09	0.03	Stockpile Fines #28	25 yd^3
0100-96-1665	8-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.04	0.03	Stockpile Fines #29	25 yd^3
0100-96-1666	8-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.1	0.03	Stockpile Fines #30	25 yd^3
0100-96-1667	8-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.11	0.03	Stockpile Fines #31	25 yd^3
0100-96-1668	8-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.9	0.03	Stockpile Fines #32	25 yd^3
0100-96-1669	8-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.06	0.03	Stockpile Fines #33	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-1670	8-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.05	0.03	Stockpile Fines #34	25 yd^3
0100-96-1671	8-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #35	25 yd^3
0100-96-1672	8-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.8	0.03	Stockpile Fines #36	25 yd^3
0100-96-1673	8-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.04	0.03	Stockpile Fines #37	25 yd^3
0100-96-1674	8-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.2	0.03	Stockpile Fines #38	25 yd^3
0100-96-1675	9-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.09	0.03	Stockpile Fines #39	25 yd^3
0100-96-1676	9-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	2	0.03	Stockpile Fines #40	25 yd^3
0100-96-1677	9-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.59	0.03	Stockpile Fines #41	25 yd^3
0100-96-1678	12-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	3.9	0.03	Stockpile Fines #42	25 yd^3
0100-96-1679	12-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.11	0.03	Stockpile Fines #43	25 yd^3
0100-96-1680	12-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.2	0.03	Stockpile Fines #44	25 yd^3
0100-96-1681	12-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	4.2	0.03	Stockpile Fines #45	25 yd^3
0100-96-1682	12-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.7	0.03	Stockpile Fines #46	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-1683	12-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	2.4	0.03	Stockpile Fines #47	25 yd^3
0100-96-1684	12-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	5.2	0.03	Stockpile Fines #48	25 yd^3
0100-96-1685	12-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.91	0.03	Stockpile Fines #49	25 yd^3
0100-96-1686	12-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	3.5	0.03	Stockpile Fines #50	25 yd^3
0100-96-1687	12-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	3	0.03	Stockpile Fines #51	25 yd^3
0100-96-1688	13-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	4.3	0.03	Stockpile Fines #52	25 yd^3
0100-96-1689	13-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	3.8	0.03	Stockpile Fines #53	25 yd^3
0100-96-1690	13-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	2.1	0.03	Stockpile Fines #54	25 yd^3
0100-96-1691	13-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	2.7	0.03	Stockpile Fines #55	25 yd^3
0100-96-1692	13-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.2	0.03	Stockpile Fines #56	25 yd^3
0100-96-1693	13-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.56	0.03	Stockpile Fines #57	25 yd^3
0100-96-1694	13-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.2	0.03	Stockpile Fines #58	25 yd^3
0100-96-1695	13-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	2.8	0.03	Stockpile Fines #59	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-1696	13-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.83	0.03	Stockpile Fines #60	25 yd^3
0100-96-1697	13-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	2.1	0.03	Stockpile Fines #61	25 yd^3
0100-96-1698	13-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.34	0.03	Stockpile Fines #62	25 yd^3
0100-96-1699	14-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	South pond backfill material	25 yd^3
0100-96-1700	14-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.99	0.03	Stockpile Fines #63	25 yd^3
0100-96-1701	14-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.5	0.03	Stockpile Fines #64	25 yd^3
0100-96-1702	14-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.15	0.03	Stockpile Fines #65	25 yd^3
0100-96-1703	14-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.47	0.03	Stockpile Fines #66	25 yd^3
0100-96-1704	14-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.34	0.03	Stockpile Fines #67	25 yd^3
0100-96-1705	14-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.6	0.03	Stockpile Fines #68	25 yd^3
0100-96-1706	14-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.25	0.03	Stockpile Fines #69	25 yd^3
0100-96-1707	14-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.13	0.03	Stockpile Fines #70	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-1708	14-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.14	0.03	Stockpile Fines #71	25 yd^3
0100-96-1709	14-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.25	0.03	Stockpile Fines #72	25 yd^3
0100-96-1710	14-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.56	0.03	Stockpile Fines #73	25 yd^3
0100-96-1711	14-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.19	0.03	Stockpile Fines #74	25 yd^3
0100-96-1712**	14-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	8.4**	0.03	Stockpile Fines #75	25 yd^3
0100-96-1712*	14-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.32	0.03	Stockpile Fines #75 Reanalysis	25 yd^3
0100-96-1712*	14-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.33	0.03	Stockpile Fines #75 Reanalysis	25 yd^3
0100-96-1713	15-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.93	0.03	Stockpile Fines #76	25 yd^3
0100-96-1714**	15-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	15**	0.03	Stockpile Fines #77	25 yd^3
0100-96-1714*	15-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1	0.03	Stockpile Fines #77 Reanalysis	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-1714*	15-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1	0.03	Stockpile Fines #77 Reanalysis	25 yd^3
0100-96-1715	15-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.4	0.03	Stockpile Fines #78	25 yd^3
0100-96-1716	15-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.47	0.03	Stockpile Fines #79	25 yd^3
0100-96-1717	15-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.88	0.03	Stockpile Fines #80	25 yd^3
0100-96-1718	15-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.94	0.03	Stockpile Fines #81	25 yd^3
0100-96-1719	15-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.56	0.03	Stockpile Fines #82	25 yd^3
0100-96-1720	15-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	2.7	0.03	Stockpile Fines #83	25 yd^3
0100-96-1721	15-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.93	0.03	Stockpile Fines #84	25 yd^3
0100-96-1722**	15-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	9.2**	0.03	Stockpile Fines #85	25 yd^3
0100-96-1722*	15-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.5	0.03	Stockpile Fines #85 Reanalysis	25 yd^3
0100-96-1722*	15-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.5	0.03	Stockpile Fines #85 Reanalysis	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-1723**	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	78**	0.03	Stockpile Fines #86	25 yd^3
0100-96-1723*	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.56	0.03	Stockpile Fines #86 Reanalysis	25 yd^3
0100-96-1723*	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.57	0.03	Stockpile Fines #86 Reanalysis	25 yd^3
0100-96-1724	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.6	0.03	Stockpile Fines #87	25 yd^3
0100-96-1725	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.95	0.03	Stockpile Fines #88	25 yd^3
0100-96-1726**	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	13**	0.03	Stockpile Fines #89	25 yd^3
0100-96-1726*	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	2.2	0.03	Stockpile Fines #89 Reanalysis	25 yd^3
0100-96-1726*	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	2.2	0.03	Stockpile Fines #89 Reanalysis	25 yd^3
0100-96-1727	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.38	0.03	Stockpile Fines #90	25 yd^3
0100-96-1728	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.92	0.03	Stockpile Fines #91	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-1729	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.8	0.03	Stockpile Fines #92	25 yd^3
0100-96-1730	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.88	0.03	Stockpile Fines #93	25 yd^3
0100-96-1731	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.3	0.03	Stockpile Fines #94	25 yd^3
0100-96-1732	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.55	0.03	Stockpile Fines #95	25 yd^3
0100-96-1733	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.59	0.03	Stockpile Fines #96	25 yd^3
0100-96-1734	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.3	0.03	Stockpile Fines #97	25 yd^3
0100-96-1735	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.38	0.03	Stockpile Fines #98	25 yd^3
0100-96-1736	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	4.1	0.03	Stockpile Fines #99	25 yd^3
0100-96-1737	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.86	0.03	Stockpile Fines #100	25 yd^3
0100-96-1738	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.30	0.03	Stockpile Fines #101	25 yd^3
0100-96-1739	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.19	0.03	Stockpile Fines #102	25 yd^3
0100-96-1740	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.10	0.03	Stockpile Fines #103	25 yd^3
0100-96-1741	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.54	0.03	Stockpile Fines #104	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-1742	16-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.24	0.03	Stockpile Fines #105	25 yd^3
0100-96-1743	19-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.10	0.03	Stockpile Fines #106	25 yd^3
0100-96-1744	19-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.38	0.03	Stockpile Fines #107	25 yd^3
0100-96-1745	19-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.80	0.03	Stockpile Fines #108	25 yd^3
0100-96-1746**	19-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	7.2**	0.03	Stockpile Fines #109	25 yd^3
0100-96-1746*	19-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.80	0.03	Stockpile Fines #109 Reanalysis	25 yd^3
0100-96-1746*	19-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.80	0.03	Stockpile Fines #109 Reanalysis	25 yd^3
0100-96-1747	19-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.10	0.03	Stockpile Fines #110	25 yd^3
0100-96-1748	19-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	3.00	0.03	Stockpile Fines #111	25 yd^3
0100-96-1749	19-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.70	0.03	Stockpile Fines #112	25 yd^3
0100-96-1750	19-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	3.20	0.03	Stockpile Fines #113	25 yd^3
0100-96-1771	19-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	3.00	0.03	Stockpile Fines #114	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-1772	19-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	4.50	0.03	Stockpile Fines #115	25 yd^3
0100-96-1773	19-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.78	0.03	Stockpile Fines #116	25 yd^3
0100-96-1774	20-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.1	0.03	Stockpile Fines #117	25 yd^3
0100-96-1775	20-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1	0.03	Stockpile Fines #118	25 yd^3
0100-96-1776	20-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.6	0.03	Stockpile Fines #119	25 yd^3
0100-96-1777	20-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.68	0.03	Stockpile Fines #120	25 yd^3
0100-96-1778	20-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	4.3	0.03	Stockpile Fines #121	25 yd^3
0100-96-1779	20-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.21	0.03	Stockpile Fines #122	25 yd^3
0100-96-1780	20-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.19	0.03	Stockpile Fines #123	25 yd^3
0100-96-1781	20-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.35	0.03	Stockpile Fines #124	25 yd^3
0100-96-1782*	20-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.8	0.03	Re-sample of Stockpile Fines #48	25 yd^3
0100-96-1783*	20-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.08	0.03	Re-sample of Stockpile Fines #48	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-1784	21-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.63	0.03	Stockpile Fines #125	25 yd^3
0100-96-1785	21-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.12	0.03	Stockpile Fines #126	25 yd^3
0100-96-1786	21-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #127	25 yd^3
0100-96-1787	21-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #128	25 yd^3
0100-96-1788	21-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #129	25 yd^3
0100-96-1789	21-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #130	25 yd^3
0100-96-1790	21-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #131	25 yd^3
0100-96-1791	21-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #132	25 yd^3
0100-96-1792	21-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.19	0.03	Stockpile Fines #133	25 yd^3
0100-96-1793	21-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #134	25 yd^3
0100-96-1800	22-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #135	25 yd^3
0100-96-1800*	22-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #135 Reanalysis	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-1801	22-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #136	25 yd^3
0100-96-1801*	22-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #136 Reanalysis	25 yd^3
0100-96-1802	23-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #137	25 yd^3
0100-96-1802*	23-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #137 Reanalysis	25 yd^3
0100-96-1803	23-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #138	25 yd^3
0100-96-1803*	23-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #138 Reanalysis	25 yd^3
0100-96-1804	23-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.79	0.03	Stockpile Fines #139	25 yd^3
0100-96-1804*	23-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.79	0.03	Stockpile Fines #139 Reanalysis	25 yd^3
0100-96-1805	26-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	5.3	0.03	Stockpile Fines #140	25 yd^3
0100-96-1805*	26-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	5.2	0.03	Stockpile Fines #140 Reanalysis	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-1806	27-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.13	0.03	Stockpile Fines #141	25 yd^3
0100-96-1806*	27-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.13	0.03	Stockpile Fines #141 Reanalysis	25 yd^3
0100-96-1807	27-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.77	0.03	Stockpile Fines #142	25 yd^3
0100-96-1807*	27-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.76	0.03	Stockpile Fines #142 Reanalysis	25 yd^3
0100-96-1808	27-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.25	0.03	Stockpile Fines #143	25 yd^3
0100-96-1808*	27-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.25	0.03	Stockpile Fines #143 Reanalysis	25 yd^3
0100-96-1809	27-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.22	0.03	Stockpile Fines #144	25 yd^3
0100-96-1809*	27-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.22	0.03	Stockpile Fines #144 Reanalysis	25 yd^3
0100-96-1810	27-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.84	0.03	Stockpile Fines #145	25 yd^3
0100-96-1810*	27-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.85	0.03	Stockpile Fines #145 Reanalysis	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-1811	28-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	1.2	0.03	Stockpile Fines #146	25 yd^3
0100-96-1812	28-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.04	0.03	Stockpile Fines #147	25 yd^3
0100-96-1813	28-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.38	0.03	Stockpile Fines #148	25 yd^3
0100-96-1814	29-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.19	0.03	Stockpile Fines #149	25 yd^3
0100-96-1815	29-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.14	0.03	Stockpile Fines #150	25 yd^3
0100-96-1816	29-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.12	0.03	Stockpile Fines #151	25 yd^3
0100-96-1817**	30-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	11**	0.03	Stockpile Fines #152	25 yd^3
0100-96-1817*	30-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.06	0.03	Stockpile Fines #152 Reanalysis	25 yd^3
0100-96-1817*	30-Aug-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.17	0.03	Stockpile Fines #152 Reanalysis	25 yd^3
0100-96-1818	3-Sep-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.12	0.03	Stockpile Fines #153	25 yd^3
0100-96-1819	4-Sep-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	2.4	0.03	Stockpile Fines #154	25 yd^3
0100-96-1820	4-Sep-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.36	0.03	Stockpile Fines #155	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-96-1821	5-Sep-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.1	0.03	Stockpile Fines #156	25 yd^3
0100-96-1822	5-Sep-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.06	0.03	Stockpile Fines #157	25 yd^3
0100-96-1823	5-Sep-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	15	0.03	Stockpile Fines #158	25 yd^3
0100-96-1824	5-Sep-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.23	0.03	Stockpile Fines #159	25 yd^3
0100-96-1825	5-Sep-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.19	0.03	Stockpile Fines #160	25 yd^3
0100-96-1826	30-Sep-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.662	0.03	Stockpile Fines #161	25 yd^3
0100-96-1827	30-Sep-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.231	0.03	Stockpile Fines #162	25 yd^3
0100-96-1870	16-Oct-96	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.861	0.03	Pine needles remaining in dumpster	Included in the 60 yd^3 above
0100-97-0001	23-Jan-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	1	0.03	Stockpile Fines #163	25 yd^3
0100-97-0002	23-Jan-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #164	25 yd^3
0100-97-0003	23-Jan-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	2	0.03	Stockpile Fines #165	25 yd^3
0100-97-0004	27-Jan-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	21	0.03	Stockpile Fines #166	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-97-0005	27-Jan-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #167	25 yd^3
0100-97-0006	27-Jan-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #168	25 yd^3
0100-97-0007	30-Jan-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #169	25 yd^3
0100-97-0008	30-Jan-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #170	25 yd^3
0100-97-0009	30-Jan-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #171	25 yd^3
0100-97-0010	6-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #172	25 yd^3
0100-97-0011	6-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #173	25 yd^3
0100-97-0012	6-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #174	25 yd^3
0100-97-0013	6-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	3	0.03	Stockpile Fines #175	25 yd^3
0100-97-0014	6-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #176	25 yd^3
0100-97-0015	11-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	2	0.03	Stockpile Fines #177	25 yd^3
0100-97-0016	11-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	1	0.03	Stockpile Fines #178	25 yd^3
0100-97-0017	11-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #179	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-97-0018	11-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #180	25 yd^3
0100-97-0019	13-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #181	25 yd^3
0100-97-0020	13-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #182	25 yd^3
0100-97-0021	13-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	2	0.03	Stockpile Fines #183	25 yd^3
0100-97-0022	13-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	2	0.03	Stockpile Fines #184	25 yd^3
0100-97-0023	13-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	2	0.03	Stockpile Fines #185	25 yd^3
0100-97-0024	18-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #186	25 yd^3
0100-97-0025	18-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	2	0.03	Stockpile Fines #187	25 yd^3
0100-97-0026	18-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #188	25 yd^3
0100-97-0027	24-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	2	0.03	Stockpile Fines #189	25 yd^3
0100-97-0028	24-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	1	0.03	Stockpile Fines #190	25 yd^3
0100-97-0029	24-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	2	0.03	Stockpile Fines #191	25 yd^3
0100-97-0030	24-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	1	0.03	Stockpile Fines #192	25 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-97-0031	24-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	2	0.03	Stockpile Fines #193	25 yd^3
0100-97-0032	24-Feb-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #194	25 yd^3
0100-97-0033	6-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	4^S	0.03	Stockpile Fines #195	25 yd^3
0100-97-0034	6-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #196	25 yd^3
0100-97-0035	6-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	110	0.03	Stockpile Fines #197	25 yd^3
0100-97-0036	6-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Fines #198	25 yd^3
0100-97-0037	18-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	270	0.03	Stockpile Gravel #1	7 yd^3
0100-97-0038	18-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	10	0.03	Stockpile Gravel #2	7 yd^3
0100-97-0039	18-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	54	0.03	Stockpile Gravel #3	7 yd^3
0100-97-0040	18-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	39	0.03	Stockpile Gravel #4	7 yd^3
0100-97-0041	18-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	3	0.03	Stockpile Gravel #5	7 yd^3
0100-97-0042	18-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	5.5^S	0.03	Stockpile Gravel #6	7 yd^3
0100-97-0043	18-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	110	0.03	Stockpile Gravel #7	7 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-97-0044	18-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	48	0.03	Stockpile Gravel #8	7 yd^3
0100-97-0045	25-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	250	0.03	Stockpile Gravel #9	7 yd^3
0100-97-0046	25-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	75	0.03	Stockpile Gravel #10	7 yd^3
0100-97-0047	25-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Gravel #11	7 yd^3
0100-97-0048	25-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Stockpile Gravel #12	7 yd^3
0100-97-0049	25-Mar-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	290	0.03	Stockpile Gravel #13	7 yd^3
0100-97-0050	2-Apr-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Range Floor Scrapings #1	20 yd^3
0100-97-0051	2-Apr-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	280	0.03	Range Floor Scrapings #2	30 yd^3
0100-97-0052	2-Apr-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Range Floor Scrapings #3	20 yd^3
0100-97-0053	2-Apr-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Range Floor Scrapings #4	20 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
0100-97-0054	2-Apr-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Range Floor Scrapings #5	20 yd^3
0100-97-0055	2-Apr-97	NR	NR	NR	NR	NA	NR	NA	NR	NA	ND	0.03	Range Floor Scrapings #6	20 yd^3
AAA6260	18-May-94	<36	61J	39J	ND	5	46	0.6	22	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAA6260*	18-May-94	NR	NR	NR	ND	5	66	0.6	13	4	NR	NA	Duplicate Analysis	125 yd^3
AAA6261	23-May-94	<36	92	66J	8.7	5	260	0.6	19	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAA6261*	23-May-94	NR	NR	NR	9.2	5	76	0.6	24	4	NR	NA	Duplicate Analysis	125 yd^3
AAA6262	24-May-94	<36	61J	38J	6.5	5	41	0.6	16	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAA6262*	24-May-94	NR	NR	NR	5.3	5	5	0.6	39	4	NR	NA	Duplicate Analysis	125 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
AAA6263	26-May-94	<36	66	<36	5.4	5	22	0.6	18	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAA6263*	26-May-94	NR	NR	NR	5.1	5	33	0.6	16	4	NR	NA	Duplicate Analysis	125 yd^3
AAA6264	6-Jun-94	<36	73	52J	ND	5	58	0.6	20	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAA6264*	6-Jun-94	NR	NR	NR	5.3	5	66	0.6	23	4	NR	NA	Duplicate Analysis	125 yd^3
AAA6265	16-May-94	<36	94	47J	ND	5	65	0.6	18	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAA6266	6-Jun-94	<36	83	92J	ND	5	65	0.6	20	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAA6267	27-Jun-94	<36	163	77J	5.4	5	160	0.6	26	4	NR	NA	Composite Processed Soil Sample	125 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
AAA6267*	27-Jun-94	NR	NR	NR	ND	5	130	0.6	22	4	NR	NA	Duplicate Analysis	125 yd^3
AAA6268	27-Jun-94	<36	268	41J	6	5	130	0.6	24	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAA6269	5-Jul-94	<36	144	68J	ND	5	340	0.6	22	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAA6269*	5-Jul-94	<36	86	73J	6.1	5	110	0.6	25	4	NR	NA	Duplicate Analysis	125 yd^3
AAA6270	11-Jul-94	<36	76	52J	12	5	46	0.6	29	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAA6271	12-Jul-94	<36	187	51J	9.8	5	100	0.6	27	4	NR	NA	Composite Pond Sediment	900,000 gallons for all pond work
AAA6279	24-Jul-94	<36	92	68J	ND	5	150	0.6	17	4	0.85	0.03	Composite Processed Soil Sample	125 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
AAA6279*	24-Jul-94	<36	NR	NR	140	5	150	0.6	30	4	0.91	0.03	Duplicate Analysis	125 yd^3
AAA6280	24-Jul-94	<36	87	<36	ND	5	200	0.6	22	4	0.69	0.03	Composite Processed Soil Sample	125 yd^3
AAA6281	24-Jul-94	<36	77	36J	ND	5	81	0.6	16	4	0.2	0.03	Composite Processed Soil Sample	125 yd^3
AAA6282	24-Jul-94	<36	65	51J	ND	5	100	0.6	15	4	0.11	0.03	Composite Processed Soil Sample	125 yd^3
AAA6283	24-Jul-94	<36	89	68J	ND	5	150	0.6	21	4	1.5	0.03	Composite Processed Soil Sample	125 yd^3
AAA6284	24-Jul-94	<36	81	53J	5	5	140	0.6	20	4	1.3	0.03	Composite Processed Soil Sample	125 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
AAA6669	12-Jul-94	<36	163	109J	9.8	5	60	0.6	28	4	NR	NA	Composite Pond Slurry Sample	900,000 gallons for all pond work
AAA6669*	12-Jul-94	NR	NR	NR	9.8	5	58	0.6	27	4	NR	NA	Duplicate Analysis	900,000 gallons for all pond work
AAA6670	13-Jul-94	41J	356	98J	NR	NA	99	0.6	NR	NA	0.95	0.03	South Pond Sediment Grab Sample	900,000 gallons for all pond work
AAA6671	6-Jul-94	<36	268	66J	NR	NA	310	0.6	NR	NA	6.6	0.03	Composite Processed Soil Sample	125 yd^3
AAA6671*	6-Jul-94	NR	NR	NR	NR	NA	NR	0.6	NR	NA	6.6	0.03	Duplicate Analysis	125 yd^3
AAA6672	18-Jul-94	<36	72	42J	ND	5	59	0.6	30	4	1.3	0.03	Composite Processed Soil Sample	125 yd^3
AAA6672*	18-Jul-94	<36	85	54J	ND	5	69	0.6	25	4	0.37	0.03	Duplicate Analysis	125 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
AAA6673	22-Jul-94	<36	73	81J	ND	5	150	0.6	28	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAA6674	24-Jul-94	<36	46J	58J	ND	5	140	0.6	15	4	0.25	0.03	Composite Processed Soil Sample	125 yd^3
AAA6675	24-Jul-94	<36	46J	88J	ND	5	45	0.6	20	4	0.03	0.03	Composite Processed Soil Sample	125 yd^3
AAA6676	24-Jul-94	<36	91	64J	13	5	85	0.6	17	4	0.27	0.03	Composite Processed Soil Sample	125 yd^3
AAA6698	23-Jul-94	<36	167	100J	9.7	5	150	0.6	44	4	0.28	0.03	South pond sediment	900,000 gallons for all pond work
AAA6699	23-Jul-94	<36	241	132	15	5	290	0.6	60	4	0.44	0.03	South pond sediment	900,000 gallons for all pond work

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
AAA6700	23-Jul-94	<36	311	113J	15	5	260	0.6	79	4	0.3	0.03	South pond sediment	900,000 gallons for all pond work
AAB2413	11-Aug-94	<36	95	41J	ND	5	660	0.6	22	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAB2413*	11-Aug-94	<36	60	<36	NR	NA	125	0.6	NR	NA	NR	NA	Duplicate Analysis	125 yd^3
AAB2414	11-Aug-94	<36	105	68J	ND	5	81	0.6	24	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAB2414*	11-Aug-94	<36	92	74J	ND	5	160	0.6	31	4	NR	NA	Duplicate Analysis	125 yd^3
AAB2418	31-Aug-94	<36	84	60J	ND	5	110	0.6	17	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAB2418*	31-Aug-94	<36	79	47J	NR	NA	NR	NA	NR	NA	NR	NA	Duplicate Analysis	125 yd^3
AAB2419	31-Aug-94	<36	123	63J	NR	NA	NR	NA	NR	NA	0.39	0.03	Composite Pond Slurry Sample	900,000 gallons900,000 gallons for all pond work

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
AAB2419*	31-Aug-94	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.43	0.03	Duplicate Analysis	900,000 gallons900,000 gallons for all pond work
AAB2420	8-Sep-94	<36	118	108J	NR	NA	NR	NA	NR	NA	0.13	0.03	Composite Pond Slurry Sample	900,000 gallons900,000 gallons for all pond work
AAB2420*	8-Sep-94	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.13	0.03	Duplicate Analysis	900,000 gallons for all pond work
AAB2421	8-Sep-94	<36	76	84J	5.3	5	110	0.6	33	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAB2421*	8-Sep-94	<36	91	50J	5.4	5	81	0.6	31	4	NR	NA	Duplicate Analysis	125 yd^3
AAB2422	9-Sep-94	<36	55J	83J	ND	5	90	0.6	28	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAB2422*	9-Sep-94	<36	43J	105J	NR	NA	NR	NA	NR	NA	NR	NA	Duplicate Analysis	125 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
AAB2423	13-Sep-94	<36	46J	54J	ND	5	400	0.6	29	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAB2423*	13-Sep-94	<36	86	104J	ND	5	110	0.6	29	4	NR	NA	Duplicate Analysis	125 yd^3
AAB2427	15-Sep-94	<36	70	83J	ND	5	51	0.6	31	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAB2427*	15-Sep-94	<36	50J	59J	ND	5	70	0.6	29	4	NR	NA	Duplicate Analysis	125 yd^3
AAB2428	15-Sep-94	<36	160	115J	NR	NA	NR	NA	NR	NA	NR	NA	Composite Pond Slurry Sample	900,000 gallons for all pond work
AAB2429	19-Sep-94	<36	61J	76J	ND	5	89	0.6	39	4	140	0.03	Composite Processed Soil Sample	125 yd^3
AAB2429*	19-Sep-94	47J	50J	60J	NR	NA	NR	NA	NR	NA	130	0.03	Duplicate Analysis	125 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
AAB2430	20-Sep-94	54J	39J	69J	5.5	5	73	0.6	40	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAB2430*	20-Sep-94	<36	45J	73J	ND	5	66	0.6	41	4	NR	NA	Duplicate Analysis	125 yd^3
AAB2431	20-Sep-94	<36	63	89J	NR	NA	NR	NA	NR	NA	0.17	0.03	South Pond Sediment Sample	900,000 gallons for all pond work
AAB2431*	20-Sep-94	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.11	0.03	Duplicate Analysis	900,000 gallons for all pond work
AAB2432	20-Sep-94	NR	NR	NR	ND	5	ND	0.6	ND	4	NR	NA	South Pond Sediment Sample	900,000 gallons for all pond work
AAB3545	22-Sep-94	<36	45J	35J	ND	5	24	0.6	17	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAB3546	27-Sep-94	<36	40	76J	ND	5	34	0.6	17	4	ND	0.03	South Pond Sediment Sample	900,000 gallons for all pond work

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
AAB3547	27-Sep-94	<36	44	74J	ND	5	ND	0.6	ND	4	NR	NA	South Pond Sediment Sample	900,000 gallons for all pond work
AAB3548	27-Sep-94	<36	30J	67J	ND	5	34	0.6	17	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAB3549	28-Sep-94	<36	18J	60	ND	5	60	0.6	29	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAB3550	28-Sep-94	<36	57J	62J	ND	5	44	0.6	46	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAB3550*	28-Sep-94	NR	NR	NR	ND	5	54	0.6	21	4	NR	NA	Duplicate Analysis	125 yd^3
AAB3551	5-Oct-94	<36	55J	27J	ND	5	22	0.6	19	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAB3551*	5-Oct-94	NR	NR	NR	ND	5	50	0.6	20	4	NR	NA	Duplicate Analysis	125 yd^3

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
AAB3552	5-Oct-94	<36	75	99J	NR	NA	NR	NA	NR	NA	0.24	0.03	South Pond Sediment Sample	900,000 gallons for all pond work
AAB3552*	5-Oct-94	NR	NR	NR	NR	NA	NR	NA	NR	NA	0.127	0.03	Duplicate Analysis	900,000 gallons for all pond work
AAB3553	5-Oct-94	<36	65	83J	ND	5	ND	0.6	ND	4	NR	NA	South Pond Sediment Sample	900,000 gallons for all pond work
AAB3554	7-Oct-94	<36	64J	44J	ND	5	110	0.6	42	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAB3555	11-Oct-94	<36	85	93J	NR	NA	NR	NA	NR	NA	NR	NA	South Pond Sediment Sample	900,000 gallons for all pond work
AAB3555*	11-Oct-94	NR	NR	NR	NR	NA	NR	NA	NR	NA	NR	NA	Duplicate Analysis	900,000 gallons for all pond work
AAB3556	11-Oct-94	<36	68	62J	NR	NA	NR	NA	NR	NA	<0.03	0.03	South Pond Sediment Sample	900,000 gallons for all pond work

		XRF			Total Analysis by ICPES or GFAA						TCLP Analysis By ICPES			
Sample ID	Sample Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cu (ppm) SAL = 2800 mg/kg	Total Cu Estimated Detection Limit (mg/kg)	Pb (ppm) SAL = 400 mg/kg	Total Pb Estimated Detection Limit (mg/kg)	Zn (ppm) SAL = 23000 mk/kg	Total Zn Estimated Detection Limit (mg/kg)	Pb (ppm) RCRA Limit = 5 mg/L	Estimated Detection Limit TCLP Lead (mg/L)	Comments	Volume
AAB3558	13-Oct-94	NR	NR	NR	ND	5	38	0.6	30	4	NR	NA	Composite Processed Soil Sample	125 yd^3
AAB3558*	13-Oct-94	NR	NR	NR	ND	5	41	0.6	16	4	NR	NA	Duplicate Analysis	125 yd^3

A = Hazardous Disposal
B = Removal to TA-72 as Berm Material for Firing Range
C = Removal to Barrow Pit at TA 53
D = Removal for Road Fill Material
*Sample Reanalysis
**Based on duplicate sample results and reanalysis of sample material, this value is apparently erroneous

TABLE 4

CROSS-WALK BETWEEN NMED COMMENTS AND LANL RESPONSES

NMED Comment	LANL Response
1. LANL should revise this report...	LANL has revised the report.
2. ...nature and extent are not adequately characterized.	Section 3.4 Confirmatory Sampling, and 3.6.1 Nature and Extent, of the revised report address nature and extent.
3. ...present ...screening and fixed laboratory analytical results for ...each portion of the VCA investigation	Table D-2 and D-3, Appendix D, of the revised report presents screening and fixed laboratory analytical results for each portion of the VCA investigation.
4. LANL should have first determined the horizontal and vertical extent of contamination relative to background values.	Explanation of the process followed is presented in the LANL Response below comment number 4. Section 3.6.1 Nature and Extent of the revised report, discusses the determination of both vertical and horizontal extent.
5. LANL must also consider the ecological impacts of the contaminants remaining at this PRS.	Section 3.7.3 Ecological Screening Assessment of the revised report considers the ecological impacts.
6. No response required	No response formulated.
7. LANL should provide the surficial area of the range floor, back area and drainage; the estimated volume of each of the berms; and the estimated volume of contaminated soil in the back area and range floor.	This information is provided in Section 2.2.1 Site Description of the revised report.
8. LANL should present a summary of the analytical results of the 1991 Forest Service study...	Section 2.3.2 Previous Investigations of the revised report presents this data.
9. LANL should include the USDA Forest Service Memorandum 7400...	Appendix G-2.0 of the revised report contains the USDA Forest Service Memorandum 7400.
10. LANL should clarify how correlating XRF results with metal detector responses establishes a correlation between metal detector responses and total lead concentrations.	Section 3.2 Screening Methods Used to Guide Remediation in the revised report provides this clarification.
11. LANL failed to perform full suite analyses for target analyte list (TAL).	The LANL response provides a table of samples that were analyzed for full suite analyses for target analyte list.
12. LANL inappropriately used PRGs as cleanup levels...	Section 3.1 Cleanup Levels of the revised report presents site-specific cleanup levels and their calculation is present in Appendix F-1.

TABLE 4

CROSS-WALK BETWEEN NMED COMMENTS AND LANL RESPONSES (Continued)

NMED Comment	LANL Response
13. LANL should indicate the volume and the intended/final disposition of these recirculation pond sediments.	Section 3.3.1 Soil Washing Operations of the revised report presents this information.
14. LANL should clarify the volume and the intended/final disposition of these washed soils which were transported off-site.	Section 3.3.1 Soil Washing Operations of the revised report presents this information.
15. LANL should clarify the disposition of the lead fines...	The clarification is provided in the LANL response directly following the NMED comment and in Section 3.3.3 Shaker Plant Operations in the revised report.
16. LANL should revise Table 3.3-1	Table D-3 in Appendix D of the revised report replaces Table 3.3-1 of the original report
17. LANL should resample these areas.	Appendix C of the revised report discusses the qualification of data.
18. LANL omitted Figure 3.3.3-1 and Table 3.3.3-1	The original report referenced Figure 3.3-1 which was included in the original report on page 16. The original report referenced Table 3.3.3-1 which was not included. Table D-2 in Appendix D in the revised report presents data that would have been in Table 3.3.3-1.
19. LANL should submit a complete data set.	Appendix D presents a complete data set.
20. Table A-1 does not include the request number and the text fails to provide the sample location/identification numbers	All tables now have the requested information.
21. ...a correlation between sample location/identification numbers and area being investigated cannot be made.	Sample location numbers are provided in the revised report for both figures and tables.
22. LANL should clarify what is meant by this endnote indicator.	Explanation is provided in the LANL Response directly following NMED comment 22.
23. LANL does not discuss the number or location of the stockpiles for which analytical results are presented	Explanation is provided in the LANL Response directly following NMED comment 23 and in Section 3.3.1 Soil Washing Operations of the revised report.
24. LANL should include a date of sampling or other unique identifier to distinguish between the many samples...	Explanation is provided in the LANL Response directly following NMED comment 24.
25. LANL should clarify which samples required the "***" endnote...	Tables in Appendix D of the revised report has this data appropriately marked.

TABLE 4

CROSS-WALK BETWEEN NMED COMMENTS AND LANL RESPONSES (Cont.)

NMED Comment	LANL Response
26. LANL should clarify the analytical methods for both of these columns.	Tables in Appendix D of the revised report has this data added into it.
27. LANL should provide the method detection limits for the analyses conducted.	Tables in Appendix D of the revised report has this data added into it.

Voluntary Corrective Action Completion Report

Solid Waste Management Unit

0-016

Former Small-Arms Range

ENVIRONMENTAL RESTORATION PROJECT

November 1998
Revision 1

A Department of Energy
Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY
LA-UR-97-2745

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EXECUTIVE SUMMARY

Background

PRS 0-016, a former small arms firing range owned by the USDA Forest Service, is located west of the Guaje Pines Cemetery in Rendija Canyon. Access to the site is via a gravel road that extends from the end of Range Road at the cemetery. The former range is a site where the terrain varies from relatively flat on the ridge top to steep grades at the edges that are associated with the valley walls. The ridge lies between two small valleys that converge about one-quarter mile to the east. The ephemeral streams in these valleys feed into the upper end of Rendija Canyon and are associated with snowmelt runoff in the spring and localized thunderstorms during the summer.

The firing range covered approximately two acres and consisted of two target areas (eastern and western) separated by a central longitudinal berm. Each of the target areas had several firing lanes each with bullets being fired in a northwest direction. Backstop berms and longitudinal berms ranged from 30 to 50 feet wide and 8 to 15 feet high. The eastern and western target areas measured approximately 215 feet and 142 feet deep from the firing points to the base of the backstop berms, respectively.

The firing range was constructed for Atomic Energy Commission (AEC) security forces use on United States Department of Agriculture (USDA) Forest Service land sometime after January 1947, when control of all Manhattan Project sites was transferred to the AEC. Security forces for the laboratory used the range for small arms target practice until it was abandoned in the early 1960s. There are no records of the basic operational activities, maintenance activities, cleaning and storage of equipment, or waste management practices at PRS 0-016 during operations by the AEC. The Department of Energy (DOE) returned PRS 0-016 and surrounding areas to the USDA Forest Service in 1976. The general public used the site for recreational shooting until VCA activities were initiated in 1992. Current ownership remains with the USDA Forest Service until a land exchange between the USDA Forest Service and a private developer is completed. Pending completion of the land exchange, the site is currently being used as a construction equipment and materials storage area by the private developer. After completion of the land exchange, the site will be developed for residential housing.

The USDA Forest Service conducted a study of PRS 0-016 in 1991 that included lead analyses. A total of 21 soil samples were collected from the surface of the backstops and other berms. The soil samples results for lead were between 20 – 156,100 mg/kg. Contamination was attributed to the presence of abundant lead bullets on the surface of the earthen berms (USDA 1992, ER ID

59597). In September of 1992, the USDA Forest Service contacted the DOE in regard to remediation of the site to appropriate residential levels (USDA 1992a, ER ID 09803.3). LANL ER agreed to the request and developed a remediation plan which was agreed to by the USDA Forest Service (USDA 1992b, ER ID). The project was verbally approved by the NMED and EPA at a meeting in May of 1993 (LANL 1993, ER ID 29898).

Remedial Activities

Soil Washing Process

After the preparation of a VCA plan in 1993 (LANL 1993, ER ID 29724.0) remedial activities were started the same year by the Laboratory's Environmental Restoration (ER) Project using a soil washing process to remove lead from the soil in order to recycle the lead. Soil from the various berms, the range floor, and an area on the hillside immediately north of the backstop berms were consolidated into a large soil stockpile in the location of the original backstop berms. The soil washing technology used a process similar to that used for gold placer-deposit mining to separate the heavier lead particulates to be recycled from the lighter soil matrix. Washed soil was screened using x-ray fluorescence (XRF) prior to collecting samples to be sent for analysis at fixed-site laboratories. After receiving laboratory results, soil, which met cleanup target criteria, was used offsite by the private land developer for road fill material in the regrading and widening of Range Road. Fine sediment from two recirculation ponds was periodically sampled at the discharge point into the ponds, from the pond bottoms, and from the pump trucks to confirm that all of the sediment being sent off-site was non-hazardous. This processed sediment was transported as a slurry to Sigma Mesa in TA-60 and a borrow pit in Sandia Canyon for drying. A total of 6700 yd^3 of soil was processed by the soil washing process.

In 1995, the soil washing method was terminated when discussions with the New Mexico Environmental Department (NMED) indicated that the unprocessed inactive firing range soil could possibly be transferred to the active firing range at TA-72 for reuse in expanding the berms at that site (DOE, 1995). After subsequent discussions with NMED and the Unites States Environmental Protection Agency (USEPA), it was determined that the soil should not be moved to TA-72 without first being processed to remove a majority of the lead bullets from the soil for recycling. Because the soil-washing contractor had demobilized from the site, other alternatives were investigated in an effort to complete the lead removal and recycling more quickly and cost effectively. The method selected after studying alternatives was dry sieving.

Dry Sieving Process

In early 1996, a second VCA plan (LANL1996, ER ID 54839.2) was developed for use of a dry sieving process to remove the lead bullets and larger fragments from the remaining stockpiled soil. This method separated the bullet-sized fraction from both the larger and smaller material in the soil matrix through the use of a shaker plant equipped with various sizes of slotted wire screens. A successful pilot study was conducted in spring of 1996 before applying the method full-scale in July of 1996. The processed coarse and fine soil fractions that were separated from the bullets were transported to TA-16 for use as industrial fill and to TA-72 for reuse as berm material, respectively. Batches of the fine fraction determined to be hazardous were shipped off-site for disposal at a RCRA landfill. The remaining bullet-sized soil fraction was further refined through use of an impact crusher, further sieving, and finally by a final vacuum-truck separation that lifted lighter gravel away from the heavier lead. A total of 7,000 yd^3 of soil was processed by the dry sieving process.

Screening and Confirmatory Sampling

Screening was performed using metal detectors and XRF analysis on all of the excavated areas prior to confirmation sampling. In cases where screening indicated that cleanup levels were not met, additional soil was excavated and processed by the dry sieving process.

Analytical results for confirmatory samples collected from the back area, the range floor, and the first-order drainages were all well below the residential cleanup levels for lead of 400 mg/kg. Of the three COPCs, lead was the only one detected at concentrations greater than background. Lead concentrations ranged from 23.7 mg/kg to 85.6 mg/kg in final confirmatory samples.

Site restoration was completed in the back area and range floor after completing confirmatory sampling. Restoration activities included re-contouring, grading, installing permanent storm water run-off and erosion controls, and re-vegetating denuded areas. Site restoration activities were completed in April 1997.

As part of site restoration, and under an agreement with the USDA Forest Service, the private land developer involved in the proposed land transfer cut and graded the site surface for additional drainage. The site was contoured to match the surrounding topography in accordance with the Forest Service specifications. The site was then covered with a one-ft thick layer of base course to prepare the surface for its current use by the private developer as heavy-equipment staging and construction materials storage area.

Results and Recommendations

At completion of the remedial activities at PRS 0-016, the volume of the feedstock processed totaled 13,700 yd^3. A total of 8.4 tons of lead was recovered for recycling. In addition to recycling the lead, 4,660 yd^3 of processed fine soil were transported off site for reuse at TA-72 as firing range berm material, 1,730 yd^3 of coarse gravel and rock were transported off site for use as industrial fill material and 6,700 yd^3 of washed soil were transported off site for reuse as road fill.

A total of 495 yd^3 of fine soils failed toxic characteristic leachate procedure for lead (TCLP) (EPA Method 1311), and was disposed of as hazardous waste. In addition, 60 yd^3 of forest liter consisting of mostly pine needles removed from the back area failed TCLP for lead and was disposed as hazardous waste. Approximately 900,000 gal. of slurry consisting of water and non-hazardous fine sediments that had accumulated in the recirculation ponds were transported to borrow pits at Sigma Mesa (TA-60) and a borrow pit in Sandia Canyon across from the entrance to TA-53 for drying and subsequent use as industrial fill material by LANL. Slurry discharge was conducted in accordance with conditions of an NMED Notice of Intent (NOI). The letters from NMED granting temporary permission to discharge (NMED 1993, ER ID 57106.42) and then subsequently advising that no discharge plan was required (NMED 1994, ER ID 57106.21) are included in Appendix G-1.0 Summary of Administrative History of PRS 0-016.

PRS 0-016 is recommended for no further action (NFA) under NFA Criterion 5: contaminants of concern are either not present or are present in concentrations that would pose an acceptable risk under the proposed land use. These sampling results clearly demonstrated that soil clean-up levels were achieved. Human health and ecological screening assessments concluded that the site posed no potential unacceptable risk.

Table ES-1 provides summary information for PRS 0-016.

TABLE ES-1
SUMMARY OF PROPOSED ACTIONS

PRS Number	PRS Description	HSWA[a]	Radionuclide Component	Proposed Action	Rationale for Recommendation	Section Number
0-016	Firing Range	Yes	No	NFA Criterion 5[b]	RCRA contamination is below cleanup levels	3.8

[a] This site is listed in Module VIII of the Laboratory's Hazardous Waste Facility Permit

[b] NFA Criteria are listed in Section II.B.4.a.(4).(b), "No Further Action (NFA) Proposals Criteria," in the NMED RCRA Permits Management Program Document Requirement Guide (NMED 1998, ER ID 57897).

VOLUNTARY CORRECTIVE ACTION COMPLETION REPORT

1.0. INTRODUCTION

Los Alamos National Laboratory (the Laboratory) is a multi-disciplinary research facility owned by the Department of Energy (DOE) and managed by the University of California. The Laboratory is located in north-central New Mexico approximately 60 miles northeast of Albuquerque and 20 miles northwest of Santa Fe (Figure 1.0-1). The Laboratory site covers 43 square miles of the Pajarito Plateau, which consists of a series of fingerlike mesas separated by deep canyons containing ephemeral and intermittent streams that run from west to east (Figure 1.0-2). Mesa tops range in elevation from approximately 6,200 ft to 7,800 ft. The eastern portion of the plateau stands 300–900 ft above the Rio Grande.

The investigation and remediation, including sampling and analysis, is conducted under the requirements of the Resource Conservation and Recovery Act (RCRA). The sites under investigation are either solid waste management units (SWMUs) or areas of concern (AOCs). In the Laboratory's Environmental Restoration (ER) Project, SWMUs and AOCs are collectively referred to as potential release sites (PRSs).

This report addresses PRS 0-016, a former small arms firing range. The firing range is located on United States Department of Agriculture (USDA) Forest Service property (Figure 1.0-1) at the northern terminus of Range Road (Figure 1.0-2), immediately west of Guaje Pines Cemetery, in Los Alamos, New Mexico.

For PRS 0-016, (a SWMU), the investigation and remediation was conducted in accordance with the Hazardous and Solid Wastes Amendments (HSWA) of 1984 and follows the requirements in Module VIII of the Laboratory's Hazardous Waste Facility Permit (EPA 1990, ER ID 01585). Module VIII was issued to the Laboratory by the US Environmental Protection Agency (EPA) on May 23, 1990, and modified on May 19, 1994. PRS 0-016 does not have a radionuclide component.

The Los Alamos National Laboratory (LANL) RCRA Facility Investigation (RFI) Work Plan for Operable Unit 1071 was approved by the US EPA (LANL 1992, ER ID 44604.15). There were two major Voluntary Corrective Action (VCA) plans for PRS 0-016. The first VCA plan proposed soil washing to decrease lead soil levels (LANL 1993, ER ID 29724.0 and LANL 1994, ER ID 56802.4). Soil washing was presented to the NMED and EPA at a monthly meeting with the

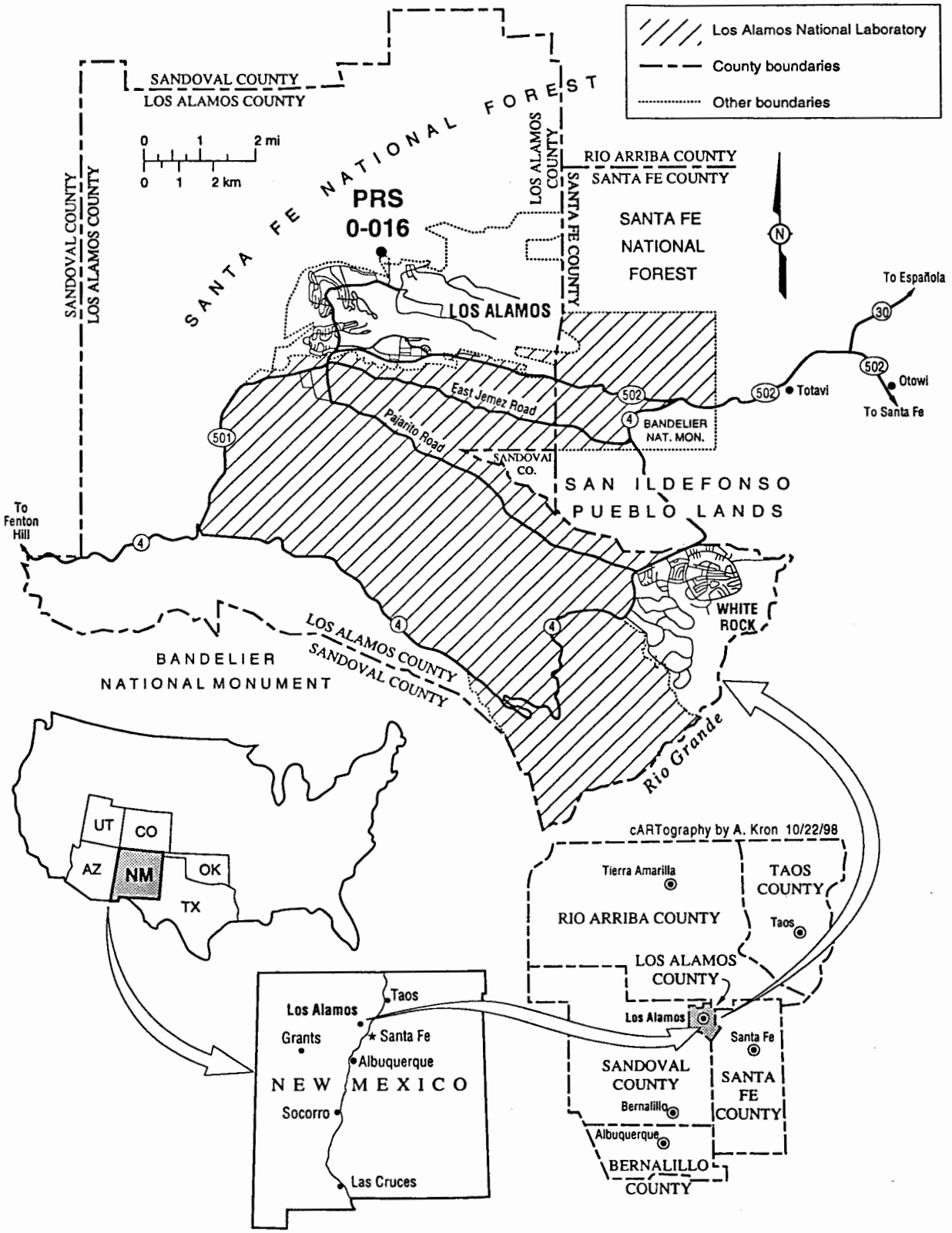


Fig. 1.0-1. Location of PRS 0-016 within Los Alamos National Laboratory, Los Alamos County, New Mexico.

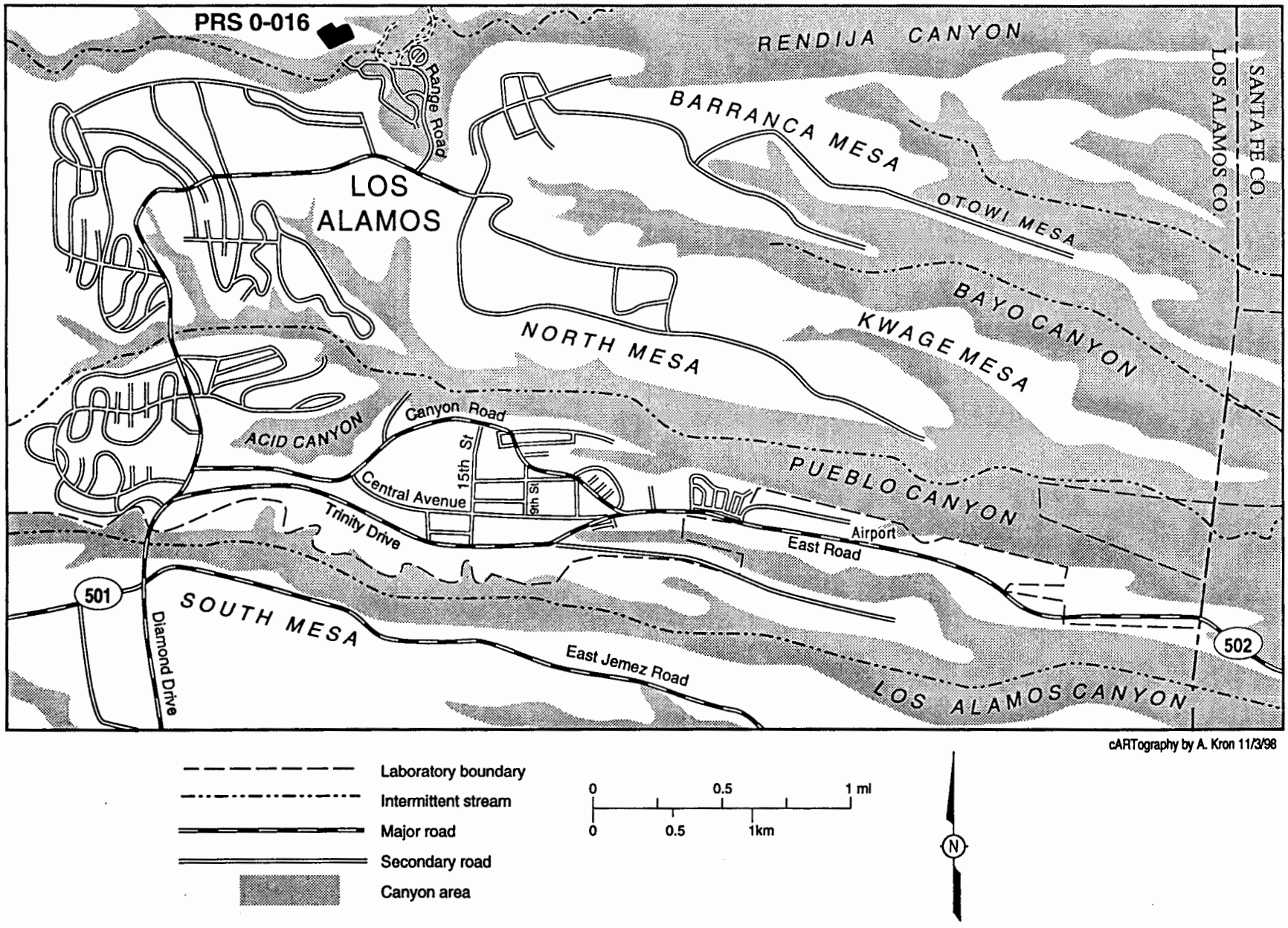


Fig. 1.0-2 Location of PRS 0-016.

ER Project and verbal approval was given at the time by those agencies for the soil washing process (LANL 1993, ER ID 28989). Written approval of the VCA plan by EPA was contained in an April 29, 1994 letter from William Honker, Chief, RCRA Permits Branch, EPA, to Joseph Vozella, Chief, Environment, Safety and Health Branch, DOE. The second VCA plan proposed the shaker plant operation and was approved by the DOE on June 20, 1996 (LANL1996, ER ID 54839.2). Both methods were used in the remediation of PRS 0-016 and both VCA plans proposed confirmation sampling analyzing for the COPCs copper, lead and zinc. The 1996 VCA Plan was presented to the NMED on March 8, 1996. NMED provided comments on the plan during a meeting on March 15, 1996 (Koch 1992, ER ID 59975) indicating that it was very good approach.

The current Installation Work Plan (IWP) (LANL 1996, ER ID 57479.1) describes the methodologies used in the investigation and analysis. Recent changes to data review and ecological screening assessment methodologies are not reflected in the current IWP. The data review methodology is included in Appendix C. The ecological screening methodology is described in "Screening level ecological risk assessment approach for the Environmental Restoration Project at Los Alamos National Laboratory," (Kelly et al 1998, ER ID 57916)

This VCA completion report describes the contaminated soil removal and the confirmatory sampling activities at PRS 0-016. This report is divided into five sections. Section 1 is the introduction. Section 2 presents the site history prior to removal. Section 3 describes the derivation of the cleanup levels, the remedial activities conducted, and presents the results of the samples collected after remediation. Human health, ecological, surface water and groundwater assessments are also included in Section 3. Section 4 describes the waste management activities, including waste types, volumes, and disposition. Section 5 contains references.

More detailed information is provided in the attached appendices. Appendix A contains a list of acronyms and a glossary of terms. Appendix B-1.0, Operational History and Land Use, discusses the current and anticipated future land use of PRS 0-016. Appendices B-2.0 through B- 6.0 include a detailed discussion of the climate, geology, hydrology, ecological resources, and cultural resources for the area. Appendix C includes the complete data quality assurance/quality control (QA/QC) results. Appendix D provides the data for the investigation/remediation.
Appendix E provides details about statistical calculations. Appendix F provides details about risk assessments and calculations. Appendix G-1.0 summarizes the administrative history of PRS 0-016 and provides copies of Administrative Authority (AA) correspondence and the Laboratory's responses. Appendix G-2.0 contains documents referenced in this VCA completion report that are specific to this report. Other references will be included in the appropriate reference set of the

Laboratory's Environmental Restoration (ER) Project Reference Library. Appendix H contains the before and after cost comparison for completion of the VCA. Appendix I contains copies of the VCA plans (1993, 1994 and 1996) for PRS 0-016. Appendix J contains photographs of the VCA activities.

Process Knowledge

PRS 0-016 is comprised of approximately two acres and consisted of some small buildings and two earthen ridges arranged in a semicircle to retain bullets. The buildings were removed prior to a field survey conducted by the Comprehensive Environmental Assessment and Response Program (CEARP) in 1987. The firing range at PRS 0-016 was used by Atomic Energy Commission (AEC) security forces for small arms target practice from 1947 until the early 1960s, and then was used unofficially by the general public for recreational target shooting until 1992. Based on this process knowledge, the only source of soil contamination at PRS 0-016 is from the use of small arms. According to the Naval Civil Engineering Laboratory (NCEL) Technical Note, *Environmental Effects of Small Arms Ranges,* soils in the berms at firing ranges have elevated concentrations of lead, copper, and zinc. The primary chemical of potential concern (COPC) is elemental lead, with copper and zinc commonly present as minor components of lead bullets (Heath 1991, p. v, ER ID 39510).

Antimony may also be present in small arms bullets. According to the NCEL Technical Note: "Bullets are made of a lead alloy consisting of copper, tin, and antimony." Since an alloy is a substance of two or more metals fused together when molten, any antimony and tin at the firing range would be co-located with the lead contamination. The bullets corrode slowly and when in an alloy with antimony they are even more resistant to corrosion. Therefore, any antimony at the site would be removed with the lead contamination.

Appropriateness of VCA

A VCA was appropriate for PRS 0-016 because:

- The COPCs (copper, lead, and zinc) were defined by use of the site as a small arms firing range.
- Methods for guiding the extent of cleanup activities (metal detectors and XRF) were available.
- The remedy (remove bullets from soil), was obvious.
- The original estimated time for removal was less than 6 months.
- The remedy was final.
- The future land use (residential) was known.

- Treatment, storage and disposal (TSD) facility was available for the waste type and volume.
- The original estimate of the cost was reasonable.

In addition to meeting the criteria for a VCA, an accelerated cleanup was appropriate to address the time constraints placed on the LANL ER Project by a pending land exchange between the USDA Forest Service and a private land developer. In 1993, the USDA Forest Service and a private land developer reached an agreement on a land exchange that included PRS 0-016. To date, only the land adjacent to the former small arms firing range has been exchanged. The agreement called for PRS 0-016 to be included in the exchange with the condition that it was to be cleaned up within two years of the initial exchange agreement. The Forest Service, the private land developer, and Los Alamos County wanted the cleanup to be completed in order to open the entire area for residential development and requested that DOE remediate the site immediately.

Table 1.0-1 presents a history and chronology of the activities at PRS 0-016. Figure 1.0-3 shows the different areas referenced in this VCA completion report.

TABLE 1.0-1
ACTIVITIES AND SITE HISTORY AT PRS 0-016

Time	Activity
1947- early1960s	Atomic energy commission security personnel use site as small arms firing range.
Early 1960s-1992	Public uses site for recreational shooting.
1987	CEARP[1] survey of the site.
1991	USDA Forest Service conducts a study of the site by testing for lead in the firing range berms.
April 13, 1992	USDA Forest Service appraises National Response Center, US Coast Guard, of inactive firing range.
September 4, 1992	USDA Forest Service requests information and assistance from LANL
1992	Fence installed around PRS 0-016 by Johnson Controls International.
1993	USDA Forest Service agrees to transfer land to a private land developer.
May 1993	Verbal approval of VCA given by EPA and NMED at monthly meeting with LANL ER.
September 1993	VCA Plan proposing soil washing, revisions 0,1,and 2.
September 1993	Mobilization for soil washing operation began.
October 4, 1993	Notice of Intent (NOI) temporary permission granted by NMED.
October 15, 1993 – November 1, 1993	Back area is screened with metal detectors.
December 3, 1993	NOI temporary permission to discharge from 3/15/94 to 7/12/94 granted by NMED
January 12, 1994	Notice of Deficiency (NOD) for VCA Plan, revision 2, from EPA.
January 20, 1994	NMED grants permission to begin discharging on March 15, 1994.
February 7, 1994	VCA Plan proposing soil washing, revision3.
February 24, 1994	Response to NOD of VCA Plan.

Table 1.0-1
Activities and Site History At PRS 0-016 (Cont'd.)

Time	Activity
February 1994	NMED gives verbal approval of VCA Plan.
1994	Site added to the HSWA Module.
March 14 – 15, 1994	Public Information Tours conducted.
April 1, 1994 – September 12, 1994	Extensive metal detector survey was conducted in back area.
April 29, 1994	EPA letter advising revised VCA Plan is acceptable as long as final report on remediation and confirmation analysis is submitted to EPA within 60 of receipt of analytical data.
May 9, 1994 - October 18, 1994	Soil washing operations were conducted, then shut down for winter.
July 1, 1994	Amendment to Forest Service Special Use Permit for Operable Unit (OU) 1071 allowing expansion of remediation into back area.
August 23, 1994	NMED advises that no discharge plan is required for soil washing activities because discharge conforms to ground water standards and does not contain any toxic pollutants as defined in WCCC Reg. 1-101.UU.
October 7, 1994	Forest Service Special Use Permit effective 11/94 to 11/95 to implement VCA Plan revision 0.
April 10, 1995	Remobilization of soil washing operations following winter shutdown.
April 18, 1995	DOE/LANL request to move soil to firing range at TA-72 for needed berm material.
May 17, 1995	NMED letter indicates willingness to authorize use of lead contaminated material as berm/backstop material at TA-72 firing range pending additional information.
May 17, 1995 – June 6, 1995	Remobilization of soil washing operations discontinued and subsequently disassembled for final demobilization.
July 6, 1995	LANL responds to request for additional information regarding use of lead contaminated material as berm/backstop material at TA-72 firing range.
September 29, 1995	Federal Register Notice of Termination of Coverage Under a NPDES General Permit for Storm Water Discharges.
October 10, 1995	EPA recommends NMED deny LANL's request to authorize use of lead contaminated material as berm/backstop material at TA-72 firing range.
December 1, 1995	Meeting with NMED/HRMB to discuss site history/activities and site tour.
April 1996	Shaker Plant Pilot Study conducted.
July 1996 – September 1996	Shaker Plant operations conducted. 7,000yd^3 of feedstock processed yielding 1,235 yd^3 of bullet-size material.
May 1996	Right-of-Way confirmation samples collected.
September 1996	Range-floor confirmation samples collected.
March 1997	Final Range Floor confirmation samples collected following remobilization of Shaker Plant and final processing with crusher and vacuum.
January 1997 – March 1997	Impact crusher operation is conducted; material reduced from 1,200 to 80 cubic yards.
March 1997	Vacuum separation is conducted.
May 1997	LANL conducts a surface water assessment of the site.
August 1997	Back Area confirmation samples collected.
1997 to present	Private land developer regrades site and uses as construction staging area
September 1997	VCA Completion Report submitted to NMED
July 1, 1998	Rejection of VCA Completion Report by NMED

[1] CEARP = Comprehensive Environmental Assessment and Response Program.

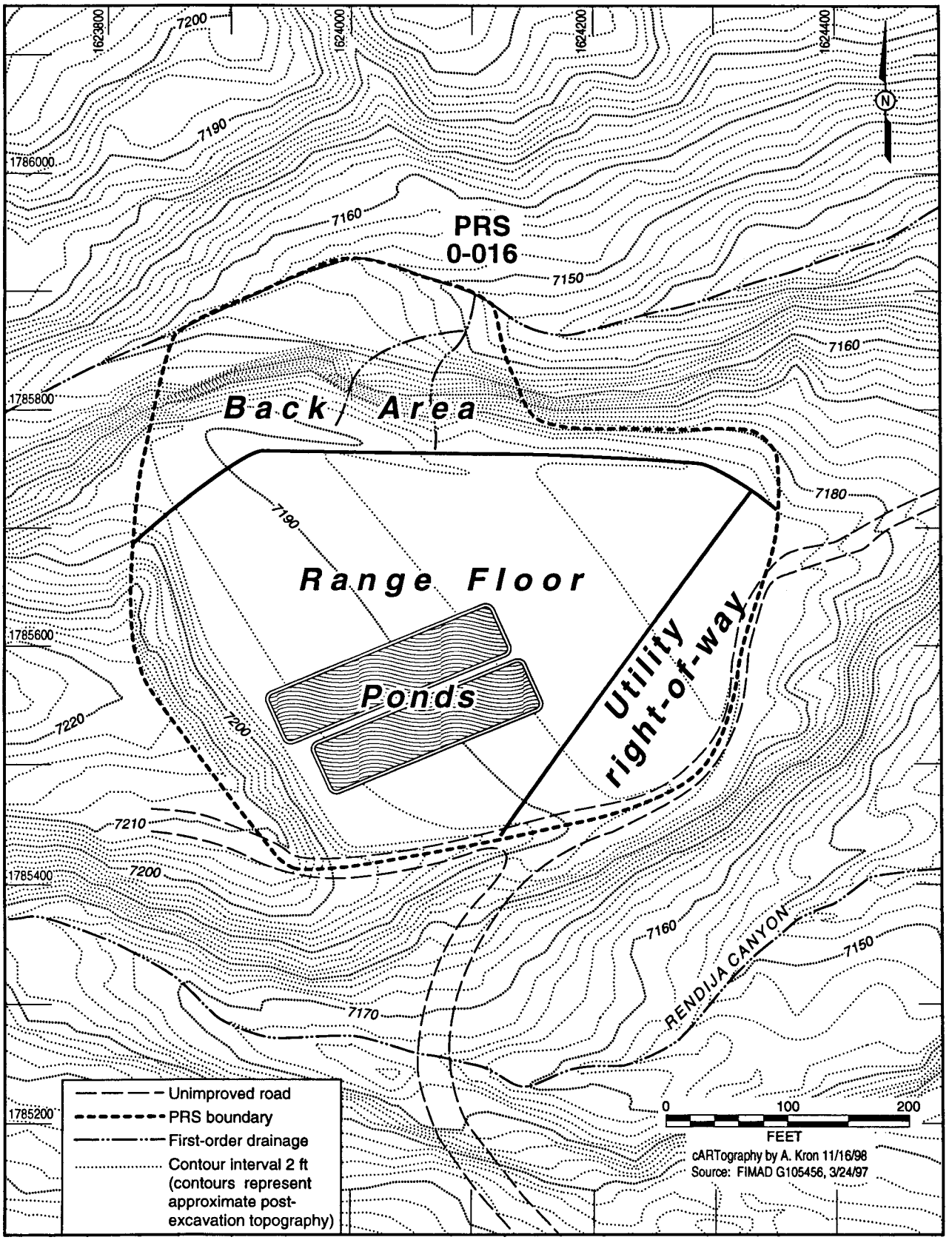


Fig. 1.0-3 Locations of range floor, back area, utility right-of-way, recirculation ponds, and first-order drainages.

2.0 SITE CHARACTERIZATION PRIOR TO REMOVAL

2.1 Summary

This section presents the site description and operational history, investigation activities, and conclusions and recommendations.

2.2 Description and Operational History

The site is identified in the Hazardous and Solid Waste Amendments (HSWA) Module (Module VIII) of LANL's RCRA permit as a SWMU requiring a RCRA field investigation. PRS 0-016 was not included in Table A of the 1990 HSWA Module and was subsequently added to the permit in 1994, via a February 1993 Class 3 permit modification. The site was added to the HSWA Module following a letter of notification of soil contamination from the USDA Forest Service to the US Coast Guard National Response Center in 1992 (USDA Forest Service, 1992 ER ID 59597). The USDA Forest Service letter identified the site as a SWMU and presented the results for USDA Forest Service soil samples collected from the firing range berms (USDA Forest Service, 1992, ER ID 59597) (Figure 2.0-1).

2.2.1 Site Description

Physical Description

PRS 0-016, an inactive small arms firing range, is in the Santa Fe National Forest, located west of the Guaje Pines Cemetery in Rendija Canyon (Figure 1.0-2). Access to the site is via a gravel road that extended from the end of Range Road at the cemetery. Photographs of various stages of the site history including original condition, remedial operations, and final condition are included in Appendix J.

Prior to remediation, the site was comprised of approximately two acres with earthen ridges arranged in a semicircle to retain bullets from target practice from 1947 to 1992. The range consisted of a backstop berm along the northern edge of the firing range floor, a side berm along the eastern edge of the range floor, and a medial berm that ran north south and separated the site into two firing areas. A cut slope of tuff bedrock flanked the western edge of the range floor. The original configuration included earthen berms at PRS 0-016 as shown in Figure 2.0-1. The firing range consisted of two target areas (eastern and western) separated by a central longitudinal

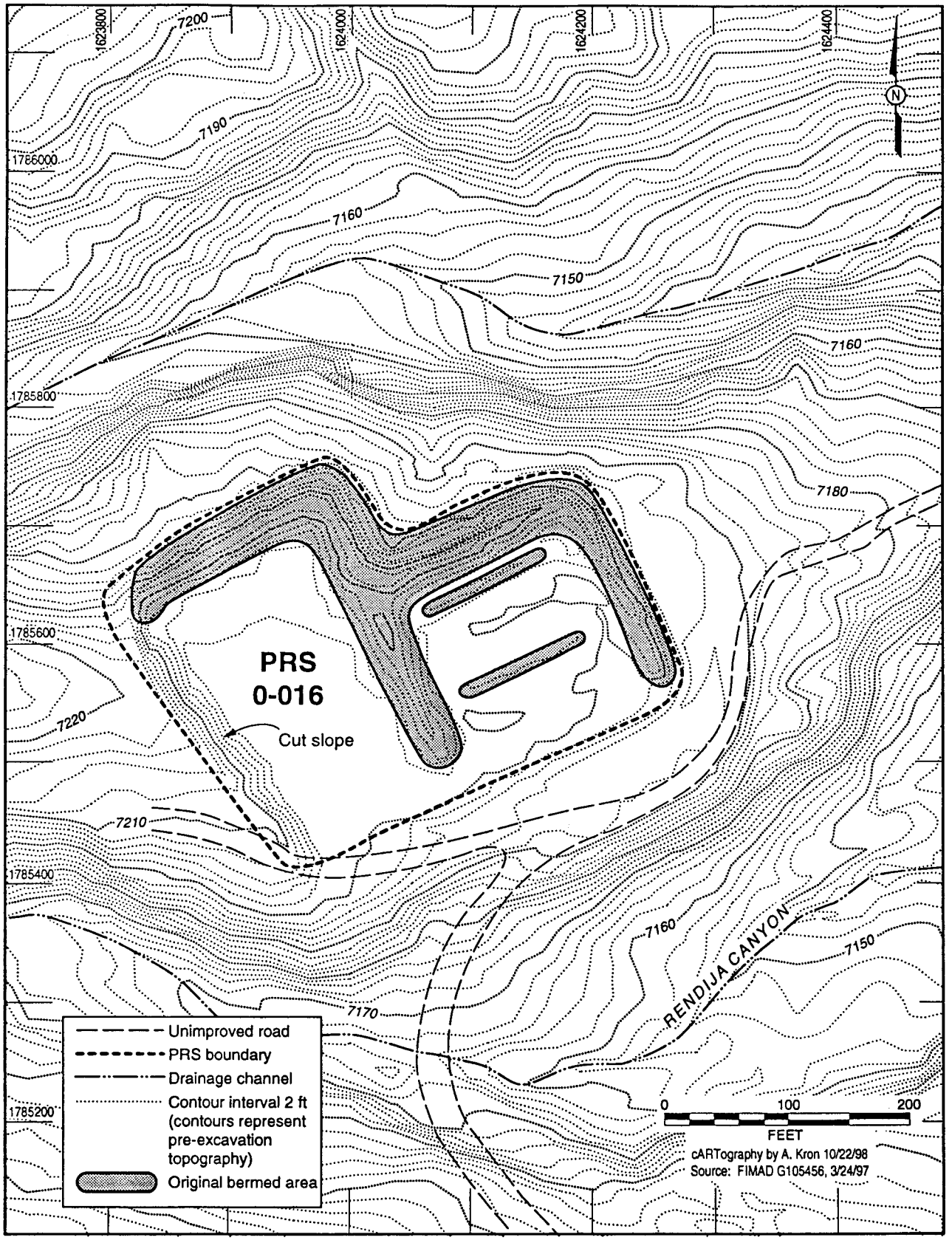


Fig. 2.0-1 Original firing range berm configuration and PRS boundary.

berm. Both of the target areas had several firing lanes with bullets being fired in a northwest direction. Backstop berms for the targets were approximately 8 to 12 ft high and 35 to 50 ft wide (Figure 2.0-2).

The western target area measured approximately 215 ft from the firing point to the base of the backstop berm, 150 ft wide at the back and 105 ft wide at the front. This area was bounded on the east by the central longitudinal berm, which measured approximately 240 ft long, 30 to 40 ft wide and about 8 ft high. The west side of the western target area was bounded by a cut slope measuring approximately 230 ft long and ranging from 9 to 15 ft in height from the base to the top of the cut. This cut slope was not parallel to the central longitudinal berm resulting in the western target area being wider at the back (Figure 2.0-2).

The eastern target area measured approximately 142 ft from the firing point to the base of the backstop berm and 165 ft wide at both the back and front. This area was bound on the east by the eastern longitudinal berm, which measured approximately 160 ft long, 25 to 35 ft wide and about 5 to 8 ft high. The west side of the eastern range floor target area was bounded by the central longitudinal berm that separated the two target areas. The eastern target area also had two smaller, transverse target berms each measuring approximately 120 to 130 ft in length, 12 to 18 ft wide, and about 2 ft high (Figure 2.0-2).

Based on the dimensions of the berms and range floor areas as measured by the USDA Forest Service (Figure 2.0-2), Table 2.2-1 presents estimated volumes of soil and area for each berm, the range floor area, the back area and peripheral areas (access/parking area to the south, slash storage area to the east, and area between the back berms and the back area) that were included in the final cleanup. Estimates for the floor areas and back area assume an average excavation depth of one ft.

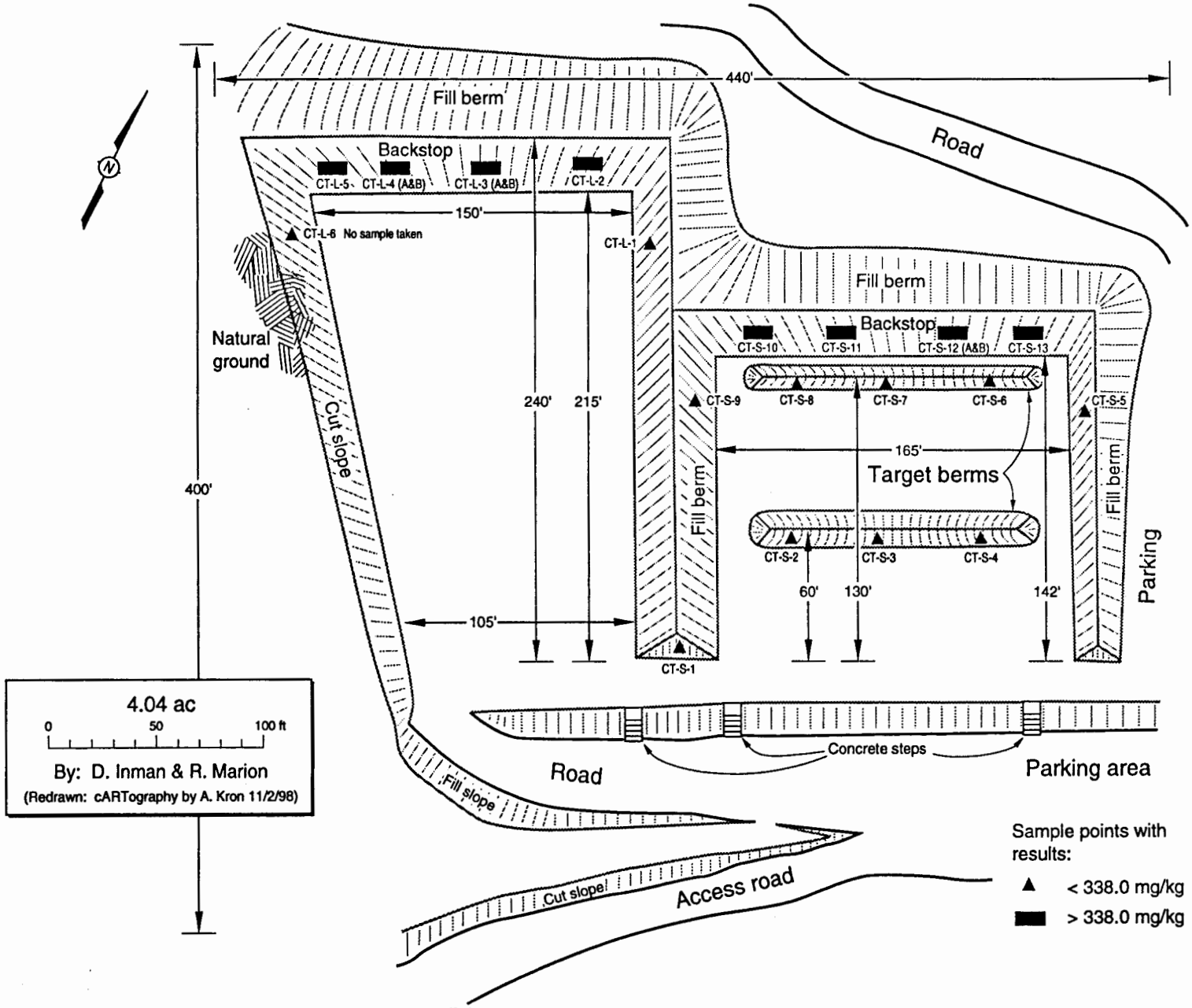


Figure 2.0-2 USDA Forest Service drawing of original firing range.

TABLE 2.2-1

ESTIMATED AREAS AND VOLUMES WITHIN THE VCA

PRS Area	Estimated Areas (ft^2)
Western Range Area	27,413
Eastern Range Area	23,430
Area Under Berms	27,955
Back Area	46,000
Peripheral Areas	49,550
Total	174,348
	Estimated Volumes (yd^3)
Western Backstop Berm	1583
Eastern Backstop Berm	1771
Central Longitudinal Berm	1254
Eastern Longitudinal Berm	710
Transverse Target Berms	167
Western Range Floor	1015
Eastern Range Floor	868
Back Area	1733
Peripheral Areas	1835
Total	10,936

When active, the firing range included several small buildings that were absent prior to the initiation of remedial activities (LANL 1992, ER ID 44604.15). No information on the decommissioning of these buildings was available. A field survey conducted by the Comprehensive Environmental Assessment and Response Program (CEARP) noted the remains of concrete steps and pads at the site (DOE 1987, 08663.1). The concrete structures were processed along with the range berm and floor soils.

Land Use

The firing range at PRS 0-016 was used by AEC security forces for small arms target practice from 1947 until the early 1960s when the present firing range in Sandia Canyon (TA-72) was built. The Department of Energy (DOE) released PRS 0-016 and surrounding areas to the USDA Forest Service in 1976. The site was then used unofficially by the general public for recreational target shooting, dirt bike (motorcycle) riding and off-road multipurpose vehicle use until 1992, when a fence was installed around the area in preparation for site remediation. Future land use is residential. There are no other PRSs that overlap or are adjacent to PRS-0-016.

Environment

Pre-Remedial Operations Conditions

The former firing range was located on top of a small ridge composed of the upper member of the Bandelier Tuff (Tshirege Member), with associated soils. Prior to site remediation, the site was covered by soil overlying the Bandelier Tuff with the exception of the areas with soil berms. Soil thickness varies across the site, weathered Bandelier Tuff was exposed at the surface in numerous places. The terrain varied from relatively flat on the ridge top to steep grades at the edges associated with the valley walls. Soil thickness typically increased in the colluvial soils on the adjacent valley slopes and was thickest in the alluvial deposits in the valley bottoms. Details on the soils and geology associated with the site are found in Appendix B.

The ridge top was relatively flat (less than 2% slope) and lay between two small valleys that converge about one-quarter mile east of the site. Any run-off from the site terminated in the drainages of these small valleys. The ephemeral streams in these small valleys fed into the upper end of Rendija Canyon and were associated with snowmelt runoff in the spring and localized thunderstorms during the summer. The elevation of the site was approximately 7,200 ft with elevations in the adjacent valleys at 7,160 to 7,180 ft. The stream gradients in the portions of the valleys adjacent to the site were about 200 ft per mile. The length of the reach of the stream that borders the back area of the site was 260 ft and the vertical drop of the stream over this reach was 10 ft. The regional aquifer beneath the site is approximately 1,000 ft below the land surface. Photographs numbers 1 and 2, in Appendix J, show the PRS prior to remediation activities.

Post –Remedial Operations Conditions

Environmental conditions at the PRS 0-016 site after remediation are significantly different from pre-remediation conditions. The range floor is several feet lower across the majority of the site than the original range floor. The final surface has been graded and stormwater flow is directed to a catch basin at the eastern end of the site. In addition, a layer of one ft or more of granular backfill (base course) has been placed over the excavated surface and the area is currently used for construction equipment and materials storage.

The surface in the back area is approximately 1 ft lower over the area than previously. It was covered with imported topsoils, a geofabric and mulch and seeded with a native plant seed mix. This area is now fully revegetated.

Cultural and Biological Resources

The Archaeological Status Report for the Environmental Restoration Readiness Review, dated September 1, 1993, (Appendix B-6.0) stated that one artifact scatter was located within the surveyed area for PRS 0-016. The artifacts from this site, LA 24902 (FS AR-03-10-06-607) were collected and the State Historic Preservation Officer has determined that the site is no longer a concern.

The Biological Resource Evaluation Readiness Review dated September 7, 1993, (Appendix B-5.0) stated that surveys indicated that no impacts to any threatened, endangered or sensitive plant or animal species were expected from sampling activities at the site. The ecological screening assessment (Section 3.7.3) indicated that there are two threatened or endangered species, Mexican spotted owl and the peregrine falcon, potentially could roost or forage in the vicinity (LANL 1998, 59846). The Ecological Checklist is included in Appendix F.

2.2.2 Operational History

The firing range was constructed for AEC security forces use sometime after January 1947, when control of all Manhattan Project sites was transferred to the AEC. Security forces for small arms target practice used the range until it was abandoned in the early 1960s. The DOE released PRS 0-016 and surrounding areas to the USDA Forest Service in 1976. The general public used the site for recreational shooting from the time security forces vacated the site until VCA activities were initiated in 1992. Current ownership remains with the USDA Forest Service until a land exchange between the Forest Service and a private land developer is completed.

The land use for surrounding and/or adjacent USDA Forest areas was recreational. Most of that land has since changed ownership and is currently being developed with housing. Prior to installation of a fence around the site in 1992, access to the site had not been restricted.

2.3 Investigation Activities

2.3.1 Summary

This section includes a discussion of previous investigations (Section 2.3.2), and the preliminary conceptual model (Section 2.3.3). Because there was no LANL ER field investigation or sample collection prior to remediation, this section provides no discussion of field investigation, (Section 2.3.4.2) or data review (Section 2.3.4.3). There were no analytical data to modify the preliminary conceptual model (Section 2.3.5).

2.3.2 Previous Investigations

The USDA Forest Service conducted a study of PRS 0-016 in 1991 that only analyzed for lead (Figure 2.0-2). A total of 21 soil samples were collected from the surface of the backstops and other berms. The USDA Forest Service analyzed the soil samples for total lead using EPA Method 7421 (atomic absorption spectroscopy). The analytical results are presented in Table 2.3-1. These analytical reports are not available but a summary of the results is given in USDA Forest Service Memorandum 7400, contained in Appendix G-2.0 (USDA 1992, ER ID 59597). Contamination was attributed to the presence of lead bullets on the surface of the earthen berms. The Laboratory's ER project did not perform any investigations at the PRS prior to the VCA.

TABLE 2.3-1

USDA FOREST SERVICE TOTAL LEAD ANALYTICAL RESULTS SURVEY AT PRS 0-016

Sample ID	Lead (mg/kg)
CT-S-1	20
CT-S-4	55
CT-S-9	66
CT-S-5	74
CT-S-2	78
CT-S-6	81
CT-S-7	126
CT-L-1	147
CT-S-3	194
CT-S-8	328
CT-S-12(A) *	1474
CT-S-11 *	1531
CT-L-2 *	1582
CT-S-12(B) *	1670
CT-L-4(B) *	2434
CT-L-5 *	3285
CT-L-4(A) *	4386
CT-L-3(B) *	38800
CT-L-3(A) *	39500
CT-S-10 *	50500
CT-S-13 *	156100

* Back-stop Berm Samples

2.3.3 Preliminary Conceptual Model

The preliminary conceptual model from the OU 1071 Workplan (LANL 1992, ER ID 44604.15) was based on the premise that PRS 0-016 was a small-arms firing range with earthen berms arranged to retain bullets. The primary release of contaminants was via the discharge of lead bullets into backstop berm and range floor soils, during the active use of the site. The preliminary conceptual model of contaminant occurrence and distribution at the site is presented in Figure 2.0-3.The conceptual model predicts that contact with contaminated soil would be of moderate significance via ingestion and dermal routes of exposure to future residents, site visitors, and terrestrial animals.

2.3.3.1 Nature and Extent of Contamination

The nature and extent of contamination was not determined prior to remediation. The lead bullets and associated fragments were assumed to be largely restricted to the range itself, with a majority of the bullets in the target and backstop berms. The primary chemical of potential concern (COPC) at PRS 0-016 is elemental lead; however, copper and zinc are also commonly present as minor components of lead bullets used with small arms (Heath, et al., 1991 ER ID 59510). Antimony may have also been present at the site, but only as a minor component in an alloy with lead.

Following the initial release of bullets, the preliminary conceptual model provided for the potential of a secondary release of contamination following weathering and dispersal through wind and/or water borne erosion. As a result, the model suggests that contaminants that may have been present in the soil could have the potential to disperse through the vadose zone or be entrained by surface water or sediment and be transported downgradient. However, the vertical extent of contamination should be limited to surficial soils due to the relatively insoluble and immobile nature of the inorganic COPCs in the pH neutral soils of PRS 0-016. Appendix F further discusses the relative insolubility of copper, lead, and zinc. Due to low erosion potential (see Surface Water Assessment in Appendix B-4.1) and the lack of mobility of the COPCs, the Canyons Focus Area did not supplement or take over the investigation at PRS 0-016. The extent of any antimony contamination would be the same as the extent of the lead contamination and would be removed with the lead cleanup.

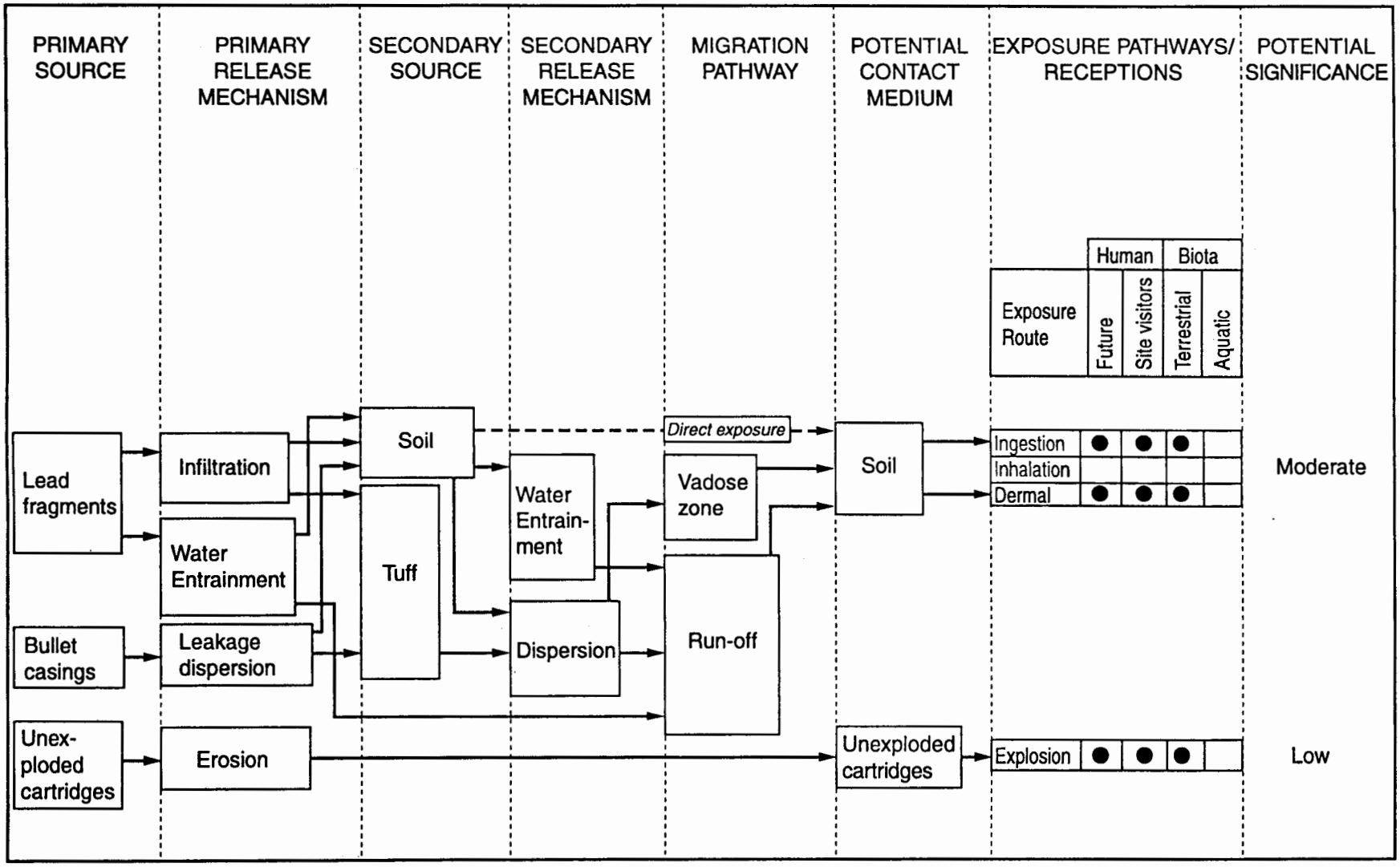


Fig. 2.0-3 Preliminary conceptual model.

2.3.3.2 Environmental Fate

The fate and distribution of chemicals in the environment are determined by several variables that can interact in numerous ways; physicochemical properties of the individual chemical and the physical transport systems such as rainwater or snowmelt runoff. The physicochemical properties such as water solubility, soils adsorption, vaporization are all-important in determining the routes by which a metal may enter the environment and be distributed. In general, metallic cations are quite insoluble in soil, especially in neutral pH soils such as those at the firing range (Brady 1974, ER ID 58203.1 p. 565). Adsorption to particulate matter is a major mechanism by which metals are retained in neutral pH soils and prevented from moving in solution. Vaporization of the COPC metals copper, lead and zinc, from soil and water is highly unlikely due to the low vapor pressures of these metals. Specific fate and transport information on the three COPCs copper, lead and zinc is located in Appendix F-1.

2.3.4 Field Investigation and Data Evaluation

All field investigation prior to soil disturbance was done just prior to remedial activities. There were no site assessments (human health, ecological, or surface water) conducted prior to remediation. An underground storage tank (UST) assessment was not performed because it was not applicable for PRS 0-016.

2.4 Conclusions and Recommendations

A VCA was determined to be the appropriate approach for an accelerated cleanup based on initial discussions with EPA in 1993 and as documented in the VCA Checklist/Fieldwork Authorization Form presented in the VCA plan (LANL, 1996, ER ID 54839.2). In addition to meeting the criteria for a VCA, an accelerated cleanup was appropriate to act responsibly and timely for the pending land exchange between the USDA Forest Service and a private land developer.

3.0 REMEDIAL ACTIVITIES, SAMPLING AND RESULTS

This section presents the cleanup levels the remedial activities were to achieve as presented in the VCA plans, the field screening methods used to guide remediation, the two different methods of remediation used in the VCA, (soil washing initially and shaker plant later), site restoration, deviations from the VCA plans, confirmation sampling, data review, revised site conceptual model, site assessments, and conclusions and recommendations.

3.1 Cleanup Levels

Cleanup levels for a site depend upon the future land use and the amount of exposure an individual would have to contaminants. The future land use of the former firing range and surrounding land is residential. Construction has already begun on the roads and houses for the subdivision on the land adjacent to PRS 0-016. The most likely exposed individual would be a resident, and the most sensitive resident would be a child. The exposure pathways would be via ingestion, inhalation, and dermal exposure to the soil.

The final residential cleanup levels for copper, lead, and zinc are provided in Table 3.1-1. The cleanup level for lead, 400 mg/kg, is based on the 1994 EPA Integrated Exposure Uptake Biokinetic Model (IEUBK) for children and is the recommended screening level for lead for residential land use (EPA 1994, ER ID 59509.1). The cleanup levels for copper and zinc are calculated using the most current toxicity values, standard default exposure parameter values, and equations available (EPA 1998, ER ID 58751). The toxicity values, exposure parameters and the equation used to derive the cleanup levels for copper and zinc are provided in Appendix F-1.0.

TABLE 3.1-1
CLEANUP LEVELS FOR PRS 0-016

Analyte	Cleanup Level (mg/kg)
Copper	2,800
Lead	400
Zinc	22,000

3.2 Screening Methods Used To Guide Remediation

There were two screening methods used to help determine extent of contamination and to screen the soil prior to the collection of fixed-site laboratory samples. These methods were metal detection of lead and bullets in the soil, and analysis of lead in the soil using XRF (X-ray fluorescence), (LANL internal method EI-732 [LANL 1993, ER ID 31794]), in a mobile laboratory set up at the PRS. These methods allowed for sample location selection that targeted higher concentrations of lead as well as rapid turn around of sample results. Without these field-screening techniques, site activities would have stopped during periods of fixed-site laboratory analytical testing. This was due to the limited space available at the site for stockpiling processed

soil. Remedial costs were kept to a minimum by avoiding these work stoppages and by limiting EPA SW-846 analysis until the confirmation-sampling phase of the VCA.

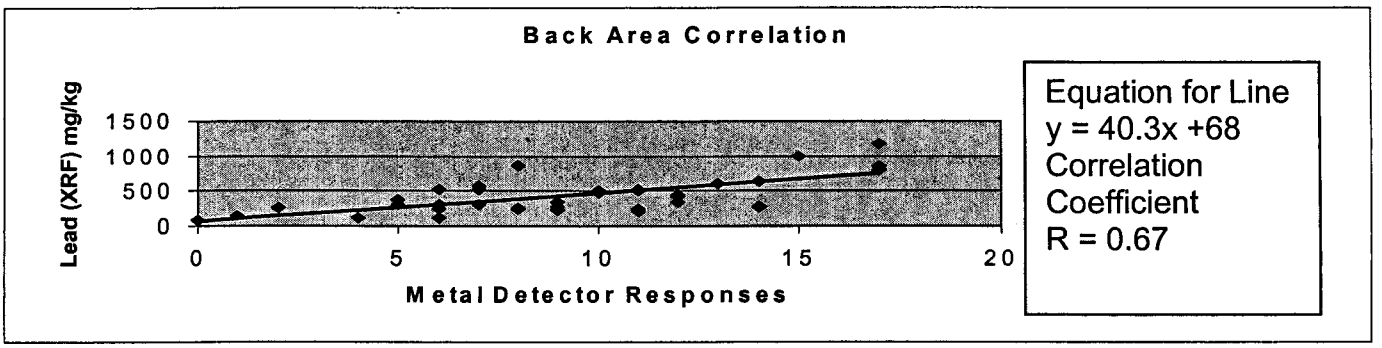
3.2.1 Metal Detector Screening

Before remedial activities at PRS 0-016 began, an investigation was conducted to correlate audio metal detector responses with XRF lead results for lead contaminated soil. This lead-contaminated soil came from the back area of PRS 0-016. All detectable bullets had been removed from the soil, however, it still contained lead contamination. Using soil for correlation that was bullet-free but still contaminated with lead was necessary so that metal detector responses could be correlated to lead levels in the lead contaminated soil. The White Model 4900/DL PRO metal detector and the Spectrace 9000 field portable XRF unit were used in this investigation and in subsequent VCA activities. The sampling strategy used thirty-six, 3-ft square areas sectioned off in the back area. Each 3-ft square area was thoroughly scanned using metal detectors to determine the number of audio metal detector responses within the grid.

Metal detector calibration was conducted in an uncontaminated area southwest of the range floor. The metal detector calibration procedure and sensitivity responses to bullets at varying depths in the soil are presented in Appendix E.

After the metal detector responses for the thirty-six grids were recorded, each 3-ft square area was further divided into nine 1-ft squares. At the center of each 1-ft square a soil sample was collected; bullets and bullet fragments were avoided while collecting these soil samples. The nine soil samples from the center of the 1-ft squares were then composited to create one representative sample for each of the thirty-six 3-ft square areas. The thirty-six composite samples were analyzed for lead using XRF. The number of audio metal detector responses within each area, and the corresponding XRF lead results for the bullet free composite samples for each thirty-six 3-ft square areas are presented in Appendix E.

A linear regression of metal detector responses against the XRF results is shown below. The



correlation coefficient (R) is 0.67. The upper confidence bound of the linear regression is used for the interpolation of how many metal detector responses corresponds to XRF lead concentrations. This ensured that lead concentrations above the clean up levels would not be missed by the metal detector surveys.

Once the correlation for the number of audio metal detector responses in a 3-ft square grid and bullet-free soil XRF lead concentrations was established, metal detector screening began at PRS 0-016. Instead of the 3-ft square grids used in the relatively small area for the initial correlation study, 6-ft grids were used for the full-scale screening of the larger back area. The number of audio metal detector responses and XRF lead results were adjusted for this larger grid area. The calculation for this adjustment can be found in Appendix E. Table 3.2-1 summarizes number of audio metal detector responses within a 6-ft grid and the corresponding bullet-free XRF lead soil value.

A full-scale metal detector survey of the back area was initiated to determine the outer boundary of the PRS. A grid was set up on the back area using 6-ft squares, and these squares were grouped into eighteen, 90-ft squares. A statistical sampling plan (see Appendix E) determined that 24 of the two hundred and twenty-five 6-ft squares should be surveyed using metal detector responses to map the lead contamination boundary of the PRS behind the backstop berms. Using the metal detector/XRF correlation an average lead concentration was determined for each 90-ft square in the back area. Photographs 3 and 4 of the back area survey are presented in Appendix J.

TABLE 3.2-1
ESTIMATION OF XRF LEAD CONCENTRATIONS IN BULLET-FREE SOIL FROM METAL DETECTOR RESPONSES

Audio Metal Detector Responses in 6-ft square grid	Average Bullet Free Lead Concentration in 6-ft square grid using XRF[1]
2 audio responses	142 mg/kg
6 audio responses	188 mg/kg
10 audio responses	237 mg/kg
14 audio responses	289 mg/kg
18 audio responses	342 mg/kg
22 audio responses	396 mg/kg
26 audio responses	450 mg/kg
30 audio responses	506 mg/kg
34 audio responses	561 mg/kg
38 audio responses	617 mg/kg
42 audio responses	672 mg/kg
46 audio responses	729 mg/kg
50 audio responses	785 mg/kg
54 audio responses	841 mg/kg
58 audio responses	897 mg/kg
62 audio responses	953 mg/kg
66 audio responses	1009 mg/kg

[1] X-ray Fluorescence

3.2.2 XRF Screening

The use of XRF for lead measurements was an attractive supplement to the sole use of fixed-site laboratory SW-846 Methods. Trace metal analysis of soils using XRF is faster, less labor intensive, and less expensive than using SW-846 Methods, therefore allowing more locations to be sampled. The SW-846 methods employed for soil sample analysis requires acid digestion of the sample before instrument analysis. Sample digestion is not required for the XRF method because of the nature and physical phenomenon on which the measurement is based. The only sample preparation required for XRF analysis is drying followed by milling and sieving.

XRF is a conservative technique for field screening of lead because XRF results are generally significantly higher than SW-846 results, lead. The higher levels measured for lead by XRF are a consequence of the penetrating nature of x-rays. Fluorescence is observed from soil matrix analytes, such as mineral crystals, as well as surface-adsorbed analytes. The acid digestion procedure used in sample preparation for SW-846 Methods dissolves surface-adsorbed

compounds but does not efficiently dissolve the mineral compounds that compose the soil matrix. Therefore, the results for lead, using XRF are generally higher than SW-846 results.

The XRF data is presented in Appendix D, Table D-3. The nature of the contamination at PRS 0-016 with contaminated soil interspersed lead bullets and fragments introduced some error in the trend of XRF results being generally higher than SW-846 results. This is attributed to lead fragments in the XRF samples, which were not in the split samples for the SW-846 analyses.

The estimated detection limits (EDLs) for both SW-846 and XRF methods, for lead, are compared in the Table 3.2-2, with the background and soil cleanup level.

TABLE 3.2-2

ESTIMATED DETECTION LIMITS VS. BACKGROUND LEVELS

Analyte	All Soils Background Value (mg/kg)	Soil Cleanup Level (mg/kg)	SW-846 EDL[1] (mg/kg)	XRF[2] EDL (mg/kg)
Lead	22.3	400	0.2	19

[1] EDL = Estimated Detection Limit
[2] XRF = X–ray fluorescence

3.3 Remedial Operations

Two different methods of remediation were used during VCA field activities at PRS 0-016 between September 1993 and May 1997. The first method used was soil washing to remove the lead bullets and fine lead by density separation (discussed in Section 3.3.1). At the time of the initial planning for the first VCA plan in 1993, the only known, economically feasible method of removing lead from soil was via a soil washing process. It had been successfully used at similar small-arms firing range sites. This process had been shown to reduce the lead concentration in soils to well below 400 mg/kg. The second method used was mechanical separation using a shaker plant to mechanically sieve the soil to remove the lead bullets and fragments (discussed in Section 3.3.3). Table 1.0-1 summarizes the chronology of activities for this VCA.

Site Preparation

A fence was installed around PRS 0-016 in 1992 during the initial planning stages of the VCA to control access to the site. To prepare for the soil remediation at PRS 0-016, soil from the longitudinal berms and the range floor was consolidated with the soil in the back berms. This consolidation consisted of pushing the longitudinal berm and range floor soil on top of and against

the back berm soil resulting in a single large soil stockpile for processing. During the consolidation process, soils were mixed by the soil-washing contractor to homogenize the feedstock for more efficient processing through the soil washing system. The range floor and consolidated soil stockpile are shown in photograph number 5 in Appendix J.

Site preparation and mobilization of soil washing equipment commenced in September 1993 and was completed on September, 1994 following shutdown for four months during winter. Site preparation activities included assembling the soil washing plant, constructing roads, constructing two recirculation ponds, grading a staging area for processed soils, and building a perimeter berm to prevent runoff from the soil drying area. Site preparation activities in the back area are shown in photograph number 6 in Appendix J. The contaminated soils on the back area hillside were covered by a layer of forest litter consisting of pine needles, pine cones, leaves and humic soil. This material had to be removed prior to excavation of underlying soils because it could not be processed through the soil washing plant. The forest litter, potentially containing elevated levels of lead, was removed between July 8, 1994 and September 21, 1994. Forest litter was raked up and placed in plastic bags for subsequent sampling and disposal. In addition, all trees smaller than eight inches in diameter were cut down and removed.

Range-Floor

The entire area was screened using a metal detector and XRF to identify areas that may require further excavation and processing. Metal detector screening was conducted over the entire site and served as a guide for identifying soils on the range floor that contained bullets. Based on the correlation established in the back area survey, if 22 or more positive metal-detector responses were detected within a 6-ft square, additional soil was excavated from the range floor in that area. Twenty-two metal-detector responses were determined by the correlation to indicate a total lead concentration of 396 mg/kg. This was the number of responses closest to but still less than the cleanup level of 400 mg/kg.

Following completion of the metal-detector survey and additional scraping of the range floor, the entire range floor was sampled and screened for lead by XRF using a Spectrace 9000 XRF unit. This was performed as a preliminary confirmation that soils remaining on the range floor did not contain total lead concentrations greater than 400 mg/kg before final confirmatory sampling for fixed-site-laboratory analysis. Locations of samples analyzed by XRF were based on a grid with a 50-ft spacing projected over the entire range-floor area. Five grab samples were collected from each grid-section (from each corner plus the center of the section), and analyzed on-site by XRF. All of the sections were determined to be less than 400 mg/kg by XRF screening during the first

round sampling. Fixed site laboratory data was ultimately used to confirm that cleanup levels were achieved. Confirmation sampling is discussed in Section 3.4.1. Much of the site was scraped to bedrock.

Back Area

The back area behind the firing range floor had an area of disturbed soil. This was assumed to be an older backstop berm that had been moved onto the back slope to extend the length of the range floor. An initial screening using metal detectors conducted from October 15 through November 1, 1993 found a significant number of bullets in the back area of PRS 0-016. To determine the extent to which the back area contained lead bullets, an extensive metal detector survey was conducted between April 1 and September 12, 1994. Thirty-six 3-ft squares were established in the back area to determine the average lead concentrations in each area. A metal detector survey was conducted over each square to determine the density of bullets in the soil. Following the metal detector survey, a series of soil samples were collected for XRF analysis from several locations within each square. These sample locations included: areas adjacent to a bullet, in the center of the square, at nine discreet locations evenly spaced throughout the square, and from the center of the square once the bullets had been removed.

An extensive metal detector survey was initiated to determine the outer boundary of the PRS. A grid was set up on the back area using a 6-ft spacing and these squares were grouped into 18, 90-ft squares. A statistical sampling plan called for randomly surveying 24 of the 225 six-ft squares in each of the larger 90-ft squares. Using this information and the correlation between metal detector responses and XRF soil-lead concentration, an average lead concentration was then determined for each 90-ft square.

The back area was surveyed and metal detector responses were recorded for each 6-ft square and plotted on a map of the back area. Based on the results of the survey, the PRS boundary was extended northward to include all of the smaller squares that yielded 29 or more metal-detector responses (Figure 3.0-1). The metal detector survey in the back area was conducted using 29 metal detector responses, which corresponds to 500 mg/kg of lead in soil. This was the residential screening level for lead in soil. When the Office of Solid Waste and Emergency Response (OSWER) Directive was released in July 1994 the clean up level for lead in soil for residential land use was changed to 400 mg/kg. When this change became known, the number of metal detector responses used as the action level at PRS 0-016 was changed to 22 responses (400 mg/kg of lead).Back area confirmation samples are discussed in Section 3.4.2.

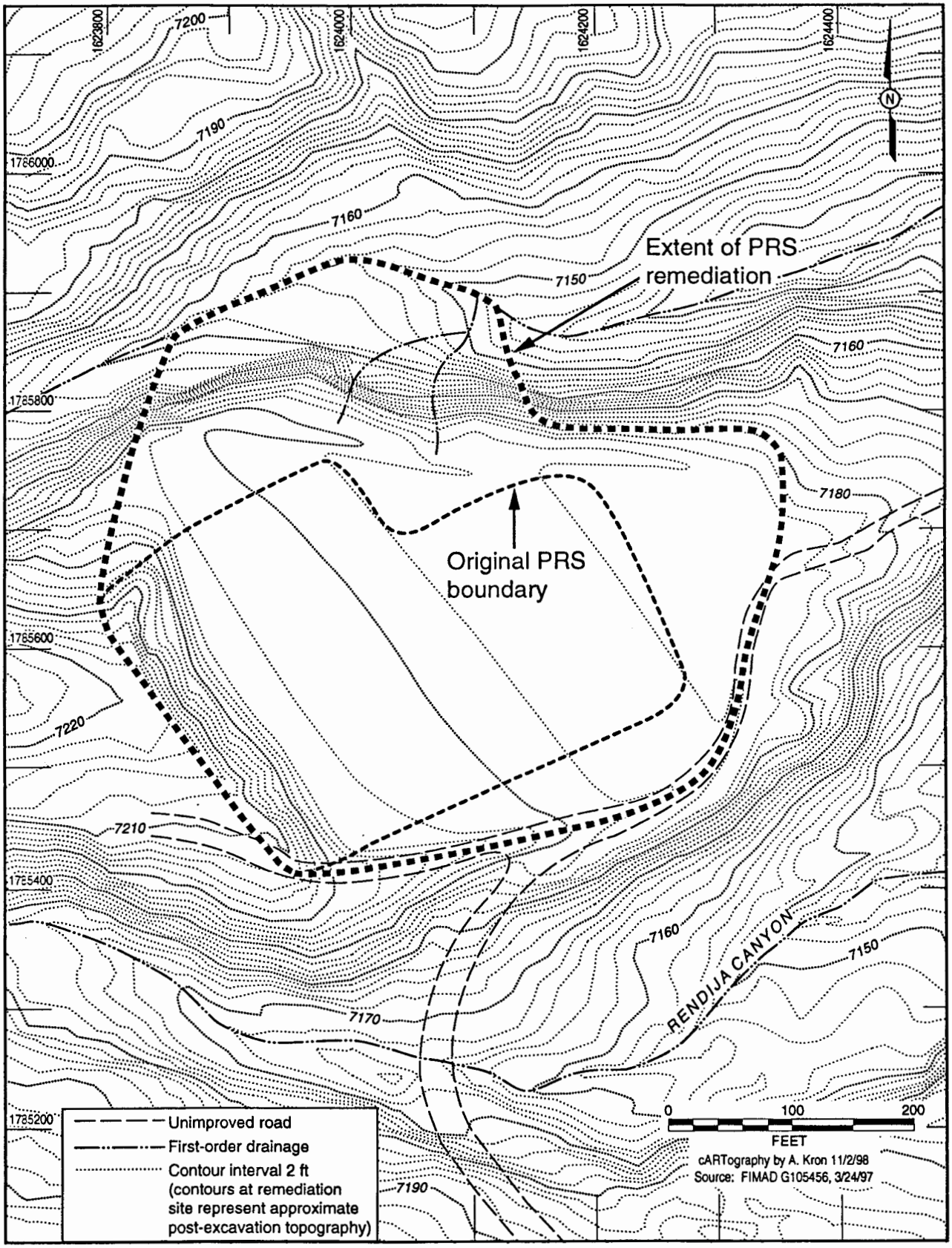


Fig. 3.0-1 Extent of PRS 0-016 remediation and original PRS boundary.

3.3.1 Soil Washing Operations

The first method used for bullet and lead fragment removal from firing range soils was soil washing. Soil remediation and lead recycling efforts at PRS 0-016 mobilized in September of 1993, and consisted of a setting up a soil washing operation designed to separate the denser lead bullets and fragments from the lighter soil. The soil washing machinery operated on the same principal as gold placer deposit mining equipment used to separate gold from stream sediment deposits. Soil washing was conducted in accordance with a VCA plan prepared in 1993 **(LANL 1994, 05-0253).** Soil washing operations were conducted between May 9 and October 18, 1994 (1994 field season), and 6,700 cubic yards of soil were processed. The outcome of the soil washing process is illustrated in Figure 3.0-2.

Description of Soil Washing Process

The soil washing apparatus used to remove lead from the firing range soils in 1994 consisted of a gold placer deposit mining plant modified to separate fine and coarse lead from soil. The soil washing process operates on the principal that most soil particles have average densities of 3 to 4 grams per cubic centimeter (g/cc), while lead has an average density of 11.4 g/cc. The difference in average densities facilitates physical separation, and concentrates and removes coarse and fine particulate lead from the soil. Larger lead fragments and bullets were separated from the coarser fraction of the soil by automated sieves and the fine lead was separated out from the finer soil fraction using a centrifugal separator.

Front-end loaders were used to move feedstock from the soil stockpile to the soil-washing plant hopper. From the hopper, a feeder carried the soil to a jigging box that removed the oversize material (boulders, cobbles, and coarse gravel), and allowed the remaining soil to continue into the system. The soil was then fed into two sand screws that, in turn fed the soil into a series of stacked power hydro-screens with 3/4-in., 1/4-in., and 1/8-in. openings. High-pressure water sprays were used to force the feedstock through the screens. The finer material that passed through the screens was then sent through a 3-ft diameter centrifugal separator, which used water and gravity to remove the fine particulate lead, by density separation. Photographs of the soil washing operation, numbers 7 through 10, are provided in Appendix J.

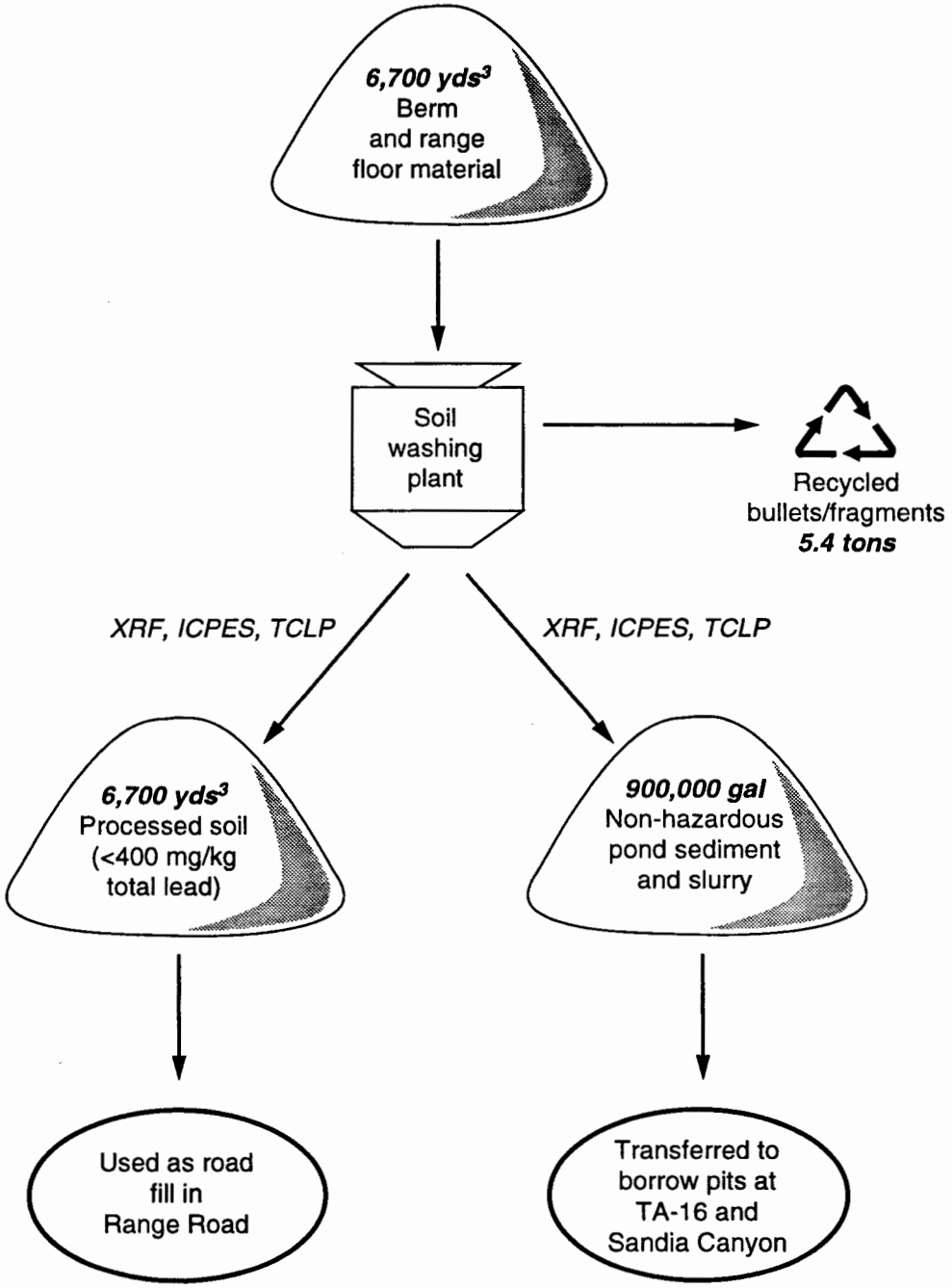


Fig. 3.0-2 Soil washing outcome.

The washed soil and associated water then flowed along a drag tank, where most of the clean soil settled out for removal to the drying area. Next, the water flowed into one of two recirculation ponds, connected by a weir, that were used to settle out the fine sediment suspended in the water, and to act as reservoirs to recirculate the water used during the soil washing process. The recirculation ponds were excavated during site preparation and were approximately 200 ft long, 40 ft wide, 7 ft deep, and lined with 60-mil seamless plastic liners to prevent the release of any water used in the soil washing process. Figure 1.0-3 shows the placement of the ponds at the site. Figure 3.0-2 is the soil washing process diagram.

Handling, Sampling and Disposition of Washed Soils

During soil washing operations, the washed soil discharged from the plant was sampled on an hourly basis for XRF screening to monitor the efficiency of the lead-removal process. These samples provided essential data for making feed rate adjustments to the soil-washing system to address changing lead concentrations in the berm feedstock as it was fed into the plant. Mixing of soils with higher and lower lead concentrations during the initial consolidation of range material was conducted to minimize the variations of the feedstock fed into the plant and thus minimize feed rate adjustments.

Washed soils were stockpiled on-site in a drying area and allowed to dry out sufficiently prior to sample collection for total-lead analysis by a fixed-analytical laboratory prior to transporting off-site. Washed soils were placed in stockpiles of approximately 125 yd^3. Each stockpile was sampled by running a sampling scoop along the surface of the stockpile from the bottom to the top of the pile to form a representative sample. Samples of washed soil were submitted to a fixed analytical laboratory for total-lead analysis in accordance with the VCA Plan (LANL, 1994, 05-0253). Samples were also submitted for TCLP-lead analysis as an additional assurance that the washed soils did not exceed the TCLP limits for lead of 5 mg/L.

Upon receipt of fixed-site analytical laboratory results that indicated a stockpile met the cleanup level of 400 mg/kg, the stockpile was released for reuse offsite as road fill in the regrading and widening of Range Road between Diamond Drive and Aspen Drive. The average lead concentration based on fixed-site laboratory results was 91 mg/kg. Stockpiles that did not meet the 400-mg/kg cleanup level, based on analytical laboratory results or preliminary XRF screening, were reprocessed through the soil-washing plant.

Handling, Sampling and Disposition of Fine Sediment

Daily water/sediment (slurry) samples were collected from the drag tank at the point of discharge into the recirculation ponds, and the ponds were sampled directly on a weekly basis to monitor the lead concentrations. Water/sediment samples were also periodically collected from the pump-trucks that were used to remove the sediment from the ponds before leaving the site. These samples consisted of slurry that was allowed to settle, so the water and the solids (sediment) could be analyzed independently. Sediments were screened on-site by XRF and submitted to a fixed-site analytical laboratory for copper, lead, zinc and TCLP lead analysis. Water samples were submitted to a fixed-analytical laboratory for total metals (unfiltered sample) and dissolved metals (filtered sample) in accordance with the New Mexico ground water and surface-water standards.

The slurry was transported by pump trucks to Sigma Mesa in TA-60, and placed in the borrows pit in Sandia Canyon across from TA-53 for drying and subsequent use as an industrial fill material. Approximately 900,000 gallons of slurry were pumped from the ponds.

Handling and Disposition of the Coarse Material Fraction

The coarse material fraction (gravel, cobbles, and boulders) that was separated from the soil during soil-washing plant processing was stockpiled separately with the intent of being transferred offsite for use as fill material. The coarse fraction was later reprocessed through the shaker plant during operations in 1996 and 1997 (Section 3.3.3 Initial Full Scale Shaker Plant Operations and Materials Disposition) because it was inadvertently combined with unwashed berm feedstock during soil washing plant demobilization.

3.3.2 Change from Soil Washing to Shaker Plant Processing

At the beginning of the 1995 field season, the active firing range used by Protection Technology of Los Alamos (PTLA) at TA-72 needed several thousand cubic yards of soil to improve the backstop berms. After determining that TA-72 would accept the PRS 0-016 soils in their unprocessed form, the option of moving the soil to the active PTLA firing range for re-use was presented to the New Mexico Environment Department (NMED). NMED considered this option to be a cost-effective and a "good common sense" alternative to washing the remaining soil, primarily because the material would continue to be used for target practice. Re-mobilization of the soil washing operations, which had been initiated on April 10, 1995, was discontinued based on a May 17, 1995 letter (ER ID 46257) from the NMED stating that they would approve moving

the soil if certain conditions were met. Soil washing equipment was subsequently disassembled for final demobilization and was demobilization was completed on June 6, 1995.

After LANL complied with the five conditions of the approval required in the May 17, 1995 NMED letter, the NMED and EPA Region VI further determined that the soil should not be moved to TA-72 without first being processed to remove a majority of the lead bullets from the soil for recycling. Because the soil-washing contractor had demobilized from the site, other alternatives, such as dry-sieving, were investigated in an effort to complete the lead removal and recycling more quickly and cost effectively.

Subsequently, a second VCA plan was developed in 1996 (LANL, 1996, 54839.2) to present an approach to removing a sufficient quantity of lead from the remaining soil to allow transfer of the material to the active PTLA firing range for re-use as berm material. The method presented in the 1996 VCA plan was dry sieving using a shaker plant system to remove bullet-sized fraction from the soil. This method was selected because it was comparable to soil washing for removing a majority of lead from the soil and was expected to require far less mobilization time, labor, and processing time.

3.3.3 Shaker Plant Operations

Dry sieving of the soil to remove the grain-size fraction that contained the bullets was determined to be a relatively quick, effective, and inexpensive method for removing a majority of the lead to facilitate transfer of the soil to TA-72. Most of the bullets observed in the firing range soils ranged in size from .22 to .45 caliber (11/50-in. to 9/20-in.). The dry-sieving process was designed to separate out the fraction of the soil that contained bullets of this size by selecting one set of screens with openings slightly smaller than .22-caliber bullets and another set slightly larger than .45-caliber bullets. Because a majority of the lead in soils at the site consisted of bullets and not fine lead fragments, removal of the bullet-size fraction of the soils greatly reduced the total lead content. Shaker plant operations were conducted in 1996 and 1997 and 7,000 yd^3 of soil were processed by dry sieving. Photographs, numbers 11 through 15, showing the shaker plant operations, are in Appendix J.

Pilot Study

A pilot study was conducted from April 29 to May 6, 1996 to ensure that the dry-sieving method was effective, and to provide the NMED with sufficient data to obtain their approval of the method. A Read™ shaker plant consisting of sand and gravel dry-sieving apparatus equipped with various sizes of slotted wire screens. The screens used were slotted harp-wire screens with 3/16-in. and 1/2-in. openings (equivalent to .19 and .50 caliber, respectively). The slotted-screen design allows the larger bullets to pass through by their smallest dimension. The feedstock processed during the pilot study was first sieved with a 1/2-in. screen to separate the bullet-size and finer material from the oversize material, then the screens were changed to 3/16-in., and the material was re-screened to separate the bullet-size from the fine material. Approximately 600 cubic yards of berm feedstock was sieved which yielded 375 yd^3 of material finer than the bullet-size fraction (fines), 175 yd^3 of material larger than the bullet-size fraction (oversize), and 50 yd^3 of bullet-size material.

Description of Full-Scale Shaker Plant Process

Full-scale sieving operations were conducted using a more complex Production Engineered Products™ (PEP) shaker-plant system in conjunction with the Read shaker. The PEP shaker is equipped with a double-screen box, which allows separation of the feedstock into the three desired sizes (oversize, bullet-size, and fines) with a single pass through the plant. This eliminates the need to change out the screens and reprocess the feedstock a second time to achieve separation of feedstock into three discrete sizes. The berm feedstock was first processed through the Read shaker using a 7/8-in. screen to remove the coarser gravel, cobbles, and boulders prior to processing through the PEP shaker for the final separation. Removing the larger material with the 7/8-in. screen in a separate shaker greatly improved the efficiency of the PEP shaker plant.

As with the soil-washing process, the shaker-plant process was started by using front-end loaders to move feedstock from the soil stockpiles to the shaker-plant hopper. The range floor was occasionally sprayed with water, as needed, to minimize the amount of lofted dust resulting from heavy-equipment traffic.

Initial Full-Scale Shaker Plant Operations and Material Disposition

Full-scale sieving operations began on July 31, 1996 and were completed on September 27, 1996. Soil that was finer than the bullet-size fraction 3/16-in.), and determined to be non-hazardous, was transported to TA-72 for re-use as berm material. The fine-grained material that was determined to be hazardous (using analysis for TCLP lead) was shipped off-site for disposal

at a RCRA landfill. The fine-grained soil fraction was placed in 25 yd^3 stockpiles. Each of the stockpiles was sampled for lead by TCLP. The method for obtaining a representative sample from each stockpile is described in Section 3.3.5 Deviations from VCA Plans. Material coarser than the bullet-size fraction (>1/2 in.) was transported to TA-16 for use as industrial fill material. The outcome of the shaker plant process is presented as Figure 3.0-3.

Upon completion of processing all feedstock on-site, the bullet-size fraction consisted of approximately 1,235 yd^3 of gravel containing all the recovered bullets. It was anticipated that this material would be suitable for recycling, however, the ratio of bullets to gravel was such that the material was not acceptable to recycling facilities. Further processing to concentrate the lead was required to facilitate recycling as described below.

Remobilization and Use of Impact Crusher

On January 2, 1997, shaker plant operations were remobilized for further processing of the 1,235 yd^3 of bullet-size material. Re-processing of the gravel was conducted between January 3, 1997 and February 3, 1997, and began with re-sieving the bullet-size material using a PEP shaker plant with a 3/16-in. screen to remove all of the residual fines in the gravel. Because most of the gravel consisted of soft volcanic tuff, a significant amount of fines were generated in the process of re-sieving due to breakage of the soft gravel. Following re-sieving, an impact crusher was used to further reduce the gravel to fine material. Photograph number 16, in Appendix J shows the impact crusher.

On February 4, 1997 a diesel-powered, vertical-shaft impact crusher was mobilized to the site. Crushing activities were conducted between February 4, 1997 and February 19, 1997. After performing several trial runs at different speeds, the bullet-size gravel was processed through the crusher at 1,500 revolutions per minute (rpm) which sufficiently pulverized the softer tuff gravel while only causing minimal deformation of the lead bullets. The harder gravel in the bullet-size materials did not readily crush at the relatively low crusher speed of 1,500 rpm. The speed could not be increased because of the potential for shattering of the bullets into small lead fragments, which would not be captured during final sieving of the crushed material through a 3/16-in. screen. The crusher was demobilized on February 20, 1997 and final sieving of the crushed material containing the bullets was conducted between February 20, 1997 and March 5, 1997. Crushing and re-sieving operations reduced the 1,235 yd^3 of bullet-size material to approximately 115 yd^3 of bullet-size material consisting of bullets and hard-rock gravel.

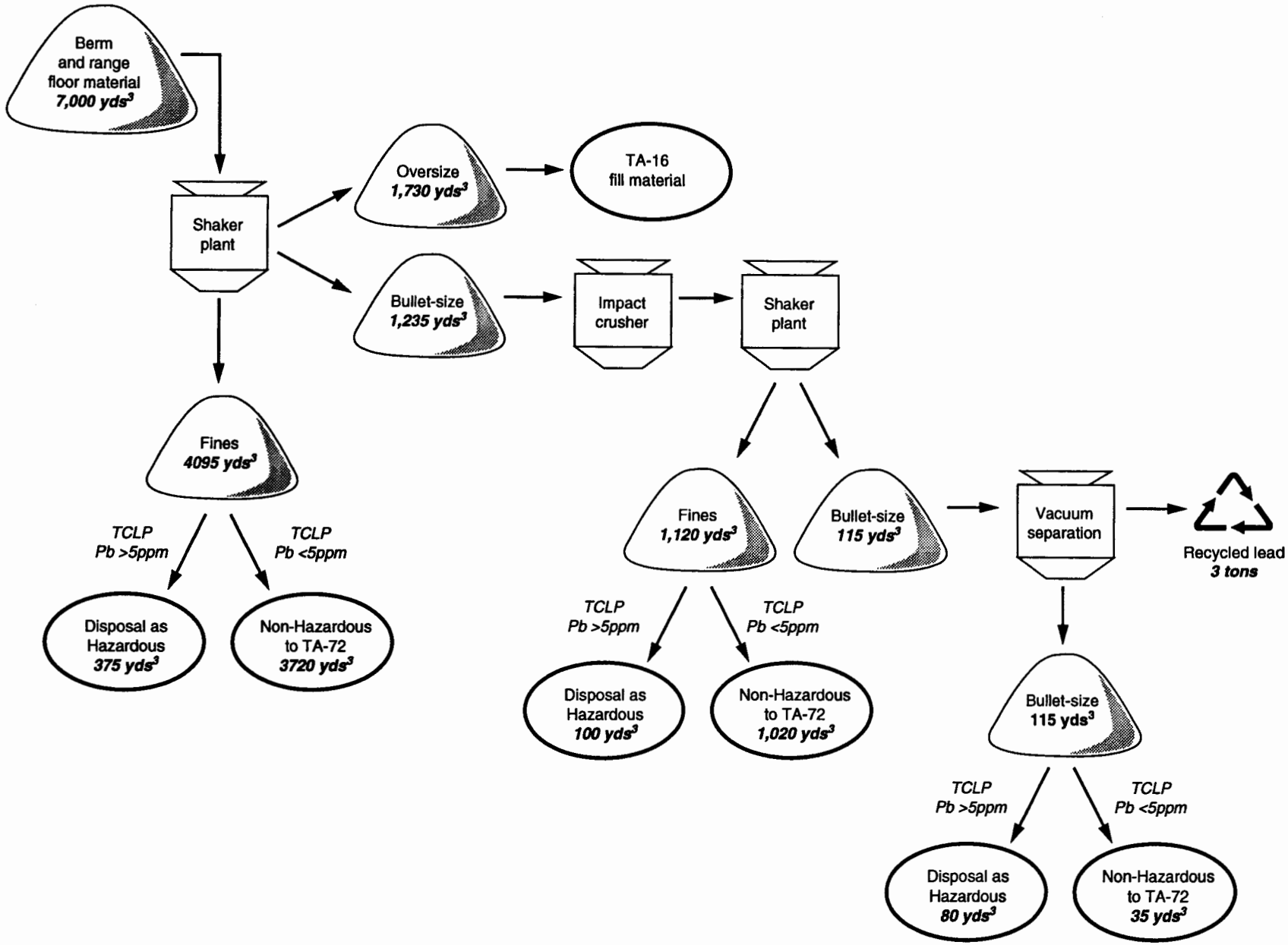


Fig. 3.0-3 Shaker plant outcome.

Use of Vacuum Truck for Final Separation

Although the lead content in the gravel was increased dramatically through the crushing and re-sieving process, the lead content in the 115 yd^3 of bullet-size gravel was only about 5 percent by volume, which was still not acceptable to recycling facilities. Following a thorough investigation of alternatives, it was determined that the most effective method for producing "clean lead" for recycling entailed using a vacuum-truck system to lift the lighter gravel away from the heavier lead. The vacuum truck operations were conducted between March 12, 1997 and March 24, 1997. Three tons of "clean lead" were recovered using the vacuum system, however, a majority of the gravel that was lifted away from the lead failed TCLP analysis due to small, flat pieces of lead that were picked up along with the gravel during the vacuum process. This gravel (totaling 80 yd^3) were disposed of as hazardous waste. Photograph number 17, in Appendix J, shows the vacuum truck operations.

3.3.4 Site Restoration

Site restoration was completed in the back area and range floor after completing confirmatory sampling. Restoration activities included re-contouring, grading, installing permanent storm water run-off and erosion controls, and re-vegetating denuded areas. Photographs numbers 18 through 22, in Appendix J, show site restoration.

3.3.4.1 Range Floor Site Restoration

Restoration of the range floor was conducted between April 11 and April 29, 1997. After receiving analytical results for confirmation samples collected from the range floor that verified all soils containing lead above cleanup levels had been removed, the site was cut to a grade desired by the private land developer, sloped for proper surface water drainage, and the edges were contoured to match the surrounding topography in accordance with the USDA Forest Service specification. The site was then covered with a 1-ft thick layer of base coarse in preparation for immediate use by the private land developer as a heavy-equipment staging area. The only erosion-prone slope associated with the range floor area is along the inside of the north fence line, immediately above the back area hillside. This narrow strip of land was tilled, seeded, fertilized, and mulched with straw to facilitate revegetation and prevent erosion. The area is currently well revegetated and no evidence of erosion was observed during recent inspections.

3.3.4.2 Back Area Site Restoration

Restoration of the back area began on August 29 and was completed on September 28, 1994. Following excavation of contaminated soils from the back area hillside, clean top soil was imported from LANL TA-16 to replace what had been removed during remediation of the area and facilitate revegetation of the hillside. A native seed mixture was planted and the entire area was covered with biodegradable erosion-control matting. By 1996 the area was well vegetated and no significant erosion was observed on the hillside.

3.3.5 Deviations from VCA Plans

During initial VCA implementation under the 1994 VCA plan, some deviations were required to effectively complete site remediation and ensure all soils were adequately characterized before removal from the site. The VCA Plan indicated that washed soils and recirculation-pond sediments would be analyzed primarily by XRF with an additional 20 confirmatory samples of these materials analyzed for total copper, lead, and zinc by EPA SW-846 at a fixed-site laboratory to support XRF results. No TCLP analysis was specified in the 1994 VCA plan; however, samples of unprocessed soils and sediments/slurries were collected for analysis of lead by TCLP to ensure that RCRA limits for hazardous waste were not exceeded.

The 1994 VCA plan specified that the top 2 feet of the range floor was to be scraped up and added to feedstock to be processed through the soil washing plant. During initial consolidation of the berms and range floor soils, only 1 ft of the range floor was scraped up for processing to avoid generating excessive feedstock that was likely to contain very little lead. After all the consolidated feedstock was processed and removed from the site, additional scraping occurred during the final stage of the VCA in areas identified by field screening that exceeded the clean up level. The additional scraping was followed by confirmatory sampling. This activity is discussed in Section 3.4.1 Range-Floor Confirmatory Sampling .

The 1996 VCA Plan specified that a tube sampler would be used to collect composite samples from a cross-section of the 25 yd^3 stockpiles; however, it was found to be ineffective because the fine soil fraction was very loose, moist, and rich in clay. The condition of the fine soil fraction caused the tube sampler to plug off after advancing through the upper 12 to 18 in. of material. The tube sampler was to be advanced to its entire length of 5 feet, into each stockpile at a single location, to collect a composite sample of soil ranging from the middle of the outer flank (side-slope) to the center of the pile. Because each 25 yd^3 stockpile consisted of six loader-buckets of

material at 4.2 yd^3 per bucket, that were placed consecutively on top of each other, the first bucket-load removed from the shaker is located at the bottom center of the stockpile. The last bucket-load is essentially the outer surface of the pile. The 25 yd^3 stockpiles are 6 feet high and 20 feet wide at the base; therefore, the distance from the middle of the side-slope to the central interior of the pile is approximately 5 feet. By using a shovel to expose a 5-foot deep cross-section of each stockpile, collection of an equivalent sample was achieved.

The 1996 VCA plan stated that the bullet-sized material generated as a result of shaker plant processing must consist of at least 50-percent lead to facilitate recycling or it would have to be further processed. Following initial separation, the bullet-size fraction did not meet these criteria. Further processing activities completed to concentrate the lead included an impact crusher to reduce the gravel to fines that could be sieved out with the shaker plant, and use of a vacuum system to lift hard gravel, that could not be reduced, away from the lead. Available recycling facilities also indicated that they could not accept the lead unless it was free of all gravel, which was eventually achieved.

3.4 Confirmatory Sampling

Confirmatory sampling was conducted in the range floor, the back area, the right of way, and the first order drainages, following excavation and processing of contaminated soils to confirm that all materials containing elevated concentrations of copper, lead, and zinc had been removed from the site. Locations of confirmatory samples are shown on Figure 3.0-4. All confirmatory samples were submitted to a fixed-site analytical laboratory for analysis of total recoverable copper, lead, and zinc by EPA SW-846 Methods-. The analytical data is presented in Table D-2 of Appendix D. Table 3.4-1 summarizes the confirmation samples collected at PRS 0-016.

TABLE 3.4-1
SOIL CONFIRMATION SAMPLES COLLECTED AT PRS 0-016

Location ID	Sample ID	Sample Type	Depth (In.)	Media	Metals Copper, Lead, Zinc
00-04738	0100-96-0031	Grab	0-6	Soil	1856
00-04740	0100-96-0033	Grab	0-6	Soil	1856
00-04741	0100-96-0034	Grab	0-6	Soil	1856
00-04739	0100-96-0036	Grab	0-6	Soil	1856
00-05470	0100-96-1570	Grab	0-6	Soil	2664
00-05471	0100-96-1571	Grab	0-3	Soil	2664
00-05472	0100-96-1572	Grab	0-6	Soil	2664
00-5971	0100-97-0216	Grab	6	Soil	3631

TABLE 3.4-1
SOIL CONFIRMATION SAMPLES COLLECTED AT PRS 0-016
(continued)

Location ID	Sample ID	Sample Type	Depth (in.)	Media	Metals (Copper, Lead, Zinc)
00-5972	0100-97-0217	Grab	6-8	Soil	3631
00-5973	0100-97-0218	Grab	6-8	Soil	3631
00-5974	0100-97-0219	Grab	4-6	Soil	3631
00-5975	0100-97-0220	Grab	4-6	Soil	3631
00-5976	0100-97-0221	Grab	10-12	Soil	3631
00-5977	0100-97-0222	Grab	8-10	Soil	3631
00-5978	0100-97-0223	Grab	10-12	Soil	3631
00-5979	0100-97-0224	Grab	8-12	Soil	3631
00-5980	0100-97-0225	Grab	8-10	Soil	3631
00-5981	0100-97-0226	Grab	8-10	Soil	3631
00-5982	0100-97-0227	Grab	11-12	Soil	3631
00-5983	0100-97-0228	Grab	10-12	Soil	3631
00-5984	0100-97-0229	Grab	10-12	Soil	3631
00-5985	0100-97-0230	Grab	10-12	Soil	3631
00-5986	0100-97-0231	Grab	12-14	Soil	3631
00-5987	0100-97-0232	Grab	6-10	Soil	3631
00-05451	0100-96-1551	Grab	0-6	Soil	2653
00-05452	0100-96-1552	Grab	0-6	Soil	2653
00-05453	0100-96-1553	Grab	0-6	Soil	2653
00-05454	0100-96-1554	Grab	0-6	Soil	2653
00-05455	0100-96-1555	Grab	0-6	Soil	2653
00-05456	0100-96-1556	Grab	0-6	Soil	2653
00-05457	0100-96-1557	Grab	0-6	Soil	2653
00-05458	0100-96-1558	Grab	0-6	Soil	2653
00-05459	0100-96-1559	Grab	0-6	Soil	2653
00-05460	0100-96-1560	Grab	0-6	Soil	2653
00-05461	0100-96-1561	Grab	0-6	Soil	2653
00-05462	0100-96-1562	Grab	0-6	Soil	2653
00-05463	0100-96-1563	Grab	0-6	Soil	2653
00-05464	0100-96-1564	Grab	0-6	Soil	2653
00-05465	0100-96-1565	Grab	0-6	Soil	2653
00-05466	0100-96-1566	Grab	0-6	Soil	2653
00-05946	0100-97-0141	Grab	0-6	Soil	3025
00-05947	0100-97-0142	Grab	0-6	Soil	3025
00-05948	0100-97-0143	Grab	0-6	Soil	3025
00-05949	0100-97-0144	Grab	0-6	Soil	3025
00-05950	0100-97-0145	Grab	0-6	Soil	3025
00-05951	0100-97-0146	Grab	0-6	Soil	3025
00-05952	0100-97-0147	Grab	0-6	Soil	3025
00-05474	0100-97-0140	Grab	0-6	Soil	2921
00-1422	AAA6273	Grab	0-9	Soil	17166

TABLE 3.4-1
SOIL CONFIRMATION SAMPLES COLLECTED AT PRS 0-016
(continued)

Location ID	Sample ID	Sample Type	Depth (in.)	Media	Metals (Copper, Lead, Zinc)
00-1422	AAA6274	Grab	0-9	Soil	17166
00-1423	AAA6275	Grab	0-9	Soil	17166
00-1424	AAA6276	Grab	0-9	Soil	17166
00-1425	AAA6277	Grab	0-9	Soil	17166
00-1426	AAA6278	Grab	0-9	Soil	17166

3.4.1 Range-Floor Confirmatory Sampling

Sample locations were randomly selected based on a 50-ft grid projected over the range-floor area in accordance with the Sampling and Analysis Plan (SAP) for confirmation/verification sampling, which is contained in the 1996 VCA plan (LANL 1996, ER ID 05-0254). In order to acquire a representative distribution of random sample locations, samples were collected from the perimeter of the range floor, the pond area, the soil-stockpile area, and the soil-washing plant area. A random selection of sample grid locations was performed individually for each area to ensure sufficient sample coverage for final confirmation/verification of VCA completion as described in the SAP (LANL 1996, ER ID 05-0254). If the site had been sampled as a single area, some distinct areas could have remained unsampled as a result of randomly selecting sample locations. Sixteen confirmatory samples were collected. Sample concentrations ranged from 10.5 to 85.6 mg/kg lead. Confirmatory sample results are provided in Table D-2 of Appendix D.

After completing the initial full-scale shaker plant operations, 16 discrete grab samples were collected on September 26, 1996 from the upper 6-in of the firing range floor. These samples were collected to confirm that all soils containing total lead concentrations greater than the cleanup level of 400 mg/kg had been removed from the site. Due to a remobilization of the shaker plant and crusher in late 1996, a second set of eight confirmation samples was collected to ensure the remobilization activities did not contribute contamination to the range floor. Sample concentrations ranged from 3.7 to 66.0 mg/kg lead. These samples were collected in areas impacted by shaker plant and crusher operations because other areas were previously confirmed to be below the 400-mg/kg lead cleanup level. Eight confirmatory samples were collected. Confirmatory sample results are provided in Table D-2 of Appendix D.

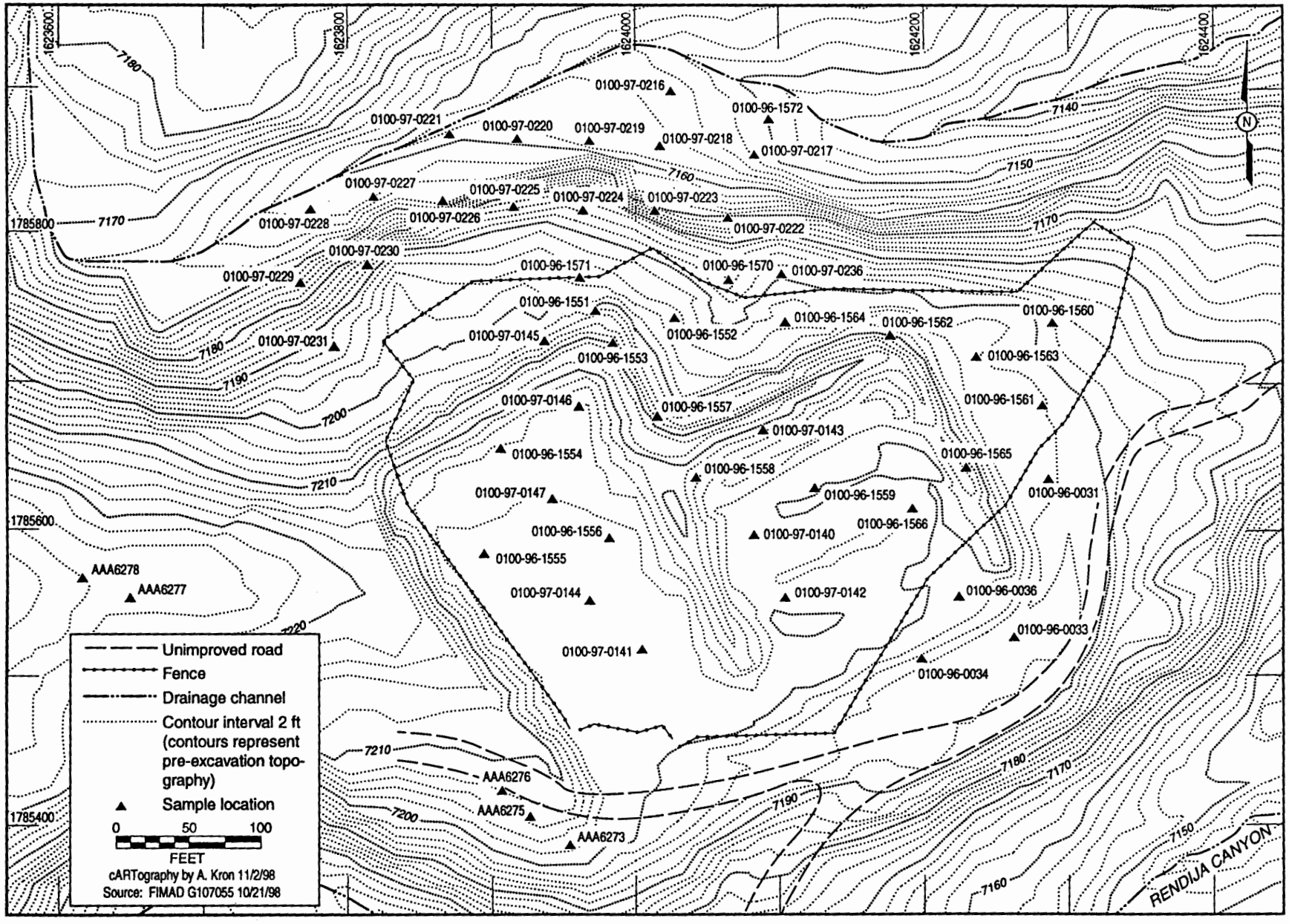


Fig. 3.0-4 PRS 0-016 confirmation sample locations.

3.4.2 Back Area Confirmatory Samples

Seventeen confirmatory samples were collected from back-area soils on August 1997 following removal of all materials that failed field-screening criteria to ensure that all soils containing lead concentrations greater than the cleanup level of 400 mg/kg had been removed. Locations of these samples were based on a grid with a 50-ft spacing projected over the back area. The grid size used was based on the original grid size specified in the 1996 VCA plan. One grab sample was collected from the center of each of the grid spaces. Samples were collected in native soil beneath imported topsoil that was emplaced in September 1994 to facilitate revegetation of the hillside (see Section 3.3.4.1 Back Area Site Restoration). Native soil beneath the topsoil was easily distinguished based on color. Sample concentrations ranged from 5.8 to 52.7 mg/kg lead. Confirmatory sample results are provided in Table D-2 of Appendix D. Locations of back area confirmation samples are shown on Figure 3.0-4.

3.4.3 Right-of-Way Confirmation Sampling

The range floor along the eastern edge of the PRS boundary was sampled on March 4, 1996 to allow the release of this portion of the site to the private land developer (Figure 3.0-4). This portion of the site encroached on the private land developer's utility right-of-way. Sampling was conducted in accordance with the SAP for confirmation/verification sampling of the range floor and the SAP for release of right-of-way (LANL 1996, ER ID 05-0254). Originally the site boundary was extended to the east to provide additional space to accommodate soil-washing operations. A 50-ft grid was established over the area to be released, and soil samples were collected from each of the grid spaces for XRF screening. Once the XRF screening results indicated lead concentrations were less than the cleanup level, confirmatory samples were collected from four randomly selected sample locations within the grid. Sample concentrations ranged from 24.8 to 81.8 mg/kg lead. Confirmatory sample results are provided in Table D-2 of Appendix D.

3.4.4 First-Order Drainage Confirmatory Sampling

Confirmatory samples were collected from the upper 6-in. of sediment in the primary first-order drainages that captured the bulk of surface water run-off from the site during VCA operations. Locations of channel sediment samples are shown on Figure 3.0-4. These locations were determined in the field, based on examination of the surface-water drainage system. These drainages are located in the central and western portion of the back-area hillside and originate on the range floor. Three confirmatory samples were collected. Sample concentrations ranged from 40.8 to 70.6 mg/kg lead. Confirmatory sample results are provided in Table D-2 of Appendix D.

3.5 Confirmatory Sampling Data Review

3.5.1 Data Quality

The inorganic fixed laboratory analytical data from the VCA are presented in Table D-2 in Appendix D. A QA/QC assessment on the inorganic data was conducted. For Request Number 1856 four soil samples were analyzed for copper, lead, and zinc. Copper had a low recovery of 74.8% in the matrix spike sample. The matrix spike sample is used to assess the quality of the sample digestion, extraction, and analysis procedures. A low recovery suggests that either there was an incomplete recovery of an analyte in these procedures or there was a problem with sample heterogeneity. For analytes where the matrix spike is out of control limits, a post digestion spike is performed. The post digestion spike is used to assess the sample extraction and analysis procedures. The post digestion spike percent recovery for copper was 116.3%, within the control limits of 75-125%. The laboratory control sample percent recovery for copper in this sample delivery group was 99.2%, also within control limits. As required by LANL data validation guidelines, J- qualifiers were added to the four copper results in this sample delivery group. The copper results in this sample delivery group are, however, valid and usable for the following reasons. The matrix spike recovery was outside of control limits by less than 1% at 74.8 %. The post digestion recovery was within control limits for copper, and the laboratory control sample recovery for copper was also within control limits.

Further, the four soil samples in Request number 1856, the four copper results should be regarded as estimated (J), because copper was detected below the method detection limit, but above the instrument detection limit.

For Request Number 2653 sixteen soil samples were analyzed for copper, lead, and zinc. Lead had a low recovery of 63% in the matrix spike sample. The matrix spike sample is used to assess the quality of the sample digestion, extraction, and analysis procedures. A low recovery suggests that either there was an incomplete recovery of an analyte in these procedures or there was a problem with sample heterogeneity. For analytes where the matrix spike is out of control limits, a post digestion spike is performed. The post digestion spike is used to assess the sample extraction and analysis procedures. The post digestion spike percent recovery for lead was within the control limits of 75-125%. The laboratory control sample percent recovery for lead in this sample delivery group was 105% also within control limits. As required by LANL data validation guidelines, J- qualifiers were added to the sixteen lead results in this sample delivery group. The lead results in this sample delivery group are, however, valid and usable for the following reasons.

The matrix spike recovery was outside of control limits at 63%. According to the EPA Fundamental Guidelines for Inorganic Data Review, if the matrix spike recovery is below 75% but above 30%, the data is usable and qualified estimated (J-). The data is only rejected if the matrix spike recovery is below 30%. The post digestion recovery was within control limits for lead. Finally, the laboratory control sample recovery for lead was also within control limits.

All other confirmation data in the VCA is usable without qualifiers.

3.5.2 Inorganic Chemical Comparison to Background Values

This section presents the comparison of inorganic chemical concentrations in VCA confirmation samples to background values (BVs). The complete analytical data set is included in Appendix D. The frequencies of detection and the reported range of concentrations for copper, lead, and zinc during the VCA are summarized in Table 3.5-1. Lead was the only COPC detected above the BVs. It is detected at concentrations greater than BV in 22 of 54 samples.

TABLE 3.5-1

PRS 0-016 FREQUENCY OF DETECTED INORGANIC CHEMICALS

Analyte	Media	Number of Samples Analyzed	Number of Detects	Concentration Range (mg/kg)	Laboratory All Soils Background Screening Value (mg/kg)	Frequency of Detects Above All Soils Background Screening Value
Copper	Soil	54	54	1.9-11.5	14.7	0/54
Lead	Soil	54	54	3.7-85.6	22.3	22/54
Zinc	Soil	54	54	12.6-42	48.8	0/54

With the exception of the four right-of-way samples, (that were analyzed by graphite furnace atomic absorption) all samples were analyzed by inductively coupled plasma emission spectroscopy (ICPES). Table D-1 in Appendix D presents the EPA Method 6010 detection limits for copper, lead, and zinc. A summary of these samples and results is listed in Table D-2 in Appendix D. The detection limits for the analytical methods employed were all less than BVs as given in "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory"(LANL 1998, ER ID 58093).

Table 3.5-2 summarizes the confirmation samples with lead concentrations above background and Figure 3.0-5 shows the locations of these 22 samples.

TABLE 3.5-2
CONFIRMATORY SAMPLES WITH LEAD VALUES ABOVE BV FOR LEAD

Request Number	Sample ID	Location ID	Sample Depth (In.)	Total Copper (mg/kg)	Total Lead (mg/kg)	Total Zinc (mg/kg)
Background Values (mg/kg)				14.7	22.3	48.8
Back Area (5 out of 17 samples)						
3631	0100-97-0217	00-5972	6-8	6.3	38.1	25.8
3631	0100-97-0219	00-5974	4-6	5.5	28.4	21.4
3631	0100-97-0221	00-5976	10-12	5.9	29.0	22.5
3631	0100-97-0222	00-5977	8-10	6.4	35.5	22.6
3631	0100-97-0229	00-5984	10-12	6.8	52.7	30.1
Range Floor – First Sampling Event (9 out of 16 samples)						
2653	0100-96-1551	00-05451	0-6	6.8	51.3 J-	31.3
2653	0100-96-1553	00-05453	0-6	9.0	42.4 J-	31.3
2653	0100-96-1556	00-05456	0-6	7.6	63.1 J-	42.0
2653	0100-96-1557	00-05457	0-6	8.0	63.8 J-	32.5
2653	0100-96-1558	00-05458	0-6	8.6	64.8 J-	34.4
2653	0100-96-1560	00-05460	0-6	6.5	42.8 J-	26.5
2653	0100-96-1561	00-05461	0-6	6.0	23.7 J-	33.6
2653	0100-96-1565	00-05465	0-6	7.0	60.0 J-	31.7
2653	0100-96-1566	00-05466	0-6	4.2	85.6 J-	29.8
Range Floor – Second Sampling Event (1 out of 8 samples)						
3025	0100-97-0143	00-05948	0-6	7.7	66.0	24.0
Right-of-Way (4 out of 4 samples)						
1856	0100-96-0031	00-04738	0-6	4.5 J-	45.6	30.5
1856	0100-96-0033	00-04740	0-6	3.6 J-	39.0	30.2
1856	0100-96-0034	00-04741	0-6	4.8 J-	81.8	31.7
1856	0100-96-0036	00-04739	0-6	10 J-	24.8	39.2
First Order Drainage (3 out of 3 samples)						
2664	0100-96-1570	00-05470	0-6	7.2	40.8 J-	28.9
2664	0100-96-1571	00-05471	0-3	9.5	70.6 J-	31.2
2664	0100-96-1572	00-05472	0-6	7.0	58.6 J-	29.3

Table 3.5-3 summarizes the results of the inorganic data review. Lead is the only analyte retained as a COPC.

TABLE 3.5-3

PRS 0-016 RESULTS OF INORGANIC DATA REVIEW

Analyte	Media	Result	Rationale
Copper	All Soils Horizon	Eliminated	No samples exceed the All Soils background screening level for copper.
Lead	All Soils Horizon	Retained	Retained as COPC because 22 sample values exceeded the all soils background level.
Zinc	All Soils Horizon	Eliminated	No samples exceed the All Soils background screening level for zinc.

3.5.3 Radionuclide Comparison with Background/Fallout Concentrations

The only COPCs at the small arms firing range were inorganic chemicals. There is not a radionuclide component to PRS 0-016.

3.5.4 Evaluation of Organic Chemicals

The only COPCs at the small arms firing range were inorganic chemicals. Samples collected from PRS0-016 were not analyzed organic compounds.

3.6 Revised Site Conceptual Model

A revised conceptual model for PRS 0-016 reflects the results of sampling results and provides an update on the current physical condition of the site. The VCA activities, as well as subsequent changes by the private land developer, have substantially altered the site and the potential exposure pathways.

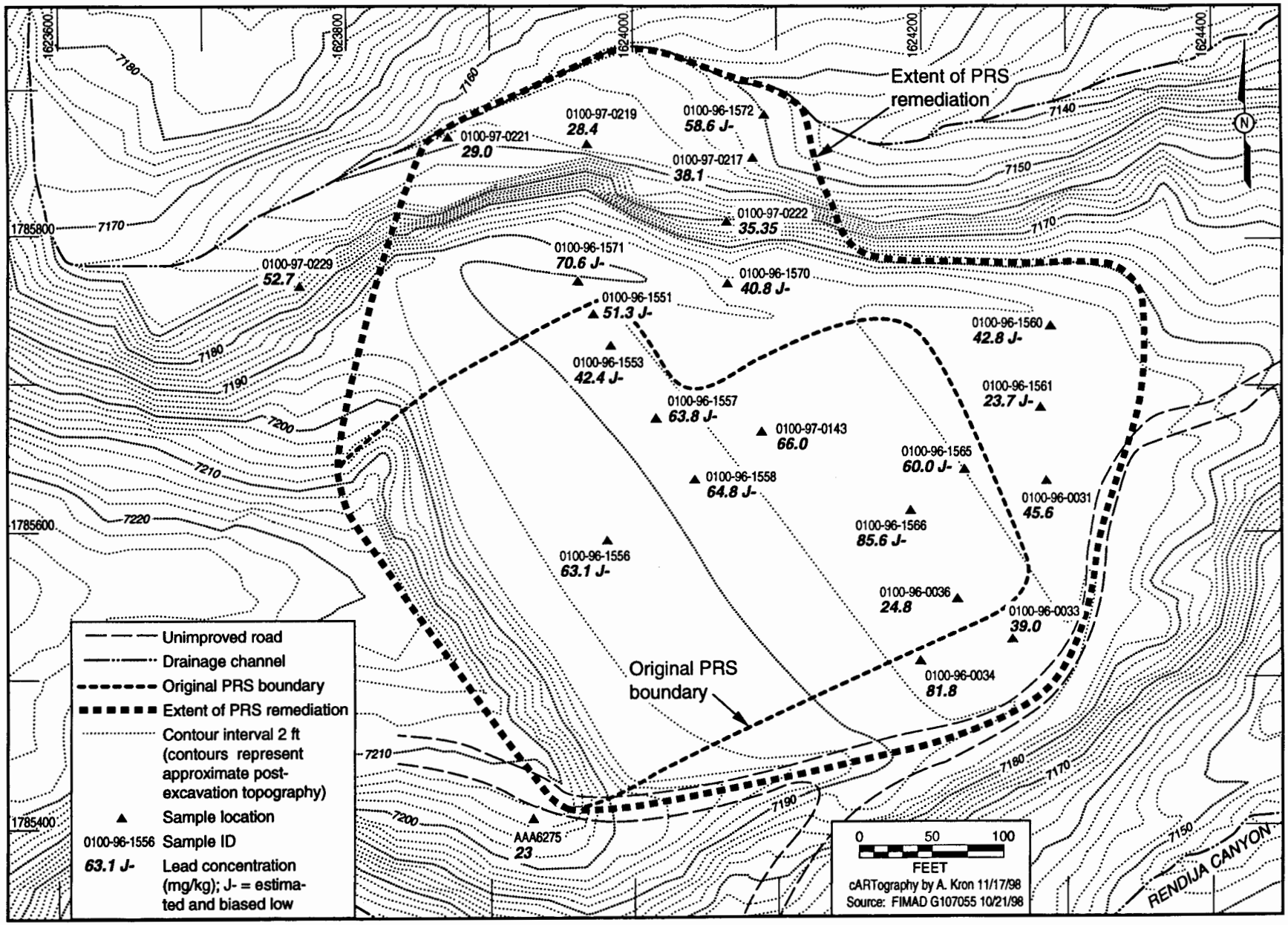


Fig. 3.0-5 Total lead concentration (mg/kg) in confirmation samples for samples with lead concentrations greater than background.

The private land developer further altered the entire range floor area to meet his requirements following the VCA. These alterations included the extensive removal of residual range floor soils and weathered tuff (approximately 1 to 4 ft. vertical depths) from across the 2-acre site. The removal was followed by regrading and the application of a new 12-in. layer of base course. As part of the VCA restoration, the back area also received an application of topsoil (4 to 12 in.) prior to the placement of erosion matting and seeding in September 1994. Depositing base course and topsoil on the site effectively decrease potential for exposure through surface soil exposure pathway to humans and the biota.

3.6.1 Nature and Extent of Contamination

Based on the physical process that created contamination at this site (the firing of bullets into targets), it was expected that lead concentration should decrease with increasing distance from and depth beneath the surficial firing range material. The decreasing concentrations were pursued, using metal detector responses, XRF lead results, and fixed laboratory results for copper, lead, and zinc. Horizontal and vertical extent was determined when residual concentrations were well less than the cleanup levels for copper, lead, and zinc, based on fixed-site laboratory analytical confirmation sample results.

3.6.1.1 Horizontal Extent

In defining horizontal extent at PRS 0-016, the back area behind the earthen berms is the primary consideration. This is because the targets at the range were set up in front of the backstop berms, such that the berms would collect the bullets. As noted previously in Section 3.3 Remedial Operations, Back Area, it was likely that an older backstop berm had been moved onto the back slope based on visual observation of a disturbed soil area behind the berm that existed when the cleanup effort began.

Figure 3.0-6 illustrates the areas where metal detector responses during the beginning phase of this VCA (as explained in Section 3.2.1) were used to map the horizontal boundaries of the site. Light gray areas indicate areas with less than 29 responses per 6-ft grid or, lead values less than the 1994 cleanup level of 500 mg/kg (see section 3.3 Remedial Operations, Back Area). The areas shaded in dark gray indicate more than 29 responses by 6-ft grid or lead concentrations above the 500-mg/kg cleanup level. This maps clearly the disturbed soil behind the earthen berm. Almost all of the area above the cleanup level was in the disturbed soil area on the back slope. Figure 3.0-6 also illustrates the decreasing metal detector response in the back area behind the

berms. The metal detector/lead correlation was used to define extent of lead contamination in the back area and around the PRS. The metal detector data used to create Figure 3.0-6 can be found in Appendix E.

The USDA Forest Service characterized the lead concentrations in the backstop berms on the range floor. The berm samples all had lead concentrations above cleanup level for lead. During the VCA activities, the metal detector surveys and XRF testing, conducted by LANL ER Project also demonstrated lead concentrations greater than 400 mg/kg across the range floor and in the back area. After the soil processing, the fixed-site laboratory confirmation samples collected across the range floor and in the back area were all below the clean up level. This documents the contamination horizontally before remediation and the achievement of cleanup levels across horizontal extent of the site after remediation.

Six samples (one of which was a duplicate) were collected southwest of the PRS 0-016 boundary in 1994. These samples were analyzed at a fixed-site laboratory for copper, lead and zinc. Locations of these samples are shown on Figure 3.0-4. A summary of these samples is presented in Table 3.6-1. These locations were determined in the field, based on examination of the surface-water drainage system. These samples define extent in the southwest portion of the site. With the exception of lead detected slightly above background in sample AAA6275, all of these six samples were below both the cleanup levels and background levels for copper, lead, and zinc.

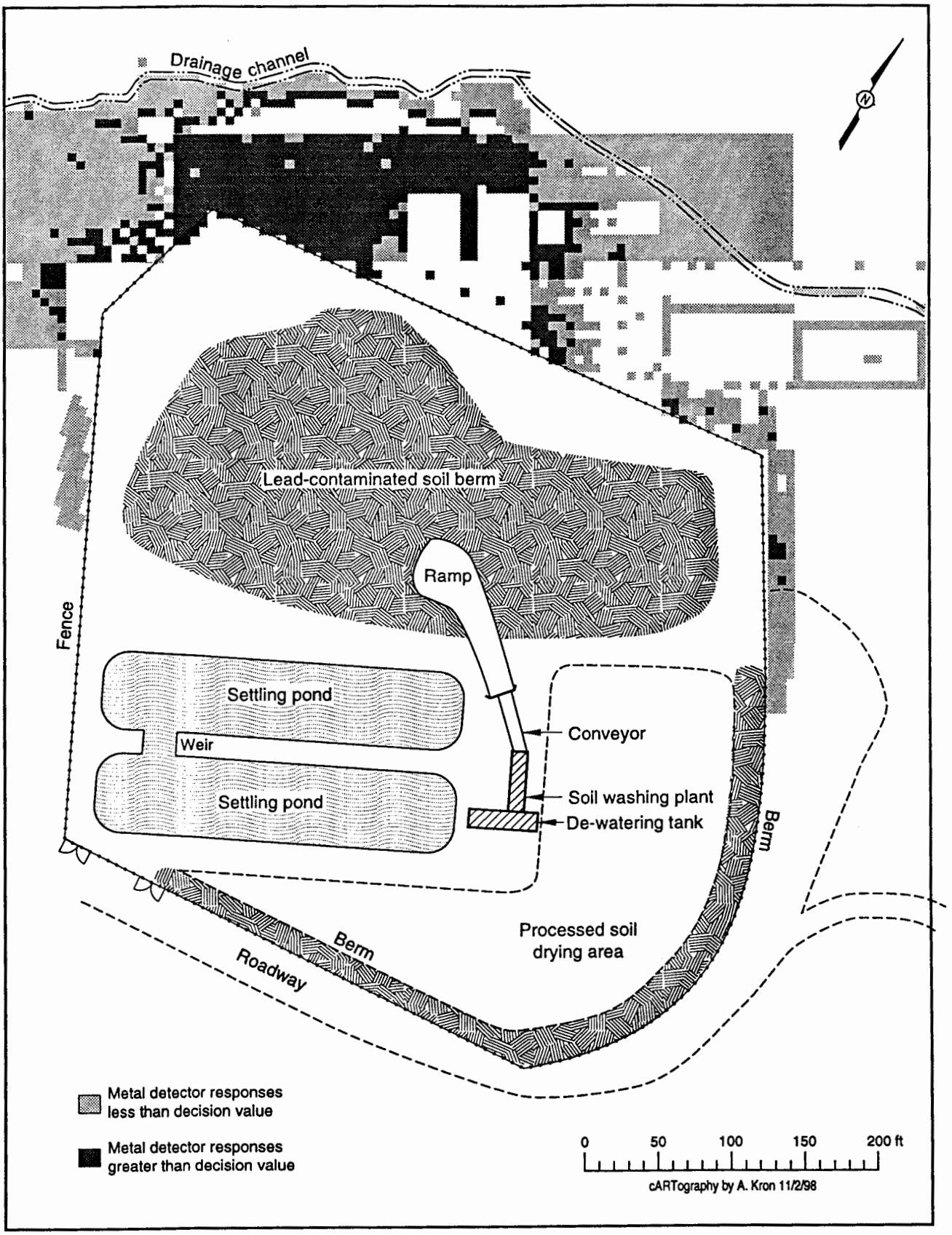


Fig. 3.0-6 Extent of lead contamination at PRS 0-016 using metal detector responses.

TABLE 3.6-1

EXTENT SAMPLES

Request Number	Sample ID	Location ID	Sample Depth (In.)	Total Copper mg/kg	Total Lead mg/kg	Total Zinc mg/kg
Extent Samples						
Background Values (mg/kg)				14.7	22.3	48.8
17166	AAA6273	00-1422	0-9	5.0	11	20
17166	AAA6274	00-1422	0-9	5.2	13	20
17166	AAA6275	00-1423	0-9	4.7	23	21
17166	AAA6276	00-1424	0-9	7.2	17	30
17166	AAA6277	00-1425	0-9	4.4	19	41
17166	AAA6278	00-1426	0-9	4.6	21	26

The horizontal extent of lead contamination was bounded in all directions by either the metal detector or soil sampling results. The southeast side of the site, however, was not sampled because it was the access road and parking area for the firing range and was opposite the direction of fired shots.

All 54 confirmation sample results were below cleanup levels for copper, lead and zinc. Figure 3.0-4 shows the locations of these confirmation samples.

3.6.1.2 Vertical Extent

Prior to site remediation by the ER Project, the USDA Forest Service conducted a study at PRS 0-016 testing for lead in the soil (using EPA Method 7421 atomic absorption spectroscopy). This study was discussed in Section 2.3.2 with Table 2.3-1 summarizing lead results at the site and Figure 2.0-2 relating these sample IDs to their locations at PRS 0-016. As seen in Figure 2.0-2 all the samples collected from the backstop berms exceed 338 mg/kg according to the Forest Service. The USDA Forest Service fixed-site laboratory results show contamination in the firing range berms as high as 156,100 mg/kg.

Using metal detector responses to guide remediation, and XRF lead results to decide when to collect samples for analysis at a fixed-site laboratory, cleanup proceeded until the contamination was removed to below cleanup levels for copper, lead, and zinc. This was verified by the 54 confirmation samples collected. While some samples remained above the BV of 22.3 mg/kg for lead, all samples were equal to or below 85.6 mg/kg for lead, well below the cleanup level of 400

mg/kg. Based on all the results, starting from the top of the berms and range floor, down to approximately 1 ft below the range floor, a decreasing trend was established and therefore vertical extent has been determined.

In addition to removing the berms, soil was also removed from both the back area and the range floor during the investigation. The soil containing lead contamination was removed until confirmation sample results were less than cleanup levels. Any unexploded bullets would have been removed in this process as well. As the remediation proceeded beneath the original elevations of the berms and range floor, lead values decreased to less than cleanup levels. While lead concentrations in some samples remained above the all soils BV of 22.3 mg/kg for lead, no samples had concentrations above 85.6 mg/kg for lead (Table 3.5-3). These sample concentrations are well below the current cleanup level of 400 mg/kg for lead.

3.6.2 Environmental Fate

The environmental fate of the COPC lead is fully described in Appendix F.

3.7 Site Assessments

Sections 3.7.1 through 3.7.5 below describe human health, ecological, and surface water assessments.

3.7.1 Summary

A human health screening assessment and an ecological screening assessment were conducted for PRS 0-016 after the remediation. The data review in Section 3.4.6 identified one COPC, lead, that was detected in confirmatory samples greater than background values. The human health screening assessment compared the maximum detected concentration of lead (85.6 mg/kg in sample 0100-96-1566) to the cleanup level of 400 mg/kg. Because lead is less than its cleanup level of 400 mg/kg, it was subsequently eliminated as a COPC; therefore, no human health risk assessment was conducted. The human health screening assessment is presented in Section 3.7.2. No COPCs were identified in the ecological screening assessment; therefore, no ecological risk assessment was performed. The ecological screening assessment is presented in Section 3.7.3. The results indicate that lead does not pose an unacceptable risk to human health or ecological receptors. The human health and ecological screening assessments follow the HRMB Risk-Based Decision Tree (NMED 1998, ER ID 57761) and appropriate EPA guidance.

A surface water assessment was also conducted for PRS 0-016. This assessment resulted in an erosion matrix score of 17.5, which indicates a low potential for erosion (see Appendix B-4.1). A groundwater assessment was not performed for PRS 0-016 because this site does not present a potential pathway for contaminant release to groundwater. An underground storage tank assessment was not performed because it is not applicable for PRS 0-016.

3.7.2 Human Health Screening Assessment

Scoping

The future land-use is residential. The area surrounding PRS 0-016 has already been improved with roads for a housing subdivision. PRS 0-016 is currently being used as a storage and staging area for construction vehicles and materials. PRS 0-016 is planned to be multi-family housing in the near future. The exposure assumptions are that people will be living on the land, 24 hours a day for 70 years. The exposure pathways for residents are inhalation, ingestion, and dermal contact of contaminated soil.

Screening Evaluation

The data review of the inorganic confirmatory sample results (Section 3.3.6 Confirmatory Sampling Data Review) indicated that lead was present at a concentration greater than the BV. The maximum detected concentration of lead, 85.6 mg/kg (Table 3.5-2) was compared to the residential cleanup level for lead, 400 mg/kg, to determine if lead was present at concentrations of potential concern. Because lead was the only COPC at the site detected at concentrations greater than BVs, the individual cleanup level did not require adjustment to account for potential toxicity interactions with other noncarcinogens. The maximum concentration of lead detected was less than one-quarter of the cleanup level. Therefore, lead is not retained as a COPC and will not be evaluated further, and a risk assessment is not warranted for PRS 0-016.

Uncertainty Analysis

The likelihood of PRS 0-016 being used as residential land is a certainty. Therefore, the cleanup level based on residential exposure assumptions is appropriate and should adequately represent the risk to future residents.

The cleanup level for lead is based on the screening level of 400 mg/kg proposed in the 1994 OSWER Directive (EPA 1994, ER ID 59509.1). This 400-mg/kg level is the product of the

Integrated Exposure Uptake Biokinetic model (IEUBK). However, this model uses mostly conservative generic inputs that most likely could result in an over representation of the level of lead in a child's blood due to living in Los Alamos and being exposed to soil at PRS 0-016.

Twelve of the confirmation sample results for lead were qualified J- usable according to the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA 1994, ER ID 48639.1), but estimated and biased low. The lead results were qualified J- because the matrix spike recovery at 63% was less than the control limit of 75% but greater than the rejection limit of 30%. Therefore the data is usable but potentially biased low by 12 to 37%. This has no effect on the outcome of the screening assessment because the highest concentration of lead detected in the confirmation samples, 85.6 mg/kg, is well below the cleanup level of 400 mg/kg. Even if the result of 85.6 mg/kg were increased by 37%, the maximum concentration would still be well below the clean up level.

Interpretation

The result of the human health screening assessment indicates that no COPCs remain following remediation. Therefore, no unacceptable risk to human health is posed by the highest concentration of lead remaining at PRS 0-016. Because the highest concentration of lead is approximately one-fourth the cleanup level, any uncertainty associated with the IEUBK model or the matrix spike recovery do not affect the conclusion.

3.7.3 Ecological Screening Assessment

The approach for conducting ecological screening assessments is described in "Screening Level Ecological Risk Assessment Approach for the ER Project at LANL" (Kelly 1998, ER ID 57916). The methodology consists of a scoping evaluation and a screening evaluation, which includes an uncertainty analysis and interpretation of results. The scoping evaluation includes: (1) the data assessment step, which identifies the list of COPCs for the PRS; (2) the problem formulation step for the PRS; and (3) the bioaccumulation evaluation step, which evaluates the level of concern for persistent bioaccumulation and/or biomagnification from COPCs at the PRS. The basis for the PRS-specific problem formulation is found in the Ecological Scoping Checklist provided in Appendix F. The scoping checklist is a useful tool for organizing existing ecological information and focusing the site visit on the information needed to develop the conceptual site model.
The screening evaluation includes the calculation of hazard quotients (HQs) and hazard indices (HIs) for all COPCs and all appropriate screening receptors. The HQ can be thought of as the ratio of the calculated exposure dose to the receptor (based on COPC levels at the PRS) to a

dose that has been determined to be acceptable (based on toxicity studies for the receptor). A HI is a sum of HQs, across COPCs with like effects, for a given receptor. An HQ or HI greater than 1 is considered an indicator of potential adverse impacts, and the COPCs resulting in an HQ or HI greater than 1 are identified as chemicals of potential ecological concern (COPECs). HQ calculations require toxicity, bioconcentration, and bioaccumulation information for all chemicals for all receptors.

An uncertainty analysis follows the COPEC identification, which describes the key sources of uncertainty in the screening assessment. The uncertainty analysis can result in adding chemicals to or removing them from the list of COPECs. This narrative contains a qualitative uncertainty analysis to help understand issues relevant to evaluating ecological risk for this PRS.

Data Assessment

The results of the data quality assessment of the confirmatory samples collected at PRS 0-016 are presented in Appendix C. The QA/QC issues do not affect the sufficiency and quality of the data for decision-making purposes. Although some of the results are potentially biased low, the data are considered adequate for a screening assessment and are representative of the site following remediation.

Problem Formulation

The purpose of the screening-level ecological risk problem formulation for PRS 0-016 is to provide information to: (1) determine if ecological receptors can be affected by a release; (2) determine how the PRS should be aggregated spatially for screening and to establish the functional/operational boundaries of the assessment; and (3) gather information to develop the conceptual site model (e.g., what are the contaminant sources, dominant transport pathways and exposure routes, and potential receptors).

Problem formulation at PRS 0-016 is required to establish the goals, breadth, and focus of subsequent screening ecological assessment or risk assessment activities. The product of problem formulation is a conceptual model for the risk assessment of the PRS in question. This screening ecological assessment is somewhat unusual in that it is not intended to support a future decision such as remedial action. It is intended to provide a retrospective evaluation of a VCA that has been implemented and includes the removal of contaminated source material and site restoration. This screening ecological assessment is intended to support decisions regarding ecological risk under current conditions and evaluate the need for additional or no further action.

As part of the VCA confirmation sampling discussed in Section 3.4 and presented in Table D-2 in Appendix D, five specific areas of PRS 0-016 were sampled. These areas were designated based on either past operational activities or physical location within the PRS. These sampled areas included; the firing range floor (23 sample locations), the right of way area (4 sample locations), the pond area (1 sample location), the first order drainage area (3 sample locations), and the back area (17 sample locations). From an ecological assessment standpoint, the PRS currently presents two distinct exposure areas for consideration. For the purpose of this report these two exposure areas will be designated as the *firing range exposure area* and the *back area exposure area*.

The firing range exposure area is generally defined by the current gravel-covered storage yard (see photographs 23-24 in Appendix J). This exposure area has been characterized and consists of the range floor, the right of way, the pond location, and the first order drainage samples. As shown in Figure 1.0-3, it is a topographically level area between two branches of Rendija Canyon, used for the storage of construction equipment, machinery, building materials and supplies. Prior to the VCA, this portion of the site contained the majority of the firing range complex including the earthen retaining berms. This area was extensively remediated and regraded.

Copper and zinc were not detected above their respective BVs (14.7 mg/kg and 48.8 mg/kg respectively) in any of the confirmatory samples collected within the firing range exposure area and are therefore eliminated from further evaluation. Lead was reported above the BV (22.3 mg/kg) in 16 of the 30 confirmatory samples collected from the firing range exposure area with concentrations ranging from 23.7 mg/kg to 85.6 mg/kg.

Since the completion of the VCA, the firing range exposure area has undergone further modification to meet the needs of the private land developer (see Section 3.3.4). This has included further excavation and soil removal to desired grade, sloping for proper surface drainage, and edge contouring. The site was then covered with a one-ft layer of base course. These modifications, when considered with the current use of the site and information contained in the Ecological Scoping Checklist for PRS 0-016 (Appendix F), support the determination that no ecological receptors are present and no viable exposure pathways or off-site transport pathways exist. Therefore, no further assessment of the firing range exposure area at PRS 0-016 is required.

The second ecological exposure area proposed for consideration and screening ecological risk assessment is the back area (1.0-3). The back area exposure unit data set includes seventeen back area soil samples and one first order drainage area sediment sample. This area includes

the descending slope to the north of the firing range which runs from approximately the 7,176-ft elevation to the ephemeral drainage channel (a branch of Rendija Canyon). This encompasses approximately 1.25 acres of Ponderosa pine forest on a north-facing slope. As with the firing range exposure unit, the back area exposure unit was previously remediated by the removal of surface soil in lifts. The cleanup level for this activity was based on human health threshold for lead of 400 mg/kg.

As with the firing range confirmatory samples, copper and zinc were not reported above their BVs in any of the back area samples and are therefore eliminated from further evaluation. Six of the eighteen confirmatory samples collected from the back area had lead concentrations above the BV of 22.3 mg/kg with concentrations ranging from 28.4 to 58.6 mg/kg.

As part of the site restoration (Section 3.3.4.1), clean topsoil was imported from TA-16 to replace soil that had been removed during remediation. This resulted in a four to twelve in. cover of clean soil over any residual contamination prior to the placement of erosion control matting and reseeding the area. Although there appears to be limited ecological exposure potential due to the covering and revegetation of the area, the root zone can be penetrated by the vegetative cover. Therefore, the back area exposure unit was subjected to the ecological screening evaluation to determine if residual lead concentrations reported in confirmatory soil samples presented a potential ecological concern.

Threatened and endangered (T&E) species are potential receptors for contaminant releases associated with PRS 0-016. Specifically, the Mexican spotted owl and the peregrine falcon could be expected to roost or forage in the vicinity (LANL 1998, 59846). Therefore, T&E species concerns are relevant to ecological risk assessment at this site.

The ecological conceptual site model for PRS 0-016 is presented graphically in Figure 3.0-7. The ecological conceptual site model identifies which exposure pathways represent major, minor, unlikely, or no pathway to ecological receptors. Exposure pathways to terrestrial receptors can occur through air (inhalation or deposition of particulates); surface soil (root uptake and rain

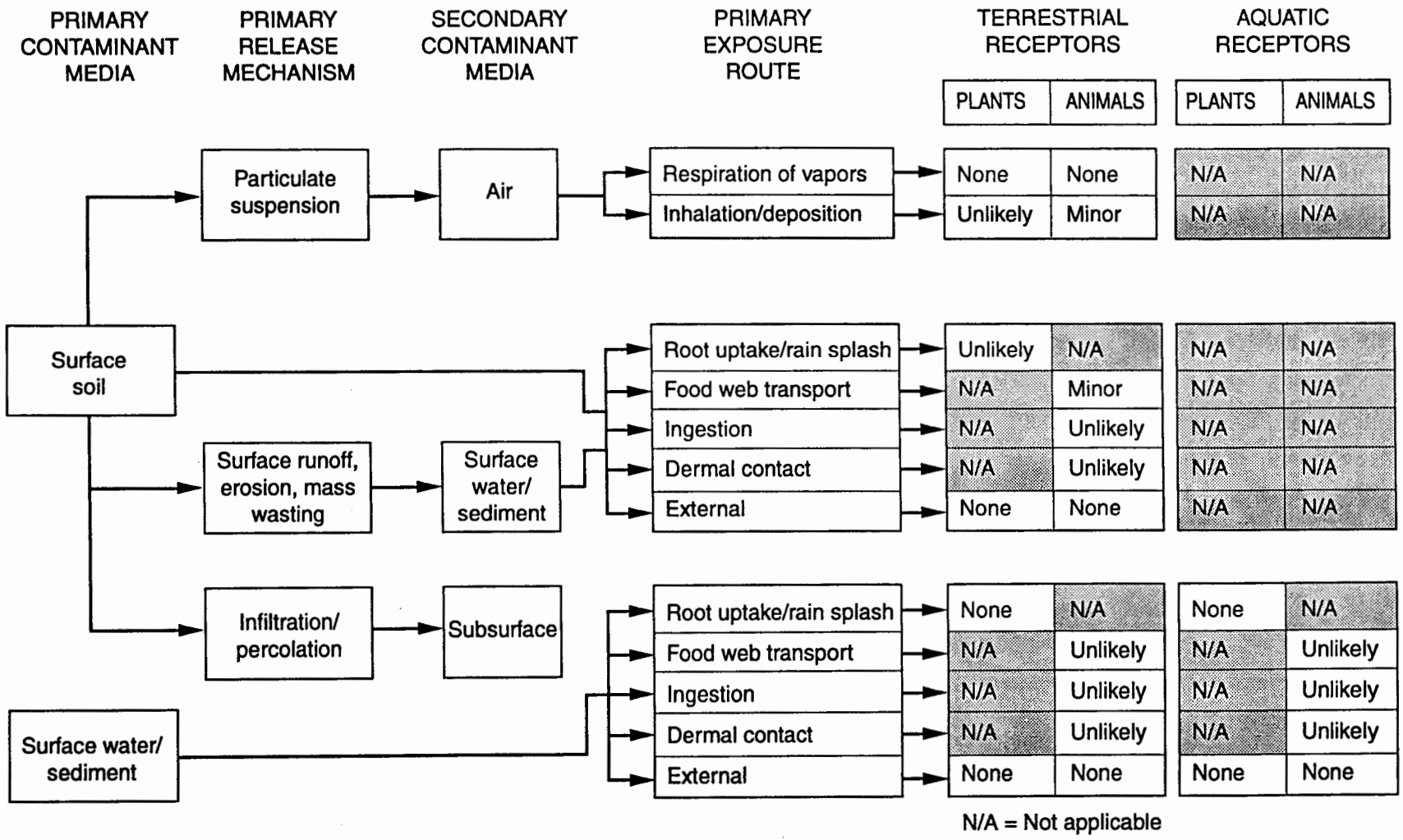


Fig. 3.0-7 Conceptual ecological exposure.

splash on plants' food web transport to plants and animals, incidental ingestion of soil, dermal contact with contaminated soil, and external radiation); and surface water or active channel sediments (root uptake and rain splash on plants, food web transport to animals, incidental ingestion of water and sediment, dermal contact with contaminated water or sediment, and external radiation from sediment). The soil-related exposure pathways are expected to be food web transport and incidental ingestion of contaminated soil. The sediment/surface water -related exposure pathway is expected to be food web transport. However, the importance of the water/sediment pathways are questionable because of the limited extent of active channel sediments and surface water in the area. Exposure to vapors is not a complete pathway because of the absence of volatile contaminants. Exposure to airborne particulates is expected to be a minor pathway because of the limited amount of contamination on the ground surface. Lastly, the remaining pathways that are related to exposure to surface soil (root uptake/rain splash and dermal contact) and surface water/sediment (dermal contact) are expected to be minor or unlikely because of the limited amount of contamination expressed at the ground surface.

Bioaccumulator Evaluation

Lead, the only COPC remaining at PRS 0-016 following remediation, is a potentially persistent bioaccumulator as defined by NMED. Bioaccumulation is defined based on the potential for bioaccumulation in aquatic environments. Because aquatic pathways are not relevant for this ecological risk assessment, lead does not warrant any specialized bioaccumulation evaluation. The potential for food web uptake has been incorporated into the model for terrestrial screening receptors.

Screening Evaluation

The firing range exposure area has been covered with base course and is currently used as a parking area for earth moving equipment. This portion of the PRS was not subjected to a screening evaluation because there are no pathways for exposure and no receptors are present. The ecological screening for the back area exposure unit of PRS 0-016, is based on exposure to terrestrial receptors by ecologically available contamination (i.e., contamination which occurs in the wooded slope north of the former firing range and within one ft of the soil surface). It is important to remember that the purpose of the screening evaluation is to identify COPECs, and not to calculate risk. The HQ analysis is used as an indicator of potential risk and this analysis is intended to be conservative to minimize the chance of missing an chemical that potentially poses an ecological risk. The HQ analysis is based on the maximum sample result for lead identified as a COPC in VCA confirmation sample results. The HQ is calculated by dividing the maximum

chemical concentration by the soil ecological screening level (ESL) for nine screening ecological risk receptors. Lead was found to have a HQ of 2.9 for a generic plant receptor and is identified as a COPEC for this site. The kestrel with an all meat diet, which is used as a surrogate to represent the T&E species (peregrine falcon and Mexican spotted owl), had a HQ of 0.03. The other receptors had HQs of 1.0 or less for lead. The results of the screening evaluations for all terrestrial receptors for the back area exposure unit of PRS 0-016 are presented in Table 3.7-1.

TABLE 3.7-1
MAXIMUM DETECTED SOIL CONCENTRATION
AND ECOLOGICAL SCREENING LEVELS (ESLS) FOR THE BACK AREA EXPOSURE UNIT

Analyte	Maximum Sample Result (mg/kg)	ESL[a] (mg/kg)	Screening Receptor	HQ
Lead	58.6	2.00E+01	Plant[b]	2.9
		1.00+02	Invertebrate	0.6
		5.9+02	Shrew	0.1
		4.8+02	Mouse	0.1
		1.9+03	Cottontail	0.03
		5.84+01	Robin	1.0
		9.7+02	Kestrel	0.06
		1.9+03	Kestrel(falcon)	0.03
		5.9+03	Red Fox	0.01

[a] ESLs are calculated based on the methodology presented in Kelly et al. (1998, 57916).

[b] Screening receptor with minimum ESL.

Uncertainty Analysis

Six of eighteen lead sample results from the back area exposure unit (as defined under Problem Formulation) exceeded both the BV of 22.3 mg/kg and the minimum ESL (plant) receptor value of 20 mg/kg. These concentrations range from 28.4 mg/kg to 58.6 mg/kg and would result in minimum receptor HQs ranging from 1.4 to 2.9. An HQ exceeding 1.0 suggests the potential for ecological risk resulting from lead. However, the maximum reported concentration exceeded the ESL for only one of nine screening receptors. The plant value is highly conservative because the lead ESL used is the lowest no observed effect concentration (NOEC) currently identified in the LANL ecotoxicological database. This NOEC is based on decreased plant weight as the toxicological test endpoint and is one of eleven NOEC studies identified in the database. The ten

additional studies identified in the database and not selected for use in screening cite no observed effect concentrations ranging from 50 to 1000 mg/kg.

The lead contamination in these back area exposure unit samples was much lower than the maximum reported value on the range area prior to remediation. In addition, the observed concentrations are currently under several inches of clean topsoil fill which further diminishes any potential exposure and risk. The ecological risk presented by lead would be more accurately estimated by determining the representative concentration for lead across the PRS aggregate and relative to the home range of the appropriate receptor. Therefore, the perceived risk from the screening evaluation (i.e., HQ>1) would be an overestimate of the actual risk and the application of the modifying factor would reduce the estimated lead HQ. The amount of reduction in the HQ would depend on the assessment endpoint selected for the ecological risk assessment.

Interpretation

The firing range exposure unit was not evaluated by this process, because it was determined that no exposure pathways and no receptors were present. Lead was the only COPEC evaluated by the screening assessment of the back area exposure unit of PRS 0-016. Based on the site conditions, the confirmatory sampling data, and the conservative assumptions associated with the ecological screening discussed in the uncertainty section, lead does not pose the potential for ecological risk at this site. Therefore, no potential ecological impacts exist at PRS 0-016 following remedial activities and a recommendation for an ecological no further action is appropriate.

3.7.4 Surface Water Assessment

The Laboratory's ER Project has developed a procedure to assess sediment transport and erosion concerns at individual PRSs. It provides a basis for prioritizing and scheduling actions to control erosion of potentially contaminated soils at specific PRSs. The procedure is a two-part evaluation. Part A is a compilation of existing PRS analytical data, site maps, and knowledge-of-process information. Part B is an assessment of the erosion/sediment transport potential at the PRS. Erosion potential is numerically rated from 1 to 100 using a matrix system. PRSs that score below 40 have a low erosion potential; those that score from 40 to 60 have a medium erosion potential; and those that score above 60 have a high erosion potential. The surface water assessment for this site was conducted on May 14, 1997. The assessment yielded a total score of 17.5. The calculated score included 3.3 points for site setting, 6.9 points for surface water runoff factors, and 7 points for surface water run-on factors. This score indicates low erosion potential. The Surface Water Assessment document is included in Appendix B-4.1. The assessment states

that there was no debris in the watercourse. There is visible evidence of runoff discharging from the site, but is it not channelized. There are no man-made or natural hydraulic structures or features that might affect the site hydrology. Interflow is not a suspected contaminant migration pathway due to the relatively insoluble nature of lead, copper and zinc. Therefore, the results of the assessment indicate little potential for contaminant transport via surface water or sediment.

Figure 2.0-1 shows the location of the ephemeral streams and drainages in the vicinity of the former firing range. There are no wetlands or springs, no groundwater or surface water monitoring stations, and no active or inactive local water supply and production wells in the vicinity.

3.7.5 Groundwater Assessment

No groundwater assessment was conducted for PRS 0-016 because this site does not present a potential pathway for contaminant release to groundwater due to the great depth to ground water and the relatively insoluble nature of lead, copper and zinc.

3.8 Conclusions and Recommendations

Analytical results for confirmatory samples collected from the back area, the range floor, right of way, pond, and the first-order drainages were all well below the cleanup levels. Lead, which was the only COPC detected at concentrations greater than background, ranged in concentration from 23.7 mg/kg (sample no. 0100-96-1561) to 85.6 mg/kg (sample no. 0100-96-1566) in final confirmatory samples. These results are well below the residential cleanup level for lead, 400 mg/kg. The analytical results for all final confirmatory samples are presented in Table D-2, Appendix D, of this VCA completion report. Final confirmatory sample results indicate that all soils have been remediated to below the residential cleanup level for lead confirming that the VCA has been successfully completed. The human health screening assessment concluded there was no unacceptable risk posed by the highest concentration of lead remaining at PRS 0-016. The ecological screening assessment concluded there were no pathways or receptors present in the former range floor area and that current conditions in the back area pose no ecological risk. No further action is recommended for PRS 0-016 based on Criteria 5: contaminants of concern are either not present or are present in concentrations that would pose an acceptable risk under the proposed land use.

4.0 WASTE MANAGEMENT

Waste management activities were conducted in accordance with the VCA Plans (LANL 1994, ER ID 56802.4; LANL 1996, ER ID 54839.2) and the site-specific Waste Management Plan (LANL, 1993 Need ER ID 57111.18). Some of the anticipated volumes, types of waste, and waste-characterization methods differ considerably from those initially anticipated, as discussed below. Total cost also reflected the increased volumes processed (Appendix C). Locations within and around LANL that received clean soil from VCA activities are shown on Figure 4.0-1. Analytical results for waste-characterization samples are summarized in Appendix F. Photograph numbers 25 through 30 in Appendix J, show waste management activities.

4.1 Material Volumes

The volume of the feedstock processed included an additional 10,700 yd^3 more than the 3,000 yd^3 estimated in the original VCA Plan (LANL, 1994, need ER ID). It was originally anticipated that little or none of the soils would fail TCLP following removal of the bullets through shaker plant processing; however, a total of 495 yd^3 of fine soils failed TCLP and were disposed of as hazardous waste. In addition, the 60 yd^3 of pine needles (forest liter) removed from the back area failed TCLP and were disposed as hazardous waste.

Stockpiles of shaker-plant processed clean soil that passed TCLP analysis were transferred to TA-72 and used for improving their existing backstop berms. The berms in ranges No. 3 and No. 4 were built up from a height of approximately 6-ft to a height of approximately 20-ft to comply with revised regulatory requirements for firing ranges.

Slurry, consisting of water and non-hazardous fine sediments accumulated in the recirculation ponds as a result of the soil washing process. Far more sediment accumulated in the ponds than anticipated, due to the increase in the volume of feedstock processed through the soil-washing plant and the high clay-content in the soils. Approximately 900,000 gal. of slurry was pumped from the ponds and transported to borrows pits at Sigma Mesa (TA-60) and a borrow pit in Sandia Canyon across from the entrance to TA-53. The slurry was sampled from the point of discharge from the soil-washing plant, directly from the ponds, and from the pump-truck tanks before transporting off-site.

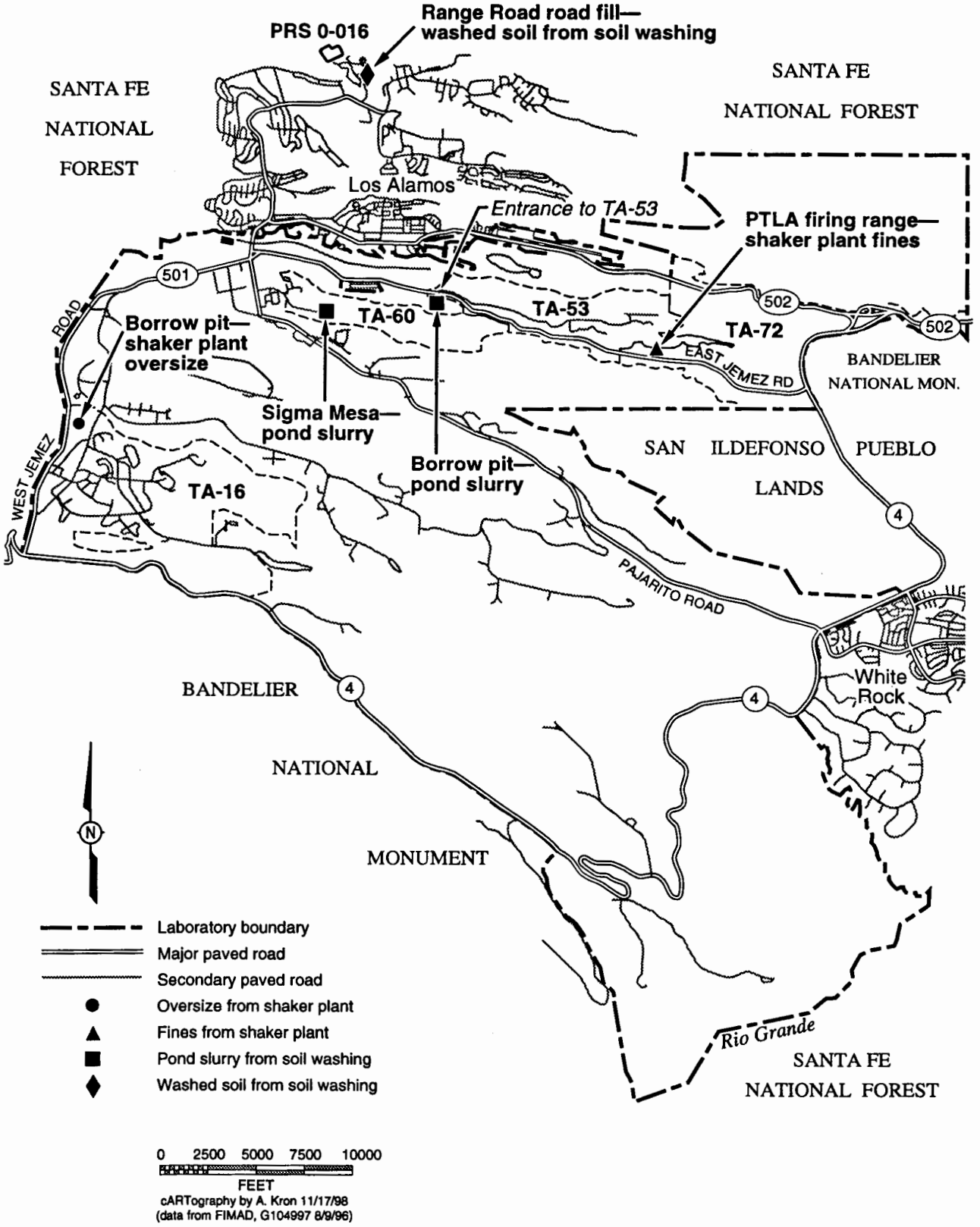


Fig. 4.0-1 Locations receiving processed soil from PRS 0-016.

The oversized fraction from the shaker plant operations consisting of boulders, cobbles, and coarser gravel (greater than 1/2-in.) was considered nonhazardous based on knowledge of process because the bullets and finer lead fragments had been removed. Visual observation and metal detectors were used to determine if uncommonly large lead slugs (greater than .50 caliber) or clods of fine material potentially containing bullets were present in the oversized fraction. Oversized material was transferred off-site to the TA-16 borrow pit (Figure 4.0-1) for future use as fill material in industrial applications within LANL facilities.

Some materials were generated during VCA activities that required disposal and not reuse. These materials included processed soils that failed TCLP for lead, the pond liners from the soil-washing recirculation ponds, miscellaneous refuse, and plastic sheeting used to cover soil stockpiles. Of these materials, only the materials that failed TCLP for lead were disposed of at a LANL-audited and approved RCRA-permitted hazardous waste treatment, storage and disposal (TSD) facility. Lead recovered during soil washing and shaker plant operations was contained and transferred to a LANL-approved and contracted recycling facility by Johnson Controls International (JCI). A total of 8.4 tons of clean lead was recovered. The composition of the bullets was predominantly lead with minor amounts of other elements such as copper and zinc.

A portion of the gravel processed by vacuum separation failed TCLP analysis for lead and was disposed of as hazardous waste. It was determined that small lead fragments were picked up by the vacuum along with the gravel at higher suction levels.

After removal of the pond liner from the southern recirculation pond, a composite sample was collected from the sediment associated with the liner and determined by TCLP analysis to be nonhazardous. The southern pond was the first of the two ponds to receive water and sediment from the soil washing plant, while the northern pond, connected by a wier, received relatively little sediment. By design, most of the sediment, particularly the heavier particles such as lead, settled out in the southern pond. Analytical results for the southern pond sediment would be a worst-case scenario for the second pond sediments, which would have a lower potential for lead accumulation. Based on this process knowledge, the second pond liner was also disposed of as nonhazardous waste.

Water in the recirculation ponds was expected to evaporate over time and not require discharge; however, only the south pond dried out. Typically the south pond was pumped out to a lower level during soil washing operations, allowing it to evaporate to dryness. The north pond continued to retain water accumulated from precipitation and surface-water run-off, and it eventually became necessary to pump out the water to allow for removal of the liner and backfilling of the pond during

site restoration. Water samples were collected from the pond to ensure that New Mexico water standards for metals were not exceeded. All concentrations of metals detected in the water samples were below New Mexico surface-water and ground water standards. A notice of intent to discharge water was filed and approximately 3 000 gallons were discharged to the ground surface at the site.

4.1.1 Waste Minimization

The primary waste management objective for PRS 0-016 was to minimize waste and maximize reusable and recyclable materials. Processing the feedstock to remove the lead facilitated recycling of the lead and reuse of the clean soils as fill and firing range berm material. Initially, all of the soils associated with firing range operations could have been considered hazardous waste based on the initial biased sampling by the Forest Service (USDA 1992, ER ID 05-0256).

Recycling and reuse activities at PRS 0-016 produced approximately 8.4 tons of recyclable lead, 4,660 yd^3 of fine soil for reuse at TA-72 as firing range berm material, 1,730 yd^3 of coarse gravel and rock for use as industrial fill material, and 6 700 yd^3 of washed soil for reuse as road fill. Waste minimization practices conducted during VCA activities included continuous efforts to minimize generation of additional soil to be processed. Excavation of additional material was conducted by scraping the range floor and back area hillside with a bulldozer or grader in lifts of a few inches at a time in an effort to avoid excessive over-excavation resulting in generation of larger volumes of feedstock that would have to be processed.

4.2 Waste-Characterization Data

Waste-characterization samples collected during VCA activities included samples of washed soil for total lead and TCLP metals analysis; samples of fines generated by dry sieving; samples of water and slurry for total metals, total dissolved metals, and TCLP metals analysis; samples of the pine needles and pond liners for TCLP metals analysis.

5.0 REFERENCES

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

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

The reference set number and tab number are assigned to located material in the Laboratory's ER Project Reference Library, which is housed at New Mexico Environment Department (NMED), Hazardous and Radioactive Materials Bureau (HRMB), Department of Energy (DOE), and the ER Project Office. This library is a living document that was developed to ensure that the Administrative Authority (AA) has all of the necessary material to review the decisions and actions proposed in documents submitted by the Laboratory's ER Project. Documents previously submitted to the AA and documents that are specific to this report are not included in the Reference Library, and their citations do not include reference set and tab numbers. Documents that are specific to this report are attached in Appendix G-2.0, Referenced Documents.

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APPENDIX A LIST OF ACRONYMS AND GLOSSARY MASTER LIST OF ACRONYMS AND ABBREVIATIONS FOR ER PROGRAM AT LOS ALAMOS

AA	Atomic absorption
ANSI	American National Standards Institute
AOC	Area of concern
AP	Administrative procedure
ATSDR	Agency for Toxic Substances and Disease Registry
BV	Background value
BGS	Below ground surface
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CLPQA	Contract Laboratory Program quality assurance
COPC	Chemical of potential concern
D&D	Decontamination and decommissioning
DOE	US Department of Energy
DOT	Department of Transportation
DQO	Data quality objective
EMO	Emergency Management Office
EPA	US Environmental Protection Agency
EQL	Estimated quantitation limit
ER	Environmental restoration
ESA	Endangered Species Act
FIDLER	Field instrument for detection of low-energy radiation
FIMAD	Facility for Information Management, Analysis, and Display
FYP	Five-year plan
GC	Gas chromatograph(y)
GFAA	Graphite furnace atomic absorption
GIS	Geographical Information System
GM	Geiger-Mueller
HASP	Health and safety plan
HAZMAT	Hazardous materials
H&S	Health and safety
HSWA	Hazardous and Solid Waste Amendments of 1984
ICPES	Inductively coupled plasma emission spectroscopy

ICPMS	Inductively coupled plasma mass spectroscopy
IWP	Installation work plan
LANL	Los Alamos National Laboratory
LC	Liquid chromatography
LOQ	Limit of quantification
LP	Laboratory procedure
MDA	Material disposal area
MDL	Minimum detection limit
MS	Mass spectrometer (spectrometry)
NMED	New Mexico Environment Department (New Mexico Environmental Improvement Division before 1991)
NMESA	New Mexico Endangered Species Act
NOD	Notice of deficiency
NPDES	National pollutant discharge elimination system
OSWER	Office of Solid Waste and Emergency Response (EPA)
OU	Operable unit
OVA	Organic vapor analyzer
PQL	Practical quantitation limit
PRG	Preliminary remediation goal
PRS	Potential release site
QAPP	Quality assurance project plan
QC	Quality control
RCRA	Resource Conservation and Recovery Act
RfD	Reference dose
RFI	RCRA facility investigation
RI/FS	Remedial investigation/feasibility study
SAL	Screening action level
SAP	Sampling and analysis plan
SMF	Sample Management Facility
SMO	Sample Management Office (formerly Sample Management Facility)
SOP	Standard operating procedure
SSHSP	Site-specific health and safety plan
SSHASP	Site-specific health and safety plan
SSO	Site safety officer
SVOC	Semivolatile organic compound
SWMU	Solid waste management unit
TA	Technical area

TAL	Target analyte list (EPA)
TCLP	Toxicity characteristic leaching procedure
TSD	Treatment, storage, disposal
UC	University of California
USCG	US Coast Guard
USDA	US Department of Agriculture
UST	Underground storage tank
VCA	Voluntary corrective action
VOA	Volatile organic analysis
VOC	Volatile organic compound
XRF	X-ray fluorescence

RFI Glossary

Abbreviated method A shortened form of a method. Usually refers to analytical methods that have been modified to require less rigorous sample preparation, analysis conditions or quality control.

Accuracy The extent to which the results of a calculation or measurement approach the true values of the calculated or measured quantities, and are free from error.

Action Level. A value that, when exceeded, will trigger a specified response.

Adsorption The surface retention of solid, liquid, or gas molecules, atoms, or ions by a solid or a liquid, as opposed to absorption, the penetration of substances into the bulk of the solid or liquid.

Alluvial Said of materials or features deposited by running water.

Alluvium Clay, silt, sand, gravel, or other rock materials transported by water and deposited in fairly recent geologic time as sorted or semi-sorted sediments in riverbeds, flood plains, lake shores, and fans at the base of mountain slopes.

Analysis A process used to measure one or more attributes of a sample in a clearly defined, controlled, systematic manner. Often requires treating a sample chemically or physically before measurement.

Analyte The particular chemical or radiochemical species to be identified and/or quantified.

Analytical laboratory data qualifiers Data qualifiers that are attached to sample results by the analytical laboratory that performed the sample analysis.

The following letter qualifier flags are for **inorganic analyses**:

"U" The compound was analyzed for but was not detected. The associated numerical value is the estimated detection limit.

"B" The reported value was obtained from a reading that was less than the estimated detection limit but greater than or equal to the instrument detection limit.

"E" The reported value is estimated because of the presence of interference.

"J" Indicates an estimated value. The "J" flag is used if the compound is present but the result is less than the sample estimated quantitation limit and greater then the instrument detection limit.

"M" Duplicate injection precision was not within control limits.

"N" Spiked sample recovery was not within control limits.

"S" The reported value was determined by the Method of Standard Additions.

"W" Post-digestion spike for GFAA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.

"*" Duplicate sample analysis was not within control limits.

"+" Correlation coefficient for the Method of Standard Additions is less than 0.995

The following letter qualifier flags are for **organic analyses**:

"U" The compound was analyzed for but was not detected. The reported numerical value is the estimated quantitation limit.

"J" Indicates an estimated value. The "J" flag is used if the compound is present but the result is less than the sample estimated quantitation limit and greater then the instrument detection limit.

"B" The analyte was found in the associated method blank as well as in the sample.

"E" The concentrations of the analyte exceeded the calibration range of the instrument.

"D" The analyte was identified in an analysis at a secondary dilution factor.

"C" Identification of a pesticide/PCB has been confirmed by GC/MS.

"P" The percent difference between a pesticide/PCB result obtained on the primary and secondary columns was greater than 25%.

"N" There is presumptive evidence of the presence of a tentatively identified compound based on mass spectral matching.

"A" A tentatively identified compound is a suspected aldol-condensation product.

Andesite A fine-grained volcanic rock, chiefly plagioclase and pyroxene.

Anomaly A deviation from normal variations, something that is abnormal.

Aquifer A permeable body of geologic material capable of yielding groundwater to wells or springs.

Area of concern An area at LANL known or suspected to be contaminated with radionuclides, but not contaminated by hazardous chemicals (or hazardous waste).

Background level The naturally occurring concentrations of an inorganic chemical (including naturally occurring radionuclides) in soil.

Background value (BV) Background values exist for inorganic chemicals and radionuclides. The background values are the upper tolerance limits (UTLs) of background sample results, calculated as the upper 95% confidence limit for the 95th percentile. In cases where a UTL cannot be calculated, either the detection limit or maximum reported value is used as a BV. Background values are used as simple threshold numbers to identify potentially contaminated site sample results as greater than background levels.

Basalt A hard, dense, dark volcanic rock composed chiefly of plagioclase, augite, olivine, and magnetite.

Baseline risk assessment (Also known as ***risk assessment***) A site-specific analysis of the potential adverse effects caused by hazardous substance releases from a site in the absence of any actions to control or mitigate these releases. There are four steps in baseline risk assessment: data collection and analysis, exposure assessment, toxicity assessment, and risk characterization.

Bentonite A clay composed of the mineral montmorillonite and variable amounts of magnesium and iron, formed over time by the alteration of volcanic ash. As bentonite can adsorb large quantities of water and expand to several times its normal volume, it is a common additive to drilling mud.

Bias (1) The degree to which the value obtained for a measured parameter deviates from the value accepted as the true, or reference, value. (2) A systematic deviation from the true value that remains constant over replicated measurements within the statistical precision of the measurement process.

Blank sample A sample expected to have negligible or unmeasurable amounts of analytes. Results of blank sample analyses indicate whether or not field samples might have been contaminated during one or more steps of the sample collection, transport, storage, preparation and analysis process.

Blind sample See ***Single blind sample*** and ***Double blind sample***.

Breccia Coarse-grained rock consisting of angular fragments cemented together or embedded in a fine-grained matrix.

Calibration A process used to identify the relationship between the true, or reference, analyte concentration or other variable and the response of a measurement instrument, chemical analysis method, or other measurement system.

Calibration blank A calibration standard prepared to contain negligible or unmeasurable amounts of analytes. It is used to establish the zero concentration point for analytical measurement calibration.

Calibration standard A sample prepared to contain known amounts of the analytes of interest and of other constituents required for the analysis.

Caliche (Properly called ***pedogenic calcite***, also known as ***calcrete***) An accumulation of calcium carbonate, typically found in the near surface.

Catchment A structure such as a basin or reservoir, for collecting or draining water; the collecting of water.

Chemical Any naturally occurring or man-made substance characterized by a definite molecular composition, including molecules that contain radionuclides.

Chemical of potential concern (COPC) A chemical detected at a site that has the potential to adversely affect human and or ecological receptors due to its concentration, distribution and mechanism of toxicity. The chemical remains a concern until exposure pathways and receptors are evaluated in a site-specific risk assessment.

Cleanup Action undertaken to physically remove or treat a hazardous substance that poses a threat or potential threat to human health and welfare and the environment. Sites are considered cleaned up when EPA removal or remedial programs have no further expectation or intention of returning to the site and threats have been mitigated or do not require further action.

Cleanup levels Media-specific target concentration levels for contaminants that must be met by a selected corrective action. Cleanup levels are established using criteria such as protection of human health and the environment; compliance with regulatory requirements; reduction of toxicity, mobility, or volume through treatment; long- and short- term effectiveness; implementability; cost; and public acceptance.

Code of Federal Regulation (CFR) A codification of all regulations developed and finalized by federal government agencies in the *Federal Register*.

Collocated sample One of two or more samples collected as close together in time and space as the sampling equipment allows so that each sample is expected to be equally representative for a given analyte within the common space and time interval.

Colluvium Rock debris accumulated at the base of a cliff or on a slope principally by the action of gravity.

Comparability A qualitative measure of the degree to which one item or data set can be compared with another.

Composite sample A sample that is formed by combining and homogenizing several grab samples.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. Amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. The acts created a special tax that goes into a trust fund, commonly known as Superfund, whose mandate is to investigate and cleanup abandoned or uncontrolled hazardous waste sites that may endanger health or the environment. The EPA is responsible for managing Superfund.

Conceptual model See also ***Site conceptual model.***

Confluence The place where two or more streams meet; the point where a tributary meets the main stream.

Contaminant Any chemical (including radionuclides) present in environmental media or on structural debris at a concentration that may present a risk to human health or the environment.

Controlled area Any Laboratory area to which access is controlled to protect individuals from exposure to radiation and/or hazardous materials.

Corrective Action A measure taken to rectify conditions adverse to human health or the environment.

Daily Calibration A combination of calibration blank and calibration standard used to determine if the instrument response to analyte concentration is within acceptable bounds relative to the initial calibration. A daily calibration establishes the 24-hour relative response factors on which quantitations are based, thus verifying the satisfactory performance of an instrument on a day-to-day basis.

Data quality assessment A statistical and scientific evaluation of the data set to assess the validity and performance of the data collection design and statistical test, and to establish whether a data set is adequate for its intended use.

Data quality objectives (DQOs) The qualitative and quantitative goals that are developed before sampling begins that clarify the investigation objectives and identify the type, quantity and quality of data needed to support decisions.

Data validation A systematic process that applies a defined set of performance-based criteria to a body of data that may result in qualification of the data. This process is performed independently of the analytical laboratory generating the data set and occurs prior to drawing a conclusion from the data. It may comprise a standardized review (routine validation) and/or a problem-specific review (focused validation) of the data.

Data validator The person who performs data validation in accordance with LANL ER procedures.

Data verification A process of evaluating the completeness, correctness, consistency, and compliance of a laboratory data package against a specified standard or contract. Completeness means all required information is present—both hard copy and electronic. Correctness means the reported results are based on properly documented and correctly applied algorithms. Consistency means that values are the same when they are reported in different reports or are transcribed from one report to another. Compliance means that the data pass numerical QC tests based on parameters or limits specified in a contract or in an auxiliary document.

Decommissioning The permanent removal from service of surface facilities and components only, after facility closure, in accordance with regulatory requirements and environmental policies.

Decontamination The removal of unwanted material from the surface of or from within another material, or the neutralizing of it.

Detection limit The minimum concentration of a substance that can be measured by an instrument with a specified statistical confidence that the analytical concentration is greater than zero.

Discharge or Hazardous Waste Discharge (As defined under RCRA, 40 CFR 260.10) The accidental or intentional spilling, leaking, pumping, pouring, emitting, emptying, or dumping of hazardous waste into or on any land or water.

Disposal The discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous

waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground waters.

U.S. Department of Energy (DOE) The federal agency that sponsors energy research and regulates nuclear materials for weapons production.

Double blind sample A sample with analyte concentration and sample identity unknown to the analyst.

Duplicate analysis An analysis performed on one of a pair of identically prepared sub-samples of the same sample.

Duplicate measurement One of a pair of measurements performed on a prepared sample under identical conditions.

Ecological Screening Level (ESL) An organism's exposure-response threshold for a given chemical constituent. It is the concentration of a substance in a particular medium that corresponds to a hazard quotient (HQ) of 1.0 for a given organism and below which no risk is indicated.

Eolian Pertaining to the wind, especially said of sediment deposition by the wind, of structures such as wind-formed ripple marks, or of erosion accomplished by the wind.

Environmental Protection Agency (EPA) The federal agency responsible for enforcing environmental laws. While state regulatory agencies may be authorized to administer some of this responsibility, EPA retains oversight authority to ensure protection of human health and the environment.

Ephemeral stream Said of a stream or spring that flows only during and immediately after periods of rainfall or snowmelt.

Equipment blank A blank sample that is used to rinse the sample collection equipment and is then transferred to a sampling container. The equipment blank is collected after equipment decontamination is completed but prior to collection of another field sample.

Error Any discrepancy between a computed, observed, or measured quantity and the expected or theoretically correct value of that quantity.

Estimated quantitation limit The lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine analytical laboratory operating conditions. Sample estimated quantitation limits are highly matrix-dependent, and the specified estimated quantitation limits might not always be achievable.

Evapotranspiration The combined discharge of water from the earth's surface to the atmosphere by evaporation from lakes, streams, and soil surfaces, and by transpiration from plants.

Exposure unit The bounded area or volume within which a person or other receptor may be exposed to contaminants that have been released to the environment.

Fault A fracture, or zone of fractures, in rock along which there has been vertical or horizontal movement; adjacent rock surfaces are displaced.

Field blank A blank sample either prepared in the field or carried to the sampling site, exposed to sampling conditions (e.g., bottle caps removed, preservatives added), and returned to a laboratory for analysis in the same manner in which environmental samples are analyzed. Used to identify the presence of contamination potentially added during the sampling and analysis process.

Field duplicate A second sample collected as near as possible to the original sample.

Field matrix spike A known amount of a field sample to which a known amount of the target analyte has been added. Used to compute the proportion of added analyte that is recovered upon analysis.

Field reagent blank Same as *field blank*.

Field sample See also *sample*.

Field split A field sample that has been divided in the field into equally representative portions (See also *split sample*).

Focused data validation A technically based analyte-, sample-, and potentially data use-specific process that extends the qualification of data beyond method or contractual compliance and provides a level of confidence that an analyte is present or absent. If the analyte is present, the quality of the quantitation may be obtained through focused validation.

Geohydrology The science that applies hydrologic methods to the understanding of geologic phenomena.

Grab sample A specimen collected by a single application of a field sampling procedure to a target population, e.g. the surface soil from a single hole collected following the spade and scoop sampling procedure, or a single air filter left in the field for three months.

Groundwater Water in a subsurface saturated zone.

Hazardous and Solid Waste Amendments (HSWA) Amendments to the Resource Conservation and Recovery Act, 1984. HSWA added land disposal restrictions, minimum technology requirements, and expanded corrective action authorities to the RCRA statue.

Hazardous substance (As defined by 40 CFR 302.3) Any substance designated pursuant to 40 CFR 302. 40 CFR 302.4 – Designation of Hazardous Substances:

Listed hazardous substances. The elements, compounds and hazardous wastes appearing in Table 302.4 are designated as hazardous substances under section 102(a) of the CERCLA.

Unlisted hazardous substances. A solid waste, defined in 40 CFR 261.2, which is not excluded from regulation as a hazardous waste under 40 CFR 261.4(b), is a hazardous substance under section 101(14) of the CERCLA if it exhibits any of the characteristics identified in 40 CFR 261.20 through 261.24. See Hazardous Waste. **Note:** This definition incorporates by reference, substances listed in CWA sections 311 and 307(a); CAA section 112; RCRA section 3001; and TSCA section 7.

Hazardous waste (As defined by RCRA 40 CFR 261.3) Any solid waste is generally a hazardous waste if it is not excluded from regulation as a hazardous waste, is listed in the regulations as a hazardous waste, exhibits any of the defined characteristics of hazardous waste (ignitability, corrosivity, reactivity, or toxicity), or is a mixture of solid waste and hazardous waste.

Holding time The maximum elapse of time that one can expect to store a sample without unacceptable changes in analyte concentrations. Holding times apply under prescribed storage conditions and deviations in storage conditions may affect the holding time. Extraction Holding Time refers to the time lapse from sample collection to sample preparation; Analytical Holding Time refers to the time lapse between sample preparation and analysis.

HSWA module A portion of the Laboratory's permit to operate under RCRA that contains requirements specific to Los Alamos National Laboratory. It is this portion of the permit that contains the list of solid waste management units that must be cleaned up in accordance with RCRA procedures.

Hydraulic conductivity The rate at which water moves through a medium in a unit of time under a unit hydraulic gradient through a unit area measured perpendicular to the direction of flow.

Hydraulic gradient The rate of change of hydraulic head per unit of distance in the direction of groundwater flow.

Hydraulic head Elevation of the water table or potentiometric surface as measured in a well.

Hydrogeology The science that applies geologic methods to the understanding of hydrologic phenomena.

Infiltration Entry of water into the ground.

Interflow A runoff process that involves lateral subsurface flow in the soil zone.

Initial calibration The process used to establish the relationship between instrument response and analyte concentration at several analyte concentration values to demonstrate that an instrument is capable of acceptable analytical performance.

Intermittent stream Said of a stream that flows only in certain reaches due to losing and gaining characteristics of the channel bed.

Laboratory duplicate sample The portions of a sample taken from the same sample container, prepared for analysis and analyzed independently but under identical conditions. Each duplicate sample is expected to be equally representative of the original material.

Land disposal restrictions (LDR) A RCRA program that requires hazardous waste be treated (or meet specified levels for hazardous constituents) before land disposal is allowed. In addition to the disposal prohibition, there are prohibitions and limits in the LDR program regarding the dilution and storage of wastes.

LANL Data validation qualifiers Data qualifiers used in the LANL ER Project baseline validation process are as follows:

"A" Contractually required data are not available for data review and evaluation.

"U" The analyte was analyzed for but not detected.

"J" The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.

"J+" The analyte was positively identified, and the result is likely to be biased high.

"J-" The analyte was positively identified, and the result is likely to be biased low.

"UJ" The analyte was not positively identified in the sample, and the associated value is an estimate of the sample-specific detection or quantitation limit.

"RPM" Without further review of the raw data, the sample results are unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. Presence or absence cannot be verified. Any results qualified as RPM must be evaluated for relevance to data use.

"P" Professional judgement should be applied to using the data in decision-making.

"PM" Professional judgement should be applied to using the data in decision-making. A manual review of raw data is recommended t determine if the defect impacts data use for decision-making.

"R" The data is rejected as a result of major problems with quality assurance/qualify control (QA/QC) parameters.

Leaching The separation or dissolving out of soluble constituents of a solid material by the natural action of percolating water or by chemicals.

Matrix See also *sample matrix*.

Matrix Relatively fine material in which coarser fragments or crystals are embedded; also called "ground mass."

Matrix spike An aliquot of sample spiked with a known concentration of target analyte(s). The spiking typically occurs before sample preparation and analysis.

Matrix spike duplicate An intralaboratory duplicate sample spiked with a known amount of target analyte(s). Spiking occurs prior to sample preparation and analysis.

Medium (environmental) Any material capable of absorbing or transporting constituents including tuffs, soils and sediments derived from these tuffs, surface water, groundwater, air, structural surfaces, and debris.

Medium (geological) The solid part of the hydrogeological system; may be unsaturated or saturated.

Method A body of procedures and techniques for systematically performing an activity.

Method blank An analyte-free matrix to which all reagents are added in the same volumes or proportions as those used in the environmental sample processing and which is prepared and analyzed in the same manner as the corresponding environmental samples. The method blank is used to assess the potential for contamination to the sample during preparation and analysis.

Method detection limit (MDL) The minimum concentration of a substance that can be measured and reported with a known statistical confidence that the analyte concentration is greater than zero. The MDL is determined from analysis of samples of a given matrix type containing the analyte after subjecting the sample to the usual preparation and analyses. The MDL is used to establish detection status.

Migration The movement of inorganic and organic species through unsaturated or saturated materials.

Migration pathway A route (e.g., a stream or subsurface flow path that controls the potential movement of contaminants to environmental receptors (plants, animals, humans).

Mitigation (1) Avoiding an impact altogether by not taking a certain action or parts of an action. (2) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.

(3) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment. (4) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action. (5) Compensating for the impact by replacing or providing substitute resources or environments.

Mixed waste Waste that contains both hazardous waste (as defined by RCRA and its amendments) and radioactive waste (as defined by the AEA and its amendments).

Model A mathematical approximation of a physical, biological, or social system.

Monitoring well A well drilled at a specific location on or off a hazardous waste site for the purpose of sampling groundwater or measuring water levels. Typically constructed with a moderate screen interval placed so as to straddle the water table or potentiometric surface associated with the saturated zone of interest.

National Pollutant Discharge Elimination System (NPDES) A federal regulation under the Clean Water Act requiring permits for discharge into surface waterways.

No further action (NFA) A decision that no further investigation or remediation is warranted for a PRS, based on risk levels for residential use, recreational use, or industrial use.

Notice of Deficiency (NOD) A notice issued to DOE and the Laboratory by EPA or NMED stating that some aspect(s) of a plan or report does not meet their requirements. The ER Project must then propose a solution acceptable to the EPA/NMED before the plan or report will be approved.

Operable unit (OU) At LANL, one of 24 areas originally established for administering the ER Project. Set up as groups of potential release sites, the OUs were aggregated based on geographic proximity for the purpose of planning and conducting the cleanup effort. As the project matured, it became apparent that 24 were too many to allow efficient communication and to ensure consistency in approach. Therefore, in 1994, the 24 OUs were reduced to six administrative "field units".

Out of control A condition in which a measured quality control parameter does not meet specified control or acceptance criteria.

Perched groundwater Groundwater that lies above the regional water table and is separated from it by an unsaturated zone.

Percolation Gravity flow of groundwater through the pore spaces in rock or soil below the ground surface.

Permit modification A process in which changes to requirements of the Laboratory's operating permit is requested by application to the EPA. The process includes a public hearing and a 60-day comment period on the proposed changes.

Pollutant Includes, but is not limited to, any element, substance, compound, or mixture, including disease-causing agents, which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction) or physical deformations, in such organisms or their offspring; except that the terms "pollutant or contaminant" shall not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under Subparagraphs (A) through (F) of Paragraph (14) and shall not include natural gas, liquefied natural gas, or synthetic gas of pipeline quality (or mixtures of natural gas and such synthetic gas).

Porphyritic Said of the texture of an igneous rock in which larger crystals (phenocrysts) are set in a finer ground mass.

Potential release site (PRS) A site suspected of releasing contaminants into the environment. PRS is a generic term that includes SWMUs, hazardous waste sites listed in Module VII of the Laboratory's Hazardous Waste Facility Permit, and sites that have been identified as potentially contaminated by radioactivity.

Precambrian All geologic time prior to the beginning of the Paleozoic era (the Paleozoic began about 600 million years ago), equivalent to about 90% of all geologic time.

Precision A concept used to describe dispersion of measurements with respect to a measure of location or central tendency. Precision may be represented by the inverse of the standard deviation of a set of measurements.

Prepared sample A sample treated in such a manner as to render it amenable to analysis. May include: digestate, distillate, electroplate, extract, filter retentate, filtrate, homogenate, precipitate, pulverized/sieved portion of sample, residue, etc.

Qualifier flag A letter code indicating, on a gross scale, a verifiable or potential data deficiency. Qualifier flags are assigned to data based on the outcome of data validation checks.

Quality assessment sample A sample submitted for analysis, the data from which are used to assess the quality of performance of a sampling or analysis process. May include performance evaluation samples, field duplicates, field blanks, etc.

Quality control (QC) sample A sample which, upon analysis, provides information useful for adjusting, controlling, or verifying continuing acceptability of sampling and/or analysis activities that are in progress.

Quaternary The second period of the Cenozoic Era, following the Tertiary, and including the last 2 – 3 million years.

RCRA facility investigation (RFI) The second step of a RCRA corrective action, to gather enough data to fully characterize the nature, extent, and rate of migration of contaminants to determine the appropriate response action. The RFI is generally equivalent to the RI portion of the Superfund process.

Reason code A code used in the ER data validation process to indicate why a qualifier flag has been assigned to a datum.

Receptor A person, plant, animal, or geographical location that is exposed to a chemical or physical agent released to the environment by human activities.

Recreational use scenario Recreational use refers to current and future use scenarios in which cleanup of a PRS is completed to a level that permits the public to safely use it on an intermittent basis for activities such as hiking and camping. The standards are more stringent than they are for the industrial use scenario but not as stringent as those for residential use.

Release Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment (including the abandonment or discarding of barrels, containers, and other closed receptacles containing any hazardous substance or pollutant or contaminant), but excludes

(A) any release which results in exposure to persons solely within a workplace, with respect to a claim which such persons may assert against the employer of such persons;

(B) emissions from the engine exhaust of a motor vehicle, rolling, stock, aircraft, vessel, or pipeline pumping station engine;

(C) release of source, byproduct, or special nuclear material from a nuclear incident, as those terms are defined in the Atomic Energy Act, if such release is subject to requirements with respect to financial protection established by the Nuclear Regulatory Commission under Section 170 of such act, or, for the purposes of Section 104 of this title or any other response action, any release of source, byproduct, or special nuclear material from any processing site designated under Section 102(a)(1) or 302(a) of the Uranium Mill Tailings Radiation Control Act of 1978, and

(D) the normal application of fertilizer. **[CERCLA 101(22)]**

Relative precision Precision measured relative to a particular value. Relative precision expressed as the relative standard deviation (RSD) may be calculated as the ratio of the standard deviation to the selected value.

Remediation The process of reducing the concentration of a contaminant (or contaminants) in air, water, or soil media to a level that poses an acceptable risk to human health; the act of restoring a contaminated area to a usable condition based on specified standards.

Remedy or remedial action Those actions consistent with permanent remedy instead of or in addition to removal actions in the event of a release or threatened release of a hazardous substance into the environment, to prevent or minimize the release of hazardous substances so that they do not migrate to cause substantial danger to present or future public health or welfare or the environment. The term includes, but is not limited to, such actions at the location of the release as storage, confinement, perimeter protection using dikes, trenches, or ditches, clay cover, neutralization, cleanup of released hazardous substances and associated contaminated materials, recycling or reuse, diversion, destruction, segregation of reactive wastes, dredging or excavations, repair or replacement of leaking containers, collection of leachate and run-off, on-site treatment or incineration, provision of alternative water supplies, and any monitoring reasonably required to assure that such actions protect the public health and welfare and the environment. **[CERCLA 101(24)]** Activities conducted at DOE facilities to reduce potential risks to people and/or harm to the environment from radioactive and/or hazardous substance contamination. **(DOE Order 5820.2A)**

Remove or removal The cleanup or removal of released hazardous substances from the environment; such actions as may be necessary taken in the event of the threat of release of

hazardous substances into the environment, such actions as may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances, the disposal of removed material, or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release. **[CERCLA 101 (23)]**

Representativeness The degree to which data accurately and precisely represent a characteristic of a population or an environmental condition.

Residential use scenario The standards for residential use are the most stringent of the three current and future use scenarios being considered by the ER Project and is the level of cleanup EPA is currently specifying for SWMUs located off the Laboratory site and for those released for non-Laboratory use.

Resource Conservation and Recovery Act (RCRA) The RCRA regulations establish a comprehensive hazardous waste management system under the authority of RCRA Subtitle C. RCRA regulates hazardous waste from its point of generation through its point of final disposal. RCRA also regulates solid waste under Subtitle D.

Risk A measure of a negative or undesirable impact associated with an event.

Risk assessment see also *Baseline Risk Assessment*

Rinsate Blank See also *Equipment blank*.

Routine analysis The analysis categories of inorganics, metals, organics, radiochemistry and high explosives as defined in the current contract laboratory statement of work.

Routine Data Validation The process of reviewing analytical data relative to quantitative routine acceptance criteria. The objective of routine data validation is two-fold: one objective is to estimate the technical quality of the data relative to minimum national standards adopted by LANL ER; the other objective is to indicate to data users the technical data quality at a gross level by assigning qualifier flags to environmental data whose quality indicators do not meet acceptance criteria.

Sample A portion of a material (e.g., rock, soil, water, air), which, alone or in combination with other samples, is expected to be representative of the material or area from which it is taken.

Samples are typically sent to a laboratory for analysis or inspection or are analyzed in the field. When referring to samples of environmental media, the term *field sample* may be used.

Sample matrix In chemical analysis, that portion of a sample which is exclusive of the analytes of interest. Together, the matrix and analytes of interest form the sample.

Screening Action Level (SAL) Medium-specific concentration level for a chemical derived using conservative criteria below which it is generally assumed that there is no potential for unacceptable risk to human health. The derivation of a SAL is based on conservative exposure and land use assumptions. However, if an applicable regulatory standard exists that is less than the value derived by risk-based computations, it will be used for the SAL.

Screening Assessment A process designed to determine whether contamination detected in a particular medium at a site may present a potential unacceptable human health and /or ecological risk. The assessment utilizes screening levels that are either human-health or ecologically based concentrations derived using chemical specific toxicity information and standardized exposure assumptions below which no additional actions are generally warranted.

Sensitivity An indication of the lowest analyte concentration that can be measured with a specified degree of confidence.

Single blind sample A sample submitted for analysis whose composition is known to the submitter but not to the analyst.

Site characterization The program of exploration and research, both in the laboratory and in the field, undertaken to establish the geological, hydrological, and chemical conditions at a site. Site characterization includes borings, surface excavations, excavation of exploratory shafts, limited subsurface lateral excavations and borings and geophysical testing. **(10 CFR 60.2)**

Site conceptual model A qualitative or quantitative description of sources of contamination, environmental transport pathways for contamination, and biota that may be impacted by contamination (called receptors) and whose relationships describe qualitatively or quantitatively the release of contamination from the sources, the movement of contamination along the pathways to the exposure points, and the uptake of contaminant by the receptors.

Solid waste Any discarded material, including any material which is abandoned, recycled, inherently waste-like, or certain military munitions.

Solid waste management unit (SWMU) Any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste.

Split sample A sample that has been subdivided into two or more portions expected to be of the same composition. Used to characterize within-sample heterogeneity, sample handling, and measurement variability.

Standard operating procedure (SOP) A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps, and is officially approved as the method for performing certain routine or repetitive tasks.

Stratification Classification of the target population into two or more non-overlapping and exhaustive categories (strata) on the basis of characteristics which are known *a priori* for the entire population.

Stratified sample A sample including one or more specimens from each of several sub-populations of the target population. (Note: If the specimens are selected from within each sub-population using *simple random sampling*, then the sample is called a stratified random sample.)

Stratigraphy The science dealing with the succession, age, composition and history of strata.

Target analyte A chemical or parameter, the concentration, mass or magnitude of which is designed to be quantified by use of a particular test method.

Technical area (TA) The Laboratory established technical areas as administrative units for all its operations. There are currently 49 active TAs spread over 43 square miles.

Topography The physical features of a place or region.

Transport or transportation The movement of a hazardous substance by any mode, including pipeline (as defined in the Pipeline Safety Act), and in the case of hazardous substance which has been accepted for transportation by a common or contract carrier, the term "transport" or "transportation" shall include any stoppage in transit which is temporary, incidental to the transportation movement, and at the ordinary operating convenience of a common or contract carrier, and any such stoppage shall be considered as a continuity of movement and not as the storage of a hazardous substance. **[CERCLA 101(26)]**

Treatment Any method, technique, or process, including elementary neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, or so as to recover energy or material resources from the waste, or so as to render such waste non-hazardous, or less hazardous; safer to transport, store, or dispose of; or amenable for recovery, amenable for storage, or reduced in volume.

Treatment, storage, and disposal facility (TSDF) Any building, structure, or installation where a hazardous waste has been treated, stored, or disposed. TSD facilities are regulated by EPA and states under RCRA.

Trip blank A sample of analyte-free media taken to the sampling site and returned to the analytical laboratory unopened along with samples collected in the field. Used to monitor cross contamination of samples during handling and storage both in the field and in the analytical laboratory.

Tuff A compacted deposit of volcanic ash and dust that contains rock and mineral fragments accumulated during an eruption.

Ultimate disposal The final disposal of hazardous substances resulting from a removal action. It does not include temporary storage or other temporary measures of managing the waste from a removal action. **(DOE 1991)**

Unrestricted area Any area, access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials and any area used for residential quarters. **(10 CFR 60.2)**

Unsaturated zone The zone between the land surface and the regional water table. Generally, fluid pressure in this zone is less than atmospheric pressure, and some of the voids may contain air or other gases at atmospheric pressure. Alternatively, the unsaturated zone generally has moisture contents less than saturation.

Water Table The top of the saturated zone; the water level associated with an unconfined aquifer.

Welded Tuff A volcanic deposit hardened by the action of heat, pressures from overlying material, and hot gases.

APPENDIX B CLIMATE, GEOLOGY, HYDROLOGY, ECOLOGICAL RESOURCES, AND CULTURAL RESOURCES

B-1.0 Operational History and Land Use

The firing range was constructed for use by security forces for the Atomic Energy Commission (AEC) after January 1947, when control of all Manhattan Project sites was transferred to the AEC. The range was used by security forces for small arms target practice until it was abandoned in the early 1960s, when the present firing range in Sandia Canyon (TA-72) was built. The Department of Energy (DOE) released the Former Small-Arms Range and surrounding areas to the USDA Forest Service in 1976. The site was utilized by the general public for recreational shooting until 1992 when VCA activities were initiated. Current ownership remains with the Forest Service until a pending land-exchange between the Forest Service and a private land developer is completed following site remediation. The site is adjacent to a residential development and future use will be multi-family residential.

B-2.0 Climate

Los Alamos County has a semiarid, temperate, mountain climate. Summers are generally sunny with moderate, warm days and cool nights. High altitude, light winds, clear skies, and dry atmosphere allow summer temperatures to range from 50°F to 90°F. During the winter, temperatures typically range from 15°F to 50°F. Normal annual precipitation in Los Alamos, including rainfall and water-equivalent snowfall, is 18 in. Of this total, approximately 40% occurs as brief, intense thunderstorms during July and August. Stream flow in canyons can occur as a result of these storms. Spring snowmelt runoff may also induce stream flow in area canyons. Winter snowfall averages 51 in. annually (Bowen 1990, ER ID 06899.1). Wind speeds are less than 2.5 m/s (5.5 mph) about 40% of the time and greater than 5 m/s (11 mph) about 20% of the time. Strong winds occur mainly in the spring. The predominant wind direction is from the south-southwest.

B-3.0 Geologic Setting

A detailed discussion of the geology of the entire Los Alamos area can be found in Section 2.5.1 of the Installation Work Plan (IWP) (LANL 1995, 52009.1). A summary of that material, emphasizing conditions expected at PRS 0-016 is presented below. The generalized stratigraphy at TA-0 is shown in Figure B-1.

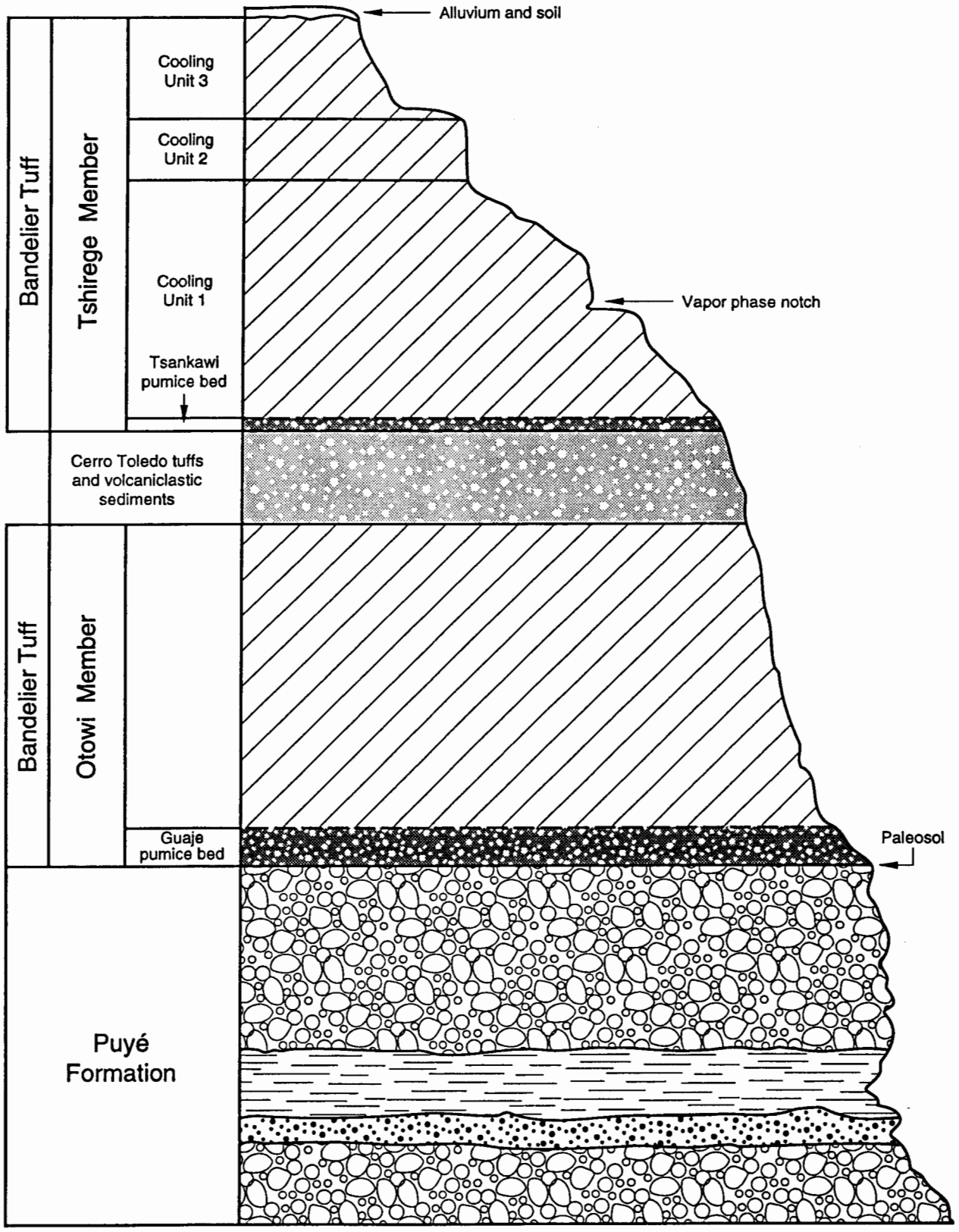


Fig. B-1 Generalized stratigraphy of TA-0.

PRS 0-016 (Small Arms Firing Range) is located in Rendija Canyon at an elevation of 7200 feet. The site is located on a paleo-alluvial fan which was built outward from Guaje Ridge and was subsequently dissected by the modern drainages. The fan is composed of post- Bandelier alluvium derived from the Jemez Mountains to the west. Bedrock underlying the site is the upper (Tshirege) Member of the Bandelier Tuff (Figure B-1), comprised of fallout and ash flow deposits of silicic volcanic rock erupted 1.2 million years ago. The thickness of this volcanic unit is about 600 feet. The exact cooling unit which underlies the Firing Range has not been determined with certainty. It may be the uppermost part of cooling unit 3, or may be cooling unit 4, which is exposed approximately two miles to the south. The post-Bandelier alluvium is up to 30 feet thick at the Firing Range. It consists of poorly- sorted, clay-rich sand, gravel, and cobbles derived mainly from the Tschicoma Formation. Much of the alluvium consists of angular to subrounded lithic clasts of Tshicoma volcanic rocks, and of crystals of feldspar, quartz, and biotite and other ferromagnesian minerals derived from the Tshicoma Formation. In addition, the alluvium contains clasts of pumice and tuff probably derived from units of the Bandelier Tuff.

The Bandelier Tuff overlies the Puye Formation which is a fanglomerate consisting of poorly sorted boulders, cobbles and coarse sands, and contains interbedded lapilli tuff beds and laharic deposits. This formation is about 700 feet thick. Both of these units overlie the Santa Fe Group that consists of predominately fluvial, slightly consolidated sedimentary rocks. In the vicinity of the Pajarito Plateau, the Santa Fe Group consists of the Tesuque Formation and overlying Chamita Formation.

B-3.1 Soils

A detailed discussion of the soils in the Los Alamos area can be found in Section 2.5.1.3 of the Installation Work Plan (IWP) (LANL 1995, ER ID 52009.1). A summary of that material specific to the Firing Range is presented below.

Probably no undisturbed soil remains at the Firing Range. The upper 15 feet of soil/alluvium has been heavily disturbed by activities associated with construction and maintenance of the Firing Range. Material has probably been removed and/or added in the process. Soil exposed in excavations on the Firing Range is very clay-rich, but its original source is not known. Soils of Rendia Canyon area have not been surveyed or studied. However, because the rock type, elevation, and geological setting is similar to other townsite mesa top sites, any undisturbed soils at PRS 0-016 would probably also be similar. In general, these soils, developed on Bandelier Tuff and on alluvium, are moderately to well developed, and belong to either the Hackroy or Nyjack

soil series (Nyhan et al., 1978, ER ID 05702.2). The Hackroy series consists of very shallow to shallow, well-drained soils that have an A-Bt-R profile. Soil textures range from sandy loam to clay. The Nyjack series consists of moderately deep, well-drained soils that have an A-Bt-C-R profile. Texture ranges from gravely sandy loam to clay loam.

B-4.0 Hydrology

The hydrology of the Pajarito Plateau is summarized in Section 2.5.2 of the IWP (LANL 1995, ER ID 52009.1). Site-specific conditions are summarized below.

B-4.1 Surface water

PRS 0-016 is located on a mesa top. There is no surface water present at this site other than run off following a rainstorm or from snowmelt. Surface runoff from the Firing Range occurs as sheetflow during precipitation events, mainly summer thunderstorms. Sheetflow may transport sediments from the surface to adjacent canyons.

Los Alamos National Laboratory

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

Surface Water Assessment
Erosion Matrix for PRS 0-016

CRITERIA EVALUATED	Value	Erosion/Sediment Transport Potential Low 0.1	Medium 0.5	High 1.0	Calculated Score
Site Setting (43)					
On mesa top	1	Defined based on topographic setting			1.0
Within bench of canyon	4				
Within the canyon floodplain but not watercourse	13				
Within bottom of canyon channel in watercourse	17				
Estimated % ground and canopy cover	13	>75%	25-75%	<25%	1.3
Slope	13	0-10%	10-30%	>30%	1.3
Surface Water Factors-Run-off (46)					
Visible evidence of runoff discharging? (Yes/No)	5	If no, score of 0 for runoff section.			5.0
		If yes, score 5 and proceed with section.			
Where does runoff terminate?	19	Other	Bench Setting	Drainage/Wetland	1.9
Has runoff caused visible erosion? (Yes/No)	22	Sheet	Rill	Gully	0.0
		If no, score as 0. If yes, calculate as appropriate.			
Surface Water Factors-Run-on (11)					
Structures adversely affecting run-on (Yes/No)	7*	If yes, score as 7. If no, score as 0.			7.0
Current operations adversely impacting (Yes/No)	4	If yes, score as 4. If no, score as 0.			0.0
Natural drainages onto site (Yes/No)	7*	If yes, score as 7. If no, score as 0.			0.0
**Select either structures or natural drainages.*					
MAX. POSSIBLE EROSION MATRIX SCORE:	**100**			**Total Score**	17.5**

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

Report Printed 9/28/98 9:19:13 AM.

Los Alamos National Laboratory
SURFACE WATER
SITE ASSESSMENT

SITE INFORMATION

1a) PRS Number 0-016 **1b) Structure Number** **1c) FMU Number**

2. Date/Time (M/D/Y H:M am/pm) 5/14/97

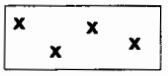
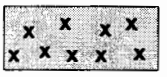
SITE SETTING (check all that apply)

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

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

Explanation: Guaje pines/Rendija Canyon.

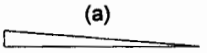
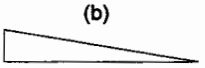
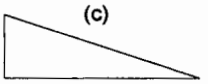
4. Estimated ground and/or canopy cover at site: (deciduous leaves, pine needles, rocks, vegetation, trees, structures, asphalt, etc.)

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

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

Explanation: Mostly base course. Back area completely revegetated. No canopy cover around base course, but trees scattered around back area.

5. Steepest slope at the area impacted:

(a)  (b)  (c) 

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

Explanation:

RUNOFF FACTORS

Y / N

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

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

Explanation: Back area sloped to the north has runoff.

RUNOFF FACTORS, CONT'D

6b) Where does evidence of runoff terminate?

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

Explanation:

Y / N

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

Explanation:

RUN-ON FACTORS

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

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

Explanation: Parking area for heavy equipment.

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

Explanation:

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

Explanation:

ASSESSMENT FINDING:

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

S. Veenis

11. Signature of Water Quality/Hydrology Representative

_____ Initials of independent reviewer.

Check here when information is entered in database: ☑

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

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

Description of existing BMPs:

BMPs in place. Dirt berms, retention pond, reseeding/mulch, jutemat & straw bales used. 70% revegetative cover has been achieved. BMPs installed 9/30/93

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

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

OTHER INTERNAL NOTES:

B-4.2 Ground water

The main aquifer beneath North Mesa is at an elevation of approximately 6,000-ft. At mesa top sites such as PRS 0-016 the surface is separated from the main aquifer by an unsaturated zone that is 1,000 to 1,300 ft thick. No known perched aquifers or springs are known to exist in the immediate vicinity of this site.

B-5.0 Ecological Resources

See Section 3.7.3 and Appendix F-2 of this report.

B-6.0 Cultural Surveys

The National Historic Preservation Act requires a cultural resource survey. The Archaeological Status Report for the Environmental Restoration Readiness Review is included here.

MEMORANDUM

ERM/GOLDER Los Alamos Project Team

To: Beverly Larson

From: Terry Johnson

Date: March 1, 1994

Regarding: Archaeological Status Report Regarding OU 1071, SWMU 0-016 The Inactive Firing Range

---

ERM/Golder is preparing to return to the field (following winter-related shutdown) to complete the site investigation/remediation of SWMU 0-016. Previously, on September 1, 1993 you provided us with an Archaeological Status Report for the above referenced area which indicated no issues related to Archaeology. To update the Readiness Review file (for FY94) we are requesting you sign and return to us a letter indicating your agreement with that statement. I have attached copies of the information previously provided for reference.

If you have any questions, please call Everett Trollinger, Daren Johnston, or myself at 662-3700. You may send comments by FAX to 662-1398.

Thank you

cc: Project File

Everett Trollinger, ASI/ERM/Golder

Al Funk, ERM/Golder

Jim Aldrich, OUPL, OU 1071

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ARCHAEOLOGICAL STATUS REPORT
FOR
ENVIRONMENTAL RESTORATION READINESS REVIEW

Date: September 1, 1993

OU: 1071, SWMU 0-016
OU PL: Jim Aldrich, EES-1, MS D462

Work Completed to Date: Area indicated on the attached map has been surveyed for archaeological resources. Report has been sent to the State Historic Preservation Officer (SHPO) and concurrence has been received.

Outstanding Work for this Fiscal Year: None.

Outstanding Work for Next Fiscal Year: Oversight and monitoring, and consultations on other sampling locations; summary report preparation.

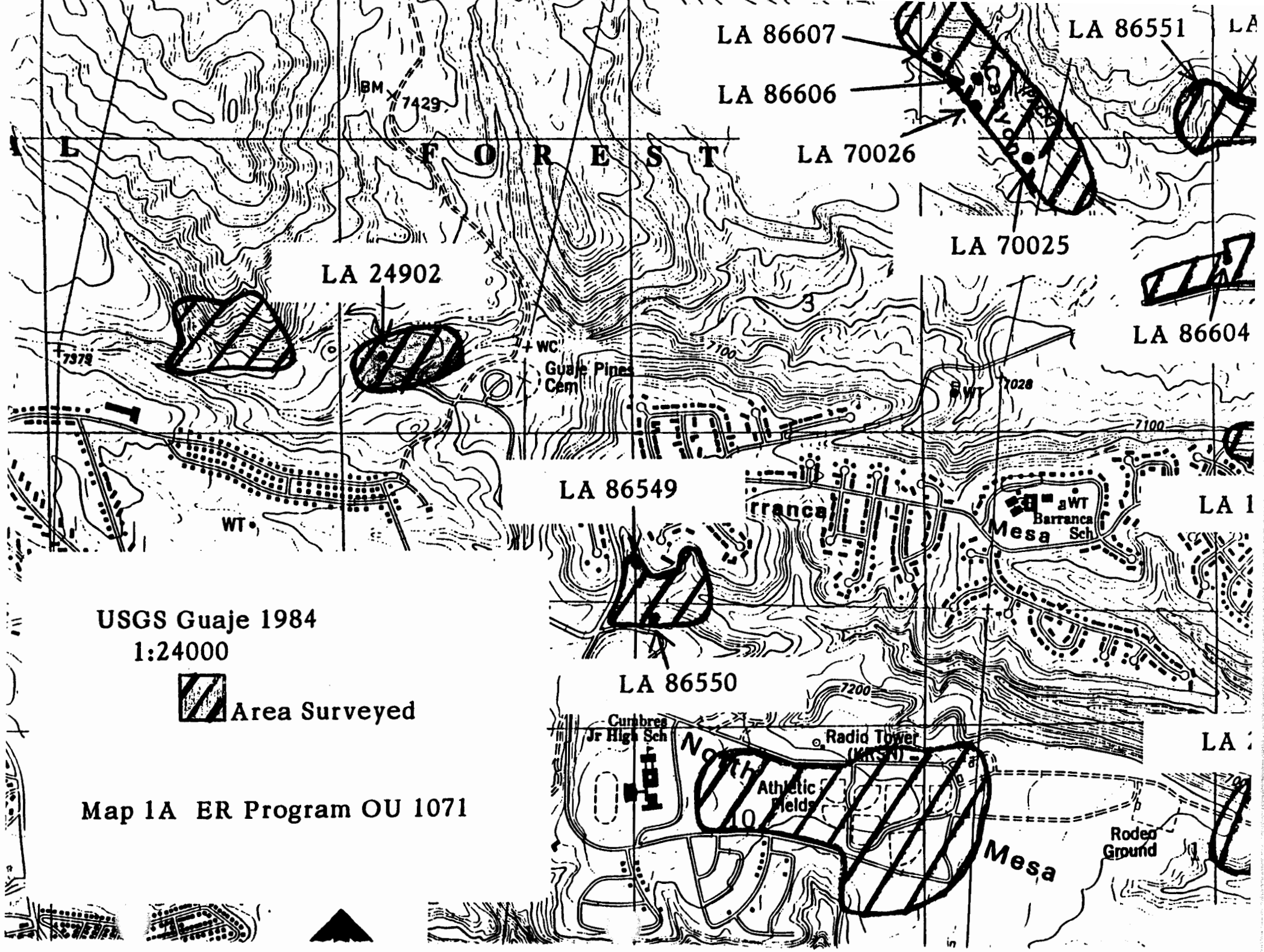
ER Activities to be Performed for this Readiness Review: All ER activities planned at SWMU 0-016 are located within the area indicated on the map. If this is incorrect, or if there are areas to be sampled which are outside the area surveyed for archaeology (see attached map), please call me at 667-2276 or 9-1-699-1534.

Outstanding Issues for this Readiness Review: No issues. One artifact scatter is located within the surveyed area for SWMU 0-016. The artifacts from this site, LA 24902 (FS AR-03-10-06-607), were collected and the SHPO has determined that the site is no longer a concern. The location of LA 24902, although within the survey area for SWMU 0-016, is to the west of the actual SWMU location. If necessary, ER ground disturbing activities can take place within this site area.

Ellen D. McGehee
(for Beverly Larson)

Beverly M. Larson
Archaeology Team Leader
EM-8, MS K490, 7-2276

cy: Keith Bowers, ERM PMC
55 Oppenheimer Suite 100, Los Alamos, NM 87544



Map 1A ER Program OU 1071

APPENDIX C RESULTS OF QUALITY ASSURANCE/QUALITY CONTROL ACTIVITIES

C-1.0 Summary

Confirmatory sampling was conducted following excavation and processing of contaminated soils to confirm that all materials containing elevated concentrations of copper, lead, and zinc had been removed from the site. Fifty-four confirmation samples were collected from the following five areas: the drainage areas (3 samples), the range floor (24 samples), the back area (17 samples), the right of way (4 samples), and background samples (6 samples). All confirmatory samples were submitted to a fixed-site analytical laboratory for analysis of total recoverable copper, lead, and zinc by EPA SW-846 Methods.

During the confirmation fixed laboratory analysis, laboratory duplicates, matrix spike samples, laboratory blanks, and laboratory standards were all used to ensure quality results. The type and frequency of QC analyses required for fixed laboratory analyses is described in the ER Project SOW for Analytical Services (LANL 1995, ER ID 49738.1). The definitions of QA/QC sample types and processes are included in the glossary in Appendix A-2.0.

Sometimes it is necessary to do a focused validation of part of a data set. The focused validation process is applied when part of the data set causes concern. These areas of concern are often marked with laboratory qualifiers. When a focused validation is conducted, one is attempting to see if the cause of concern is worthy of disregarding the data or retaining the data for use in assessing the PRS. A variety of procedures are followed in assessing the data (i.e., examining method blanks, field duplicates, matrix spikes, and calibration standards) to determine the usefulness of the data. In general, data is still usable even though qualifier flags are applied during routine and focused validation. The definition of laboratory qualifiers, LANL qualifiers, and focused validation qualifiers are included in the glossary in Appendix A. A more detailed description of the focused validation process may be found in QAPP (LANL 1996, ER ID 53450).

Results of the data validation for the confirmation samples is found in Table C-1 of Section C-5.0 of this report. The validation process conclusion is that all the confirmation data collected at PRS 0-016 are of sufficient for use in the assessment of this PRS.

C-2.0 Inorganic Analyses

C-2.1 Field Analyses

X-ray fluorescence was used as a method for the detection of copper, lead, and zinc during the clean-up phase of this Voluntary Corrective Action. No field methods were used for the confirmation samples for this report.

The SRF protocol used is described in the Laboratory Internal Method EI-732 (LANL 1993, 31794). All XRF analyses were carried out in a mobile laboratory facility set up at PRS 0-016. The XRF was calibrated daily according to the manufacturer's instructions. Calibration was accomplished using National Institute of Standards & Technology (NIST) soil standards.

C-2.2 Fixed Laboratory Analyses

Fifty-four confirmatory soil samples were analyzed for copper, lead, and zinc. A summary of these samples and results is listed in Table D-2 in Appendix D of this report. The detection limits for the analytical methods employed were all less than background values as given in LANL 1998, ER ID 58093.

C-3.0 Radiochemical Analyses

No radiochemical analyses were performed as part of the Voluntary Corrective Action.

C-4.0 Organic Analyses

No organic analyses were performed as part of the Voluntary Corrective Action.

C-5.0 Results of Data Validation

Table C-1 below summarizes the data that was qualified for this report.

For Request Number or Sample Delivery Group (SDG) 1856 four soil samples were analyzed for copper, lead, and zinc. Copper had a low recovery of 74.8% in the matrix spike sample. The matrix spike sample is used to assess the quality of the sample digestion, extraction, and analysis procedures. A low recovery suggests that either there was an incomplete recovery of an analyte in these procedures or there was a problem with sample heterogeneity. For analytes where the

matrix spike is out of control limits, a post digestion spike is performed. The post digestion spike is used to assess the sample extraction and analysis procedures. The post digestion spike percent recovery for copper was 116.3%, within the control limits of 75-125%. The laboratory control sample percent recovery for copper in this sample delivery group was 99.2%, also within control limits. As required by LANL data validation guidelines, J- qualifiers were added to the four copper results in this sample delivery group. The copper results in this sample delivery group are, however, valid and usable for the following reasons. The matrix spike recovery was outside of control limits by less than 1% at 74.8 %. The post digestion recovery was within control limits for copper, and the laboratory control sample recovery for copper was also within control limits.

Further, the four soil samples in Request number 1856, the four copper results should be regarded as estimated (J), because copper was detected below the method detection limit, but above the instrument detection limit.

For Request Number 2653 (19338) sixteen soil samples were analyzed for copper, lead, and zinc. Lead had a low recovery of 63% in the matrix spike sample. The matrix spike sample is used to assess the quality of the sample digestion, extraction, and analysis procedures. A low recovery suggests that either there was an incomplete recovery of an analyte in these procedures or there was a problem with sample heterogeneity. For analytes where the matrix spike is out of control limits, a post digestion spike is performed. The post digestion spike is used to assess the sample extraction and analysis procedures. The post digestion spike percent recovery for lead was within the control limits of 75-125%. The laboratory control sample percent recovery for lead in this sample delivery group was 105% also within control limits. As required by LANL data validation guidelines, J- qualifiers were added to the sixteen lead results in this sample delivery group. The lead results in this sample delivery group are, however, valid and usable for the following reasons. The matrix spike recovery was outside of control limits at 63%. According to the EPA Fundamental Guidelines for Inorganic Data Review, if the matrix spike recovery is below 75% but above 30%, the data is usable and qualified estimated (J-). The data is only rejected if the matrix spike recovery is below 30%. The post digestion recovery was within control limits for lead. Finally, the laboratory control sample recovery for lead was also within control limits.

Seventeen soil samples were analyzed for copper, lead, and zinc in request 3631. There were no QC problems with this request; therefore all data are valid and usable without qualification.

Six soil samples were analyzed for copper, lead, and zinc in request 17166. There were no QC problems with this request; therefore all data are valid and usable without qualification.

Three soil samples were analyzed for copper, lead, and zinc in request 2664. There were no QC problems with this request; therefore all data are valid and usable without qualification.

One soil samples were analyzed for copper, lead, and zinc in request 2921. There were no QC problems with this request; therefore all data are valid and usable without qualification.

Seven soil samples were analyzed for copper, lead, and zinc in request 3025. There were no QC problems with this request; therefore all data are valid and usable without qualification.

TABLE C-1
DATA QUALITY EVALUATION FOR CONFIRMATORY SAMPLES COLLECTED FROM PRS 0-016

Request No.	Location ID	Sample ID	Analytical Suite	QC Parameter	Explanation
1856	00-04738 00-04739 00-04740 00-04741	0100-96-0031 0100-96-0033 0100-96-0034 0100-96-0036	Metals	Accuracy	The matrix spike recovery for copper was low at 74.8 %. The control limits are 75-125%. The result for copper should be regarded as estimated and biased low (J-).
1856	00-04738 00-04739 00-04740 00-04741	0100-96-0031 0100-96-0033 0100-96-0034 0100-96-0036	Metals	Accuracy	The result for copper should be regarded as estimated (J), because copper was detected below the method detection limit but above the instrument detection limit.
2653 2664	00-05451 00-05452 00-05453 00-05454 00-05455 00-05456 00-05457 00-05458 00-05459 00-05460 00-05461 00-05462 00-05463 00-05464 00-05465 00-05466 00-05470 00-05471 00-05472	0100-96-1551 0100-96-1552 0100-96-1553 0100-96-1554 0100-96-1555 0100-96-1556 0100-96-1557 0100-96-1558 0100-96-1559 0100-96-1560 0100-96-1561 0100-96-1562 0100-96-1563 0100-96-1564 0100-96-1565 0100-96-1566 0100-96-1570 0100-96-1571 0100-96-1572	Metals	Accuracy	The matrix spike recovery for lead was low at 63 %. The control limits are 75-125%. The result for lead should be regarded as estimated and biased low (J-).

APPENDIX D ANALYTICAL SUITES AND RESULTS

D-1.0 Target Analytes and Detection Limits

TABLE D-1
TARGET ANALYTES AND DETECTION LIMITS

Analyte	EPA Method	Soil EDL[1]
Copper	6010A	5 mg/kg
Lead	6010A	0.6 mg/kg
Zinc	6010A	4 mg/kg

[1] EDL = Estimated Detection Limit

D-2.0 Analytical Results

TABLE D-2
PRS 0-016 CONFIRMATION SOIL SAMPLES RESULTS TABLE

Request Number	Sample ID	Location ID	Sample Depth (In.)	Total Copper mg/kg	Total Lead mg/kg	Total Zinc mg/kg
Right-of-Way						
1856	0100-96-0031	00-04738	0-6	4.5 J-	45.6	30.5
1856	0100-96-0033	00-04740	0-6	3.6 J-	39.0	30.2
1856	0100-96-0034	00-04741	0-6	4.8 J-	81.8	31.7
1856	0100-96-0036	00-04739	0-6	10 J-	24.8	39.2
First-Order Drainage						
2664	0100-96-1570	00-05470	0-6	7.2	40.8 J-	28.9
2664	0100-96-1571	00-05471	0-3	9.5	70.6 J-	31.2
2664	0100-96-1572	00-05472	0-6	7.0	58.6 J-	29.3
Back Area						
3631	0100-97-0216	00-5971	6	6.0	11.7	26.5
3631	0100-97-0217	00-5972	6-8	6.3	38.1	25.8
3631	0100-97-0218	00-5973	6-8	4.4	8.0	18.2
3631	0100-97-0219	00-5974	4-6	5.5	28.4	21.4
3631	0100-97-0220	00-5975	4-6	3.3	8.2	15.8
3631	0100-97-0221	00-5976	10-12	5.9	29.0	22.5
3631	0100-97-0222	00-5977	8-10	6.4	35.5	22.6
3631	0100-97-0223	00-5978	10-12	4.4	15.4	18.6
3631	0100-97-0224	00-5979	8-12	3.6	5.8	12.6
3631	0100-97-0225	00-5980	8-10	4.4	18.8	18.5

TABLE D-2
PRS 0-016 CONFIRMATION SOIL SAMPLES RESULTS TABLE
(Continued)

Request Number	Sample ID	Location ID	Sample Depth (In.)	Total Copper mg/kg	Total Lead mg/kg	Total Zinc mg/kg
3631	0100-97-0226	00-5981	8-10	5.7	12.6	27.6
3631	0100-97-0227	00-5982	11-12	5.3	12.5	28.0
3631	0100-97-0228	00-5983	10-12	5.3	18.6	27.6
3631	0100-97-0229	00-5984	10-12	6.8	52.7	30.1
3631	0100-97-0230	00-5985	10-12	5.6	12.8	27.8
3631	0100-97-0231	00-5986	12-14	4.0	10.8	18.7
3631	0100-97-0232	00-5987	6-10	6.1	6.8	16.3
Range Floor						
2653	0100-96-1551	00-05451	0-6	6.8	51.3 J-	31.3
2653	0100-96-1552	00-05452	0-6	10.6	13.2 J-	32.0
2653	0100-96-1553	00-05453	0-6	9.0	42.4 J-	31.3
2653	0100-96-1554	00-05454	0-6	2.7	21.4 J-	32.0
2653	0100-96-1555	00-05455	0-6	2.5	10.5 J-	33.4
2653	0100-96-1556	00-05456	0-6	7.6	63.1 J-	42.0
2653	0100-96-1557	00-05457	0-6	8.0	63.8 J-	32.5
2653	0100-96-1558	00-05458	0-6	8.6	64.8 J-	34.4
2653	0100-96-1559	00-05459	0-6	7.4	18.2 J-	30.8
2653	0100-96-1560	00-05460	0-6	6.5	42.8 J-	26.5
2653	0100-96-1561	00-05461	0-6	6.0	23.7 J-	33.6
2653	0100-96-1562	00-05462	0-6	6.9	12.5 J-	26.4
2653	0100-96-1563	00-05463	0-6	10.2	16.9 J-	31.4
2653	0100-96-1564	00-05464	0-6	11.5	14.9 J-	30.2
2653	0100-96-1565	00-05465	0-6	7.0	60.0 J-	31.7
2653	0100-96-1566	00-05466	0-6	4.2	85.6 J-	29.8
3025	0100-97-0141	00-05946	0-6	1.9	6.2	29.0
3025	0100-97-0142	00-05947	0-6	1.9	3.7	23.0
3025	0100-97-0143	00-05948	0-6	7.7	66.0	24.0
3025	0100-97-0144	00-05949	0-6	2.2	6.0	30.0
3025	0100-97-0145	00-05950	0-6	9.1	17.0	29.0
3025	0100-97-0146	00-05951	0-6	10.0	13.0	34.0
3025	0100-97-0147	00-05952	0-6	3.9	13.0	31.0
2921	0100-97-0140	00-05474	0-6	10.0	5.3	15.0
Extent						

TABLE D-2
PRS 0-016 CONFIRMATION SOIL SAMPLES RESULTS TABLE
(Continued)

Request Number	Sample ID	Location ID	Sample Depth (In.)	Total Copper mg/kg	Total Lead mg/kg	Total Zinc mg/kg
17166	AAA6273	00-1422	0-9	5.0	11	20
17166	AAA6274	00-1422	0-9	5.2	13	20
17166	AAA6275	00-1423	0-9	4.7	23	21
17166	AAA6276	00-1424	0-9	7.2	17	30
17166	AAA6277	00-1425	0-9	4.4	19	41
17166	AAA6278	00-1426	0-9	4.6	21	26

TABLE D-3

SUMMARY OF XRF SAMPLE RESULTS AT PRS 0-016

Location ID	Sample ID	Collection Date	Area	XRF [1] Lead (mg/kg)	ICPES[2] Lead (mg/kg)	XRF Copper (mg/kg)	ICPES Copper (mg/kg)	XRF Zinc (mg/kg)	ICPES Zinc (mg/kg)
N/A	0100-96-0801	30-Apr-96	SPS 1	68	Not Analyzed	<36	Not Analyzed	51J	Not Analyzed
N/A	0100-96-0802	30-Apr-96	SPS 2	63J	Not Analyzed	<36	Not Analyzed	55J	Not Analyzed
N/A	0100-96-0803	30-Apr-96	SPS 3	53J	Not Analyzed	<36	Not Analyzed	41J	Not Analyzed
N/A	0100-96-0804	30-Apr-96	SPS 4	<19	Not Analyzed	<36	Not Analyzed	71J	Not Analyzed
N/A	0100-96-0805	30-Apr-96	SPS 5	106	Not Analyzed	<36	Not Analyzed	62J	Not Analyzed
N/A	0100-96-0806	30-Apr-96	SPS 6	67	Not Analyzed	<36	Not Analyzed	23J	Not Analyzed
N/A	0100-96-0807	30-Apr-96	RF	114	Not Analyzed	<36	Not Analyzed	77J	Not Analyzed
N/A	0100-96-0808	30-Apr-96	RF	71	Not Analyzed	<36	Not Analyzed	72J	Not Analyzed
N/A	0100-96-0809	30-Apr-96	RF	62J	Not Analyzed	<36	Not Analyzed	49J	Not Analyzed
N/A	0100-96-0810	30-Apr-96	RF	<19	Not Analyzed	<36	Not Analyzed	ND	Not Analyzed
N/A	0100-96-0811	30-Apr-96	RF	<19	Not Analyzed	<36	Not Analyzed	<36	Not Analyzed
N/A	0100-96-0812	30-Apr-96	RF	107	Not Analyzed	38J	Not Analyzed	65J	Not Analyzed
N/A	0100-96-0813	02-May-96	SPF 1	87	Not Analyzed	<36	Not Analyzed	63	Not Analyzed
N/A	0100-96-0814	02-May-96	SPF 2	38J	Not Analyzed	<36	Not Analyzed	51J	Not Analyzed
N/A	0100-96-0814	02-May-96	SPF 2DUP	50J	Not Analyzed	<36	Not Analyzed	<36	Not Analyzed
N/A	0100-96-0815	02-May-96	SPF 3	43J	Not Analyzed	<36	Not Analyzed	75	Not Analyzed
N/A	0100-96-0816	02-May-96	SPF 4	39J	Not Analyzed	<36	Not Analyzed	63J	Not Analyzed
N/A	0100-96-0817	02-May-96	SPF 5	30J	Not Analyzed	<36	Not Analyzed	91J	Not Analyzed
N/A	0100-96-0818	02-May-96	SPF 6	<19	Not Analyzed	<36	Not Analyzed	50J	Not Analyzed
N/A	0100-96-0819	03-May-96	SPF 7	45J	Not Analyzed	37J	Not Analyzed	78J	Not Analyzed
N/A	0100-96-0820	15-May-96	SPF 8	46J	Not Analyzed	<36	Not Analyzed	41	Not Analyzed
N/A	0100-96-0820	15-May-96	SPF 8DUP	21J	Not Analyzed	46J	Not Analyzed	47J	Not Analyzed

TABLE D-3
SUMMARY OF XRF SAMPLE RESULTS AT PRS 0-016
(Continued)

Location ID	Sample ID	Collection Date	Area	XRF [1] Lead (mg/kg)	ICPES[2] Lead (mg/kg)	XRF Copper (mg/kg)	ICPES Copper (mg/kg)	XRF Zinc (mg/kg)	ICPES Zinc (mg/kg)
N/A	0100-96-0821	15-May-96	SPF 9	50J	Not Analyzed	<36	Not Analyzed	73J	Not Analyzed
N/A	0100-96-0822	15-May-96	SPF 10	66	Not Analyzed	<36	Not Analyzed	<36	Not Analyzed
N/A	0100-96-0823	15-May-96	SPF-13	NR	Not Analyzed	NR	Not Analyzed	NR	Not Analyzed
N/A	0100-96-0824	15-May-96	SPF-14	NR	Not Analyzed	NR	Not Analyzed	NR	Not Analyzed
N/A	0100-96-0825	15-May-96	SPF-11	NR	Not Analyzed	NR	Not Analyzed	NR	Not Analyzed
N/A	0100-96-0826	02-May-96	RF	21J	Not Analyzed	<36	Not Analyzed	66J	Not Analyzed
N/A	0100-96-0827	02-May-96	RF	<19	Not Analyzed	<36	Not Analyzed	56J	Not Analyzed
N/A	0100-96-0828	02-May-96	RF	<19	Not Analyzed	<36	Not Analyzed	60J	Not Analyzed
N/A	0100-96-0829	02-May-96	RF	<19	Not Analyzed	<36	Not Analyzed	41J	Not Analyzed
N/A	0100-96-0830	02-May-96	RF	22J	Not Analyzed	<36	Not Analyzed	<36	Not Analyzed
N/A	0100-96-0831	02-May-96	RF	41J	Not Analyzed	<36	Not Analyzed	55J	Not Analyzed
N/A	0100-96-0832	02-May-96	NPS	234	Not Analyzed	<36	Not Analyzed	90J	Not Analyzed
N/A	0100-96-0833	03-May-96	NPS	184	Not Analyzed	<36	Not Analyzed	68	Not Analyzed
N/A	0100-96-0834	03-May-96	NPS	144	Not Analyzed	45J	Not Analyzed	102J	Not Analyzed
N/A	0100-96-0835	03-May-96	RF	<19	Not Analyzed	<36	Not Analyzed	<36	Not Analyzed
N/A	0100-96-0836	03-May-96	RF	<19	Not Analyzed	79J	Not Analyzed	54J	Not Analyzed
N/A	0100-96-0837	03-May-96	RF	<19	Not Analyzed	47J	Not Analyzed	<36	Not Analyzed
N/A	0100-96-0838	03-May-96	RF	<19	Not Analyzed	43J	Not Analyzed	46J	Not Analyzed
N/A	0100-96-0839	24-Apr-98	RF	<19	Not Analyzed	<36	Not Analyzed	48J	Not Analyzed
N/A	0100-96-0840	03-May-96	RF	34J	Not Analyzed	<36	Not Analyzed	39J	Not Analyzed
N/A	0100-96-0841	05-May-96	NPS	168	Not Analyzed	<36	Not Analyzed	78J	Not Analyzed
N/A	0100-96-0841	05-May-96	NPS DUP	142	Not Analyzed	<36	Not Analyzed	180	Not Analyzed
N/A	0100-96-0842	05-May-96	NPS	121	Not Analyzed	47J	Not Analyzed	47J	Not Analyzed

TABLE D-3
SUMMARY OF XRF SAMPLE RESULTS AT PRS 0-016
(Continued)

Location ID	Sample ID	Collection Date	Area	XRF [1] Lead (mg/kg)	ICPES[2] Lead (mg/kg)	XRF Copper (mg/kg)	ICPES Copper (mg/kg)	XRF Zinc (mg/kg)	ICPES Zinc (mg/kg)
N/A	0100-96-0843	05-May-96	NPS	237	Not Analyzed	<36	Not Analyzed	118	Not Analyzed
N/A	0100-96-0844	05-May-96	BCP	21J	Not Analyzed	<36	Not Analyzed	109J	Not Analyzed
N/A	0100-96-0845	05-May-96	BCP	<19	Not Analyzed	<36	Not Analyzed	<36	Not Analyzed
N/A	0100-96-0846	05-May-96	BCP	20J	Not Analyzed	<36	Not Analyzed	<36	Not Analyzed
N/A	0100-96-0847	05-May-96	BCP	<19	Not Analyzed	58J	Not Analyzed	65J	Not Analyzed
N/A	0100-96-0848	05-May-96	BCP	<19	Not Analyzed	<36	Not Analyzed	<36	Not Analyzed
N/A	0100-96-0849	07-May-96	SPF 6	39J	56.00	40J	6.80	66J	32.00
N/A	0100-96-0850	07-May-96	SPF 2	80	63.00	82J	6.50	84J	33.00
N/A	0100-96-0851	07-May-96	SPF 3	37J	62.00	65J	6.70	59J	30.00
N/A	0100-96-0852	07-May-96	SPF 4	27J	75.00	56J	6.50	76J	30.00
N/A	0100-96-0853	07-May-96	SPF 5	59J	120.00	<36	10.00	67J	34.00
N/A	0100-96-0854	07-May-96	SPF 1	39J	70.00	49J	7.60	51J	38.00
N/A	0100-96-0855	07-May-96	SPF 7	79	61.00	39J	6.30	42J	33.00
N/A	0100-96-0855	07-May-96	SPF 7DUP	37J	61.00	54J	6.30	<36	33.00
N/A	0100-96-0856	07-May-96	SPF 8	61J	77.00	60J	7.60	95J	33.00
N/A	0100-96-0857	08-May-96	SPF 9	57J	83.00	74J	7.50	62J	34.00
N/A	0100-96-0858	08-May-96	SPF 10	57J	180.00	82J	7.50	79J	36.00
N/A	0100-96-0859	08-May-96	SPF 11	62J	69.00	42J	7.10	54J	35.00
N/A	0100-96-0860	08-May-96	SPF 12	53J	82.00	<36	9.30	63J	36.00
N/A	0100-96-0861	08-May-96	SPF 13	31J	340.00	46J	8.10	64J	35.00
N/A	0100-96-0862	08-May-96	SPF 14	48J	75.00	<36	7.80	66J	38.00
N/A	0100-96-0863	08-May-96	SPF 15	47J	65.00	72J	7.50	85J	35.00
N/A	AAA6252	09-May-94	NA	367	350.00	<36	21.00	80J	31.00

TABLE D-3
SUMMARY OF XRF SAMPLE RESULTS AT PRS 0-016
(Continued)

Location ID	Sample ID	Collection Date	Area	XRF [1] Lead (mg/kg)	ICPES[2] Lead (mg/kg)	XRF Copper (mg/kg)	ICPES Copper (mg/kg)	XRF Zinc (mg/kg)	ICPES Zinc (mg/kg)
N/A	AAA6253	13-May-94	NA	383	4100.00	37J	37.00	95J	28.00
N/A	AAA6254	12-May-94	NA	499	340.00	<36	8.40	<36	22.00
N/A	AAA6255	12-May-94	NA	449	240.00	<36	7.60	81J	21.00
N/A	AAA6256	09-May-94	NA	407	290.00	<36	10.00	56J	23.00
N/A	AAA6257	09-May-94	NA	472	340.00	<36	17.00	86J	32.00
N/A	AAA6258	13-May-94	NA	407	340.00	<36	10.00	56J	25.00
N/A	AAA6259	06-May-94	NA	233	220.00	<36	10.00	58J	26.00
N/A	AAA6260	18-May-94	NA	61J	46.00	<36	3.70	39J	22.00
N/A	AAA6261	23-May-94	NA	92	260.00	<36	8.70	66J	19.00
N/A	AAA6262	24-May-94	NA	61J	41.00	<36	6.50	38J	16.00
N/A	AAA6263	26-May-94	NA	66	0.00	<36	0.00	<36	0.00
N/A	AAA6264	06-Jun-94	NA	73	58.00	<36	3.90	52J	20.00
N/A	AAA6265	16-May-94	NA	94	65.00	<36	3.30	47J	18.00
N/A	AAA6266	06-Jun-94	NA	83	65.00	<36	4.10	92J	20.00
N/A	AAA6267	27-Jun-94	NA	163	160.00	<36	5.40	77J	26.00
N/A	AAA6268	27-Jun-94	NA	268	130.00	<36	6.00	41J	24.00
N/A	AAA6269	05-Jul-94	NA	144	340.00	<36	130.00	68J	25.00
N/A	AAA6269D	05-Jul-94	NA	86	Not Analyzed	<36	Not Analyzed	73J	Not Analyzed
N/A	AAA6270	11-Jul-94	NA	76	46.00	<36	12.00	52J	29.00
N/A	AAA6271	12-Jul-94	NA	187	100.00	<36	9.80	51J	27.00
N/A	AAA6272	08-Aug-94	NA	129	Not Analyzed	<36	Not Analyzed	54J	Not Analyzed
N/A	AAA6272D	08-Aug-94	NA	100	Not Analyzed	<36	Not Analyzed	43J	Not Analyzed
00-1422	AAA6273	07-Apr-94	NA	<19	11.00	<36	5.00	57J	20.00

TABLE D-3
SUMMARY OF XRF SAMPLE RESULTS AT PRS 0-016
(Continued)

Location ID	Sample ID	Collection Date	Area	XRF [1] Lead (mg/kg)	ICPES[2] Lead (mg/kg)	XRF Copper (mg/kg)	ICPES Copper (mg/kg)	XRF Zinc (mg/kg)	ICPES Zinc (mg/kg)
00-1422	AAA6274	07-Apr-94	NA	<19	13.00	<36	5.20	76J	20.00
00-1423	AAA6275	07-Apr-94	NA	28J	23.00	<36	4.70	82J	21.00
00-1424	AAA6276	07-Apr-94	NA	<19	17.00	<36	7.20	77J	30.00
00-1425	AAA6277	07-Apr-94	NA	<19	19.00	<36	4.40	43J	41.00
00-1426	AAA6278	07-Apr-94	NA	22J	21.00	<36	4.60	50J	26.00
N/A	AAA6279	24-Jul-94	NA	92	Not Analyzed	<36	Not Analyzed	68J	Not Analyzed
N/A	AAA6280	24-Jul-94	NA	87	200.00	<36	4.00	<36	22.00
N/A	AAA6281	24-Jul-94	NA	77	81.00	<36	3.80	36J	16.00
N/A	AAA6282	24-Jul-94	NA	65	100.00	<36	3.50	51J	15.00
N/A	AAA6283	24-Jul-94	NA	89	150.00	<36	3.80	68J	21.00
N/A	AAA6284	24-Jul-94	NA	81	140.00	<36	4.10	53J	20.00
N/A	AAA6669	12-Jul-94	NA	163	60.00	<36	9.80	109J	28.00
N/A	AAA6670	13-Jul-94	NA	356	99.00	41J	Not Analyzed	98J	Not Analyzed
N/A	AAA6671	06-Jul-94	NA	268	310.00	<36	Not Analyzed	66J	Not Analyzed
N/A	AAA6672	18-Jul-94	NA	72	69.00	<36	4.00	42J	30.00
N/A	AAA6672D	18-Jul-94	NA	85	Not Analyzed	<36	Not Analyzed	54J	Not Analyzed
N/A	AAA6673	22-Jul-94	NA	73	150.00	<36	4.80	81J	27.00
N/A	AAA6674	24-Jul-94	NA	46J	140.00	<36	3.60	58J	15.00
N/A	AAA6675	24-Jul-94	NA	46J	45.00	<36	4.10	88J	20.00
N/A	AAA6676	24-Jul-94	NA	91	85.00	<36	13.00	64J	17.00
N/A	AAA6677	19-Apr-94	NA	251	201.00	<36	Not Analyzed	104	Not Analyzed
N/A	AAA6678	19-Apr-94	NA	80	83.70	<36	Not Analyzed	65J	Not Analyzed
N/A	AAA6679	19-Apr-94	NA	988	867.00	<36	4.00	44J	17.00

TABLE D-3
SUMMARY OF XRF SAMPLE RESULTS AT PRS 0-016
(Continued)

Location ID	Sample ID	Collection Date	Area	XRF [1] Lead (mg/kg)	ICPES[2] Lead (mg/kg)	XRF Copper (mg/kg)	ICPES Copper (mg/kg)	XRF Zinc (mg/kg)	ICPES Zinc (mg/kg)
N/A	AAA6680	19-Apr-94	NA	635	900.00	65J	Not Analyzed	39J	Not Analyzed
N/A	AAA6681	21-Apr-94	NA	849	418.00	<36	Not Analyzed	<36J	Not Analyzed
N/A	AAA6681D	21-Apr-94	NA	988	Not Analyzed	<36	Not Analyzed	53J	Not Analyzed
N/A	AAA6682	18-May-94	NA	92	Not Analyzed	<36	Not Analyzed	66J	Not Analyzed
N/A	AAA6686	14-Jun-94	NA	317	Not Analyzed	<36	Not Analyzed	73J	Not Analyzed
N/A	AAA6687	14-Jun-94	NA	204	Not Analyzed	<36	Not Analyzed	56J	Not Analyzed
N/A	AAA6688	14-Jun-94	NA	<36	Not Analyzed	38J	Not Analyzed	<36	Not Analyzed
N/A	AAA6689	14-Jun-94	NA	24J	Not Analyzed	<36	Not Analyzed	40J	Not Analyzed
N/A	AAA6690	14-Jun-94	NA	<36	Not Analyzed	<36	Not Analyzed	61J	Not Analyzed
N/A	AAA6691	14-Jun-94	NA	<36	Not Analyzed	<36	Not Analyzed	54J	Not Analyzed
N/A	AAA6692	14-Jun-94	NA	<36	Not Analyzed	<36	Not Analyzed	54J	Not Analyzed
N/A	AAA6693	14-Jun-94	NA	<36	Not Analyzed	<36	Not Analyzed	38J	Not Analyzed
N/A	AAA6694	14-Jun-94	NA	48J	Not Analyzed	<36	Not Analyzed	76J	Not Analyzed
N/A	AAA6695	14-Jun-94	NA	<36	Not Analyzed	<36	Not Analyzed	80J	Not Analyzed
N/A	AAA6696	14-Jun-94	NA	<36	14.00	<36	5.10	54J	24.00
N/A	AAA6698	23-Jul-94	NA	167	Not Analyzed	<36	Not Analyzed	100J	Not Analyzed
N/A	AAA6699	23-Jul-94	NA	241	Not Analyzed	<36	Not Analyzed	132	Not Analyzed
N/A	AAA6700	23-Jul-94	NA	311	Not Analyzed	<36	Not Analyzed	113J	Not Analyzed
N/A	AAB2413	11-Aug-94	NA	95	Not Analyzed	<36	Not Analyzed	41J	Not Analyzed
N/A	AAB2413D	11-Aug-94	NA	60	Not Analyzed	<36	Not Analyzed	<36	Not Analyzed
N/A	AAB2414	11-Aug-94	NA	105	Not Analyzed	<36	Not Analyzed	68J	Not Analyzed
N/A	AAB2414D	11-Aug-94	NA	92	Not Analyzed	<36	Not Analyzed	74J	Not Analyzed
N/A	AAB2415	24-Aug-94	NA	193	Not Analyzed	<36	Not Analyzed	54J	Not Analyzed

TABLE D-3
SUMMARY OF XRF SAMPLE RESULTS AT PRS 0-016
(Continued)

Location ID	Sample ID	Collection Date	Area	XRF [1] Lead (mg/kg)	ICPES[2] Lead (mg/kg)	XRF Copper (mg/kg)	ICPES Copper (mg/kg)	XRF Zinc (mg/kg)	ICPES Zinc (mg/kg)
N/A	AAB2416	24-Aug-94	NA	81	Not Analyzed	<36	Not Analyzed	68J	Not Analyzed
N/A	AAB2417	24-Aug-94	NA	79	Not Analyzed	<36	Not Analyzed	<36	Not Analyzed
N/A	AAB2418	31-Aug-94	NA	84	Not Analyzed	<36	Not Analyzed	60J	Not Analyzed
N/A	AAB2418D	31-Aug-94	NA	79	Not Analyzed	<36	Not Analyzed	47J	Not Analyzed
N/A	AAB2419	31-Aug-94	NA	123	Not Analyzed	<36	Not Analyzed	63J	Not Analyzed
N/A	AAB2420	08-Sep-94	NA	118	Not Analyzed	<36	Not Analyzed	108J	Not Analyzed
N/A	AAB2421	08-Sep-94	NA	76	Not Analyzed	<36	Not Analyzed	84J	Not Analyzed
N/A	AAB2421D	08-Sep-94	NA	91	Not Analyzed	<36	Not Analyzed	50J	Not Analyzed
N/A	AAB2422	09-Sep-94	NA	55J	Not Analyzed	<36	Not Analyzed	83J	Not Analyzed
N/A	AAB2422D	09-Sep-94	NA	43J	Not Analyzed	<36	Not Analyzed	105J	Not Analyzed
N/A	AAB2423	13-Sep-94	NA	46J	Not Analyzed	<36	Not Analyzed	54J	Not Analyzed
N/A	AAB2423D	13-Sep-94	NA	86	Not Analyzed	<36	Not Analyzed	104J	Not Analyzed
N/A	AAB2424	14-Sep-94	NA	20J	Not Analyzed	<36	Not Analyzed	73J	Not Analyzed
N/A	AAB2425	14-Sep-94	NA	39J	Not Analyzed	<36	Not Analyzed	98J	Not Analyzed
N/A	AAB2426	14-Sep-94	NA	<19	Not Analyzed	<36	Not Analyzed	83J	Not Analyzed
N/A	AAB2427	14-Sep-94	NA	70	Not Analyzed	<36	Not Analyzed	83J	Not Analyzed
N/A	AAB2427D	14-Sep-94	NA	50J	Not Analyzed	<36	Not Analyzed	59J	Not Analyzed
N/A	AAB2428	15-Sep-94	NA	160	Not Analyzed	<36	Not Analyzed	115J	Not Analyzed
N/A	AAB2429	19-Sep-94	NA	61J	Not Analyzed	<36	Not Analyzed	76J	Not Analyzed
N/A	AAB2430	20-Sep-94	NA	39J	Not Analyzed	54J	Not Analyzed	69J	Not Analyzed
N/A	AAB2430D	20-Sep-94	NA	45J	Not Analyzed	<36	Not Analyzed	73J	Not Analyzed
N/A	AAB2431	20-Sep-94	NA	63	Not Analyzed	<36	Not Analyzed	89J	Not Analyzed
N/A	AAB3545	22-Sep-94	NA	45J	Not Analyzed	<36	Not Analyzed	35J	Not Analyzed

TABLE D-3
SUMMARY OF XRF SAMPLE RESULTS AT PRS 0-016
(Continued)

Location ID	Sample ID	Collection Date	Area	XRF [1] Lead (mg/kg)	ICPES[2] Lead (mg/kg)	XRF Copper (mg/kg)	ICPES Copper (mg/kg)	XRF Zinc (mg/kg)	ICPES Zinc (mg/kg)
N/A	AAB3546	27-Sep-94	NA	40	Not Analyzed	<36	Not Analyzed	78J	Not Analyzed
N/A	AAB3547	27-Sep-94	NA	44	Not Analyzed	<36	Not Analyzed	74J	Not Analyzed
N/A	AAB3548	27-Sep-94	NA	30J	Not Analyzed	<36	Not Analyzed	67J	Not Analyzed
N/A	AAB3549	28-Sep-94	NA	18J	Not Analyzed	<36	Not Analyzed	60	Not Analyzed
N/A	AAB3550	30-Sep-94	NA	57J	Not Analyzed	<36	Not Analyzed	62J	Not Analyzed
N/A	AAB3551	05-Oct-94	NA	55J	Not Analyzed	<36	Not Analyzed	27J	Not Analyzed
N/A	AAB3552	05-Oct-94	NA	75	Not Analyzed	<36	Not Analyzed	99J	Not Analyzed
N/A	AAB3553	05-Oct-94	NA	65	Not Analyzed	<36	Not Analyzed	83J	Not Analyzed
N/A	AAB3554	07-Oct-94	NA	64J	Not Analyzed	<36	Not Analyzed	44J	Not Analyzed
N/A	AAB3555	11-Oct-94	NA	85	Not Analyzed	<36	Not Analyzed	93J	Not Analyzed
N/A	AAB3556	11-Oct-94	NA	68	Not Analyzed	<36	Not Analyzed	62J	Not Analyzed

1 x-ray Florescence
2 ICPES = Inductively Coupled Plasma Emission Spectroscopy
N/A = Not applicable
BCP = berm, center of ponds
DUP =duplicate XRF analysis
J = estimated value (above detection and below quantitation limits)
NPS = north pond sediment
RF = range floor
SPC = stockpile, coarse (<1/2")
SPF = stockpile, fine (<3/16")
SPO = stockpile, oversized (>1/2")
SPS = south pond sediment

APPENDIX E STATISTICAL CALCULATIONS

MEMORANDUM

To: John Williams

From: Michelle Y. Morgenstern *mym*

Date: July 12, 1994

Regarding: **OU 1071 SWMU 016 Back-area Investigation Report**

cc: D. Johnston
Project File C9450.07

The SWMU 016 back-area investigation began in mid-March, 1994. The objective of this investigation was to define the boundary of SWMU 016 so that any lead contaminated area could be remediated as part of the SWMU 016 voluntary action plan. The SWMU 016 back-area extent from the region immediately northwest of the Inactive Firing Range soil berm to the drainage channel (see Figure 1 in Appendix A).

White model 4900/DL PRO metal detectors (MD) and a Spectrace 9000 field portable X-ray fluorescence unit (XRF) were used in this investigation. A metal detector quality assurance test area was established at SWMU 016 to ensure metal detector response reproducibility as well as to quantify the metal detector responsiveness in terms of depth of metal objects. The details of the instrumental detection limits and quality assurance program are attached in Appendix B.

A plot area adjacent to the northwest side of the soil berm was set up to study the extent of contamination. The "disturbed area" and "undisturbed area" were defined based on visual inspection. Soil samples obtained from the disturbed and undisturbed areas were identified by "D" and "U" respectively. The approximate locations of these areas are shown in Figure 2 in Appendix C. Results obtained per April 18, 1994 draft #2 sampling strategy are presented in Table 4 in Appendix D.

Due to the high concentrations of lead in the soils studied (see Tables 4 and 5), further investigation in the region northwest of the soil berm down to the drainage channel was initiated. Based on the undisturbed appearance of this region, Kathy Campbell prepared a statistical sampling plan to character large areas (see Appendix E). This task was completed in early June, 1994, and the surveying results are illustrated in Appendix F.

In addition to the statistical sampling plan, Kathy Campbell also prepared Figure 4 in Appendix G illustrating the correlation between the metal detector response and the total lead concentration using data obtained from the undisturbed area. Based on the correlation, the 15'x15' grids were determined potentially contaminated (meaning total lead concentration exceeding 500 ppm) when the number of metal detector response within the grid exceeds 29. The boundary of SWMU 016 was then defined as shown in Figure 5 in Appendix H. The depth of lead contamination was determined to be six inches below surface based on a study performed by M. Coyle and K. Louie. Based on this estimate, we calculate that there are approximately 900 cubic yards of contaminated soil in the back-area.

Appendix A

Figure 1.
Soil Washing Site Within Inactive
Firing Range, OU 1071 SWMU 016

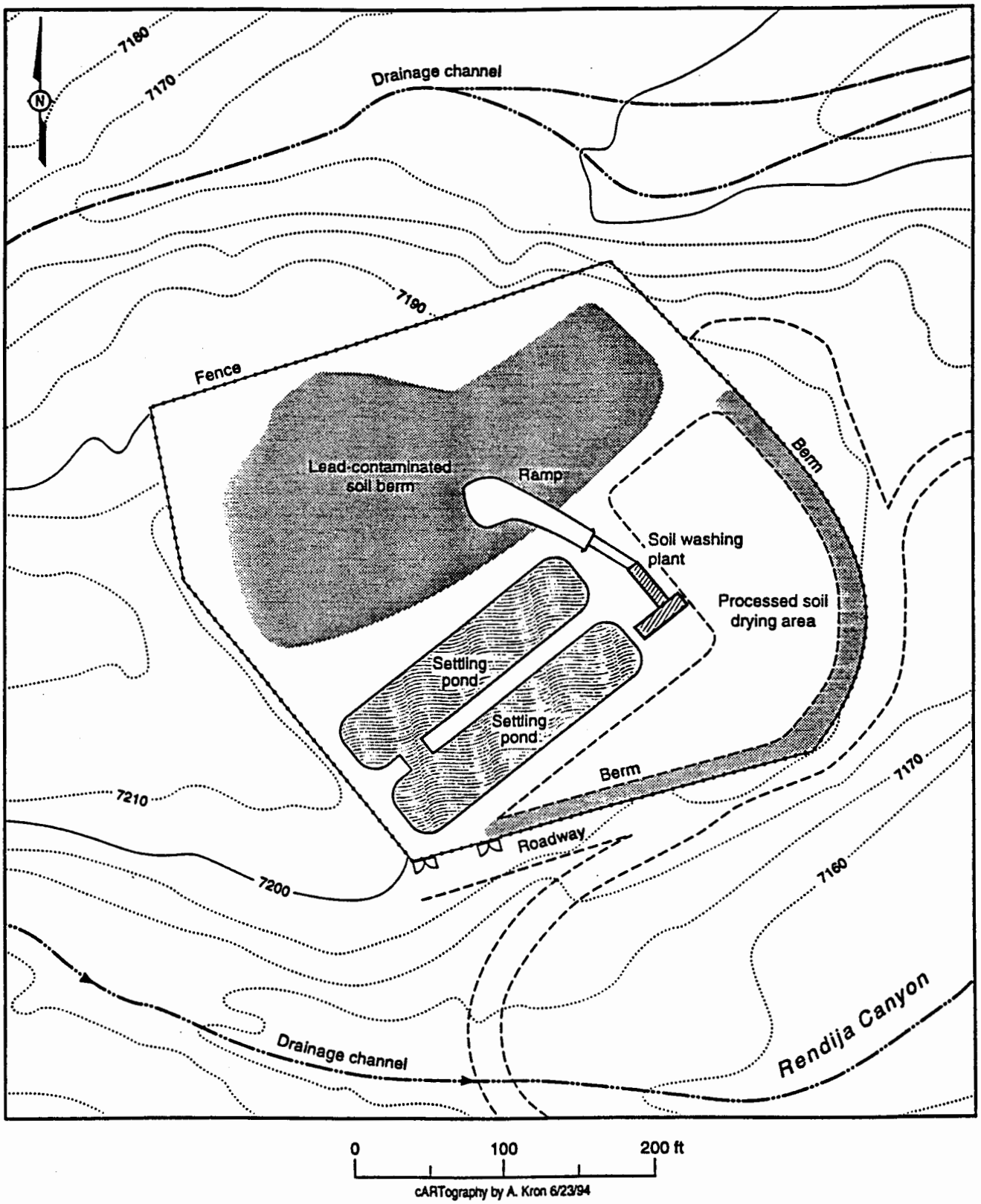


Figure 1. Soil washing site within Inactive Firing Range, SWMU 0-016 (OU 1071).

Appendix B

Depth below surface	No. of bullets	MD Response
1 inch	1	positive
1.5 inches	1	positive
2 inches	1	negative
2 inches	2	positive
3 inches	5	negative
3 inches	6	positive

Table 1. Metal Detector Responses

	Pb	Cu	Zn
Method Detection Limit	19 ppm	36 ppm	36 ppm
Method Quantitation Limit	63 ppm	120 ppm	120 ppm

Table 2. XRF MDLs and MQLs

LANL ENVIRONMENTAL RESTORATION PROGRAM
Operable Unit 1071 - SWMU 0-016 - Inactive Firing Range

Metal Detector Calibration Procedure

1) Check battery charge with on the detector with the power switch, then to turn switch to **P** (ON).
2) Set the GEB, DISC, and SENSITIVITY dials to **P**.
3) Set the detector's MODE switch at GEB/NORM.
4) Adjust the TUNER dial while holding down the TUNER BUTTC the handle, and while holding the pad waist high, to set detector's threshold.
5) Conduct response check in test area with known numbers o bullets buried at known depths.
6) Record results of response check on form below.

Metal Detector Response Check

Twice a day and prior to metal detector survey, conduct a response in test area with known numbers of bullets buried at known depths. Record results of response check on the following form:

Date/Time: 6-3-94 8:15 Operator: MIKE COYLE Detector I.D. 14278

NUMBER OF BULLETS	BURIAL DEPTH	RESPONSE
1	1 inch	✓
1	1½ inches	✓
1	2 inches	NO
2	2 inches	✓
5	3 inches	✓
6	3 inches	✓

LANL ENVIRONMENTAL RESTORATION PROGRAM
Operable Unit 1071 - SWMU 0-016 - Inactive Firing Range

Metal Detector Calibration Procedure

1) Check battery charge with on the detector with the power switch, then to turn switch to **P** (ON).
2) Set the GEB, DISC, and SENSITIVITY dials to **P**.
3) Set the detector's MODE switch at GEB/NORM.
4) Adjust the TUNER dial while holding down the TUNER BUTTON the handle, and while holding the pad waist high, to set detector's threshold.
5) Conduct response check in test area with known numbers of bullets buried at known depths.
6) Record results of response check on form below.

Metal Detector Response Check

Twice a day and prior to metal detector survey, conduct a response in test area with known numbers of bullets buried at known depths. Record results of response check on the following form:

Date/Time: [illegible] Operator: K. Lowi Detector I.D. ___

NUMBER OF BULLETS	BURIAL DEPTH	RESPONSE
1	1 inch	✓
1	1½ inches	✓
1	2 inches	✓
2	2 inches	✓
5	3 inches	✓
6	3 inches	✓

LANL ENVIRONMENTAL RESTORATION PROGRAM
Operable Unit 1071 - SWMU 0-016 - Inactive Firing Range

Metal Detector Calibration Procedure

1) Check battery charge with on the detector with the power switch, then to turn switch to **P** (ON).
2) Set the GEB, DISC, and SENSITIVITY dials to **P**.
3) Set the detector's MODE switch at GEB/NORM.
4) Adjust the TUNER dial while holding down the TUNER BUTTO the handle, and while holding the pad waist high, to set detector's threshold.
5) Conduct response check in test area with known numbers o bullets buried at known depths.
6) Record results of response check on form below.

Metal Detector Response Check

Twice a day and prior to metal detector survey, conduct a response in test area with known numbers of bullets buried at known depths. Record results of response check on the following form:

Date/Time: 6/2/94 AM Operator: [illegible] Detector I.D. __

NUMBER OF BULLETS	BURIAL DEPTH	RESPONSE
1	1 inch	✓
1	1½ inches	✓
1	2 inches	✓
2	2 inches	✓
5	3 inches	✓
6	3 inches	✓

LANL ENVIRONMENTAL RESTORATION PROGRAM
Operable Unit 1071 - SWMU 0-016 - Inactive Firing Ra

Metal Detector Calibration Procedure

1) Check battery charge with on the detector with the power switch, then to turn switch to **P** (ON).
2) Set the GEB, DISC, and SENSITIVITY dials to **P**.
3) Set the detector's MODE switch at GEB/NORM.
4) Adjust the TUNER dial while holding down the TUNER BUTTO the handle, and while holding the pad waist high, to set detector's threshold.
5) Conduct response check in test area with known numbers o bullets buried at known depths.
6) Record results of response check on form below.

Metal Detector Response Check

Twice a day and prior to metal detector survey, conduct a response in test area with known numbers of bullets buried at known depths. Record results of response check on the following form:

Date/Time: 6-7-94 9:15 Operator: Mike Coyle Detector I.D. _

NUMBER OF BULLETS	BURIAL DEPTH	RESPONSE
1	1 inch	—
1	1½ inches	✓
1	2 inches	NO
2	2 inches	✓
5	3 inches	✓
6	3 inches	✓

LANL ENVIRONMENTAL RESTORATION PROGRAM
Operable Unit 1071 - SWMU 0-016 - Inactive Firing Range

Metal Detector Calibration Procedure

1) Check battery charge with on the detector with the power switch, then to turn switch to **P** (ON).
2) Set the GEB, DISC, and SENSITIVITY dials to **P**.
3) Set the detector's MODE switch at GEB/NORM.
4) Adjust the TUNER dial while holding down the TUNER BUTTON the handle, and while holding the pad waist high, to set detector's threshold.
5) Conduct response check in test area with known numbers of bullets buried at known depths.
6) Record results of response check on form below.

Metal Detector Response Check

Twice a day and prior to metal detector survey, conduct a response in test area with known numbers of bullets buried at known depths. Record results of response check on the following form:

Date/Time: _____ Operator: K. Lewis Detector I.D. ___

NUMBER OF BULLETS	BURIAL DEPTH	RESPONSE
1	1 inch	✓
1	1½ inches	✓
1	2 inches	✓
2	2 inches	✓
5	3 inches	✓
6	3 inches	✓

LANL ENVIRONMENTAL RESTORATION PROGRAM
Operable Unit 1071 - SWMU 0-016 - Inactive Firing Ra

Metal Detector Calibration Procedure

1) Check battery charge with on the detector with the power switch, then to turn switch to **P** (ON).
2) Set the GEB, DISC, and SENSITIVITY dials to **P**.
3) Set the detector's MODE switch at GEB/NORM.
4) Adjust the TUNER dial while holding down the TUNER BUTTO the handle, and while holding the pad waist high, to set detector's threshold.
5) Conduct response check in test area with known numbers o bullets buried at known depths.
6) Record results of response check on form below.

Metal Detector Response Check

Twice a day and prior to metal detector survey, conduct a response in test area with known numbers of bullets buried at known depths. Record results of response check on the following form:

Date/Time: 6/1/94 am Operator: K. [illegible] Detector I.D. _

NUMBER OF BULLETS	BURIAL DEPTH	RESPONSE
1	1 inch	✓
1	1½ inches	✓
1	2 inches	✓
2	2 inches	✓
5	3 inches	✓
6	3 inches	✓

LANL ENVIRONMENTAL RESTORATION PROGRAM
Operable Unit 1071 - SWMU 0-016 - Inactive Firing Range

Metal Detector Calibration Procedure

1) Check battery charge with on the detector with the powe: switch, then to turn switch to **P** (ON).
2) Set the GEB, DISC, and SENSITIVITY dials to **P**.
3) Set the detector's MODE switch at GEB/NORM.
4) Adjust the TUNER dial while holding down the TUNER BUTTC the handle, and while holding the pad waist high, to set detector's threshold.
5) Conduct response check in test area with known numbers c bullets buried at known depths.
6) Record results of response check on form below.

Metal Detector Response Check

Twice a day and prior to metal detector survey, conduct a response in test area with known numbers of bullets buried at known depths. Record results of response check on the following form:

Date/Time: 5/31/94 Operator: K. Lovi Detector I.D. _

NUMBER OF BULLETS	BURIAL DEPTH	RESPONSE
1	1 inch	✓
1	1½ inches	✓
1	2 inches	✓
2	2 inches	✓
5	3 inches	✓
6	3 inches	✓

LANL ENVIRONMENTAL RESTORATION PROGRAM
Operable Unit 1071 - SWMU 0-016 - Inactive Firing Ra

Metal Detector Calibration Procedure

1) Check battery charge with on the detector with the power switch, then to turn switch to **P** (ON).
2) Set the GEB, DISC, and SENSITIVITY dials to **P**.
3) Set the detector's MODE switch at GEB/NORM.
4) Adjust the TUNER dial while holding down the TUNER BUTTO: the handle, and while holding the pad waist high, to set detector's threshold.
5) Conduct response check in test area with known numbers o: bullets buried at known depths.
6) Record results of response check on form below.

Metal Detector Response Check

Twice a day and prior to metal detector survey, conduct a response in test area with known numbers of bullets buried at known depths. Record results of response check on the following form:

Date/Time: 5-27-94 9:00 Operator: Greg Moon Detector I.D.

NUMBER OF BULLETS	BURIAL DEPTH	RESPONSE
1	1 inch	✓
1	1½ inches	✓
1	2 inches	✓
2	2 inches	✓
5	3 inches	✓
6	3 inches	✓

LANL ENVIRONMENTAL RESTORATION PROGRAM
Operable Unit 1071 - SWMU 0-016 - Inactive Firing Range

Metal Detector Calibration Procedure

1) Check battery charge with on the detector with the power switch, then to turn switch to **P** (ON).
2) Set the GEB, DISC, and SENSITIVITY dials to **P**.
3) Set the detector's MODE switch at GEB/NORM.
4) Adjust the TUNER dial while holding down the TUNER BUTTON the handle, and while holding the pad waist high, to set t detector's threshold.
5) Conduct response check in test area with known numbers of bullets buried at known depths.
6) Record results of response check on form below.

Metal Detector Response Check

Twice a day and prior to metal detector survey, conduct a response c in test area with known numbers of bullets buried at known depths. Record results of response check on the following form:

Date/Time: 5-26 94 9:30 Operator: Harry Jim Hinson Detector I.D. 1027

NUMBER OF BULLETS	BURIAL DEPTH	RESPONSE
1	1 inch	
1	1½ inches	✓
1	2 inches	NO
2	2 inches	✓
5	3 inches	✓
6	3 inches	✓

LANL ENVIRONMENTAL RESTORATION PROGRAM
Operable Unit 1071 - SWMU 0-016 - Inactive Firing Ra

Metal Detector Calibration Procedure

1) Check battery charge with on the detector with the power switch, then to turn switch to **P** (ON).
2) Set the GEB, DISC, and SENSITIVITY dials to **P**.
3) Set the detector's MODE switch at GEB/NORM.
4) Adjust the TUNER dial while holding down the TUNER BUTTO the handle, and while holding the pad waist high, to set detector's threshold.
5) Conduct response check in test area with known numbers o bullets buried at known depths.
6) Record results of response check on form below.

Metal Detector Response Check

Twice a day and prior to metal detector survey, conduct a response in test area with known numbers of bullets buried at known depths. Record results of response check on the following form:

Date/Time: [illegible] AM Operator: [illegible] Detector I.D. _

NUMBER OF BULLETS	BURIAL DEPTH	RESPONSE
1	1 inch	[illegible]
1	1½ inches	[illegible]
1	2 inches	[illegible]
2	2 inches	[illegible]
5	3 inches	[illegible]
6	3 inches	[illegible]

Appendix C

Figure 2.
Approximate Location of 3-foot Square Sample Areas

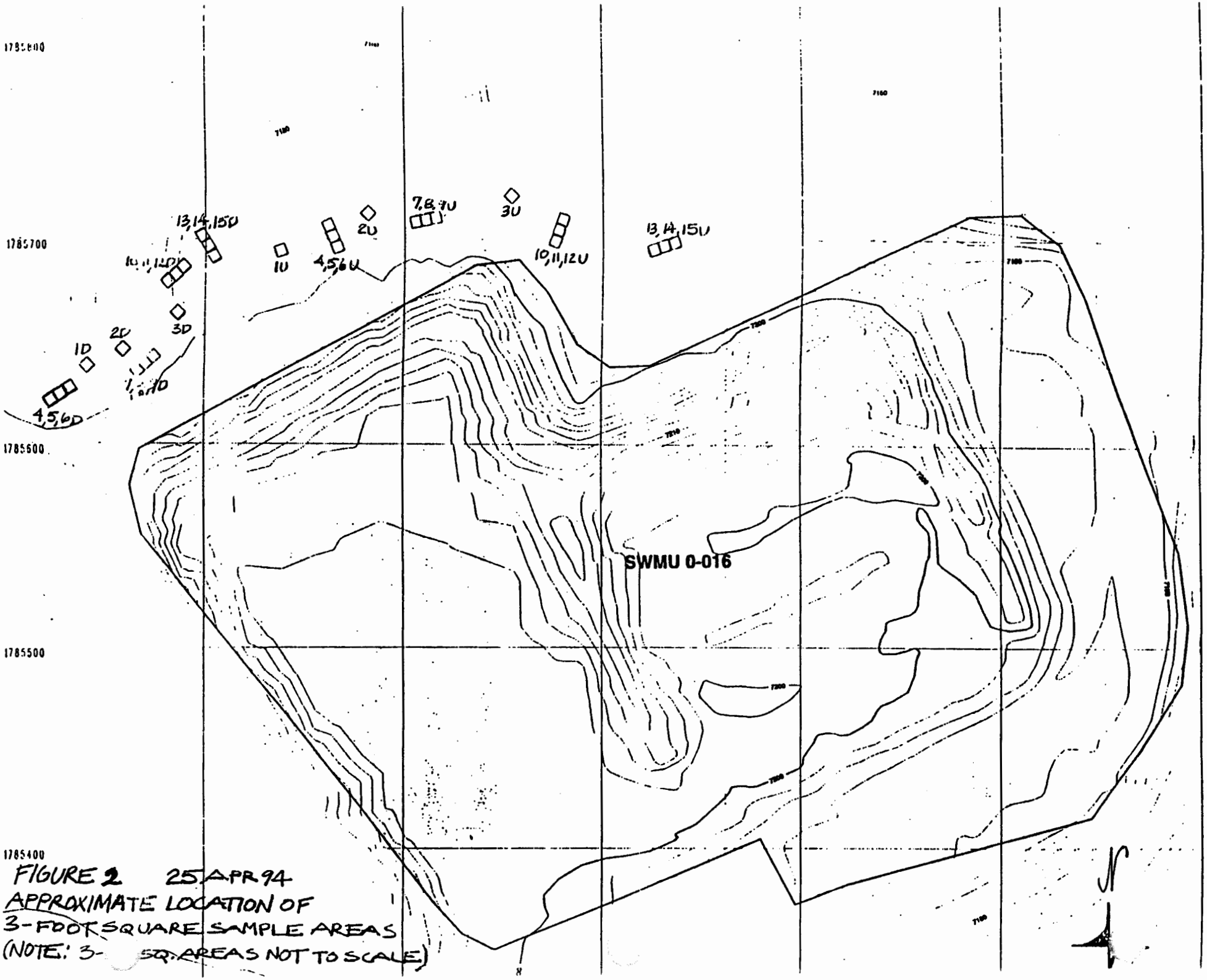


FIGURE 2 25 APR 94
APPROXIMATE LOCATION OF
3-FOOT SQUARE SAMPLE AREAS
(NOTE: 3- SQ. AREAS NOT TO SCALE)

Appendix D

Back-area Investigation Results

Table 3. OU 1071 SWMU 016 Back-area Investigation XRF Screening Results

No. of MD Positive Before Excavation	Sample Description	Sample ID	Pb conc. in ppm MQL/MDL 63/19	Cu conc. in ppm MQL/MDL 120/36	Zn conc. in ppm MQL/MDL 120/36
10	Center of grid	1D01	28J	nd	78J
	Composite of 9 samples (center)	1D02	155	nd	68J
	Next to a bullet	1D03	310	nd	91J
	Next to a bullet	1D04	533	nd	76J
	Next to a bullet	1D05	1114	nd	46J
	Next to a bullet	1D06	1063	nd	120J
	Next to a bullet	1D07	529	nd	76J
	Next to a bullet	1D08	1620	nd	99J
	Next to a bullet	1D09	981	nd	60J
	Next to a bullet	1D10	620	nd	75J
	Next to a bullet which was not found	1D11	341	nd	65J
	Next to a bullet which was not found	1D12	237	nd	86J
	Next to a bullet	1D13	1004	nd	75J
	Next to a bullet	1D14	333	39J	56J
	Next to a bullet	1D15	653	nd	71J
	Next to a bullet	1D16	428	nd	88J
	Next to a bullet	1D17	1173	40J	78J
	Next to a bullet	1D18	915	nd	81J
	Next to a bullet	1D19	475	nd	65J
	Next to a bullet	1D20	290	nd	103J
	Homogenized, bullet-free	1D21	472	nd	86J
2	Center of grid	2D01	248	nd	63J
	Composite of 9 samples (center)	2D02	261	nd	89J
9	Next to a bullet	3D01	615	nd	95J
	Next to a bullet	3D02	732	nd	100J
	Next to a bullet	3D03	604	nd	nd
	Next to a bullet	3D04	636	nd	49J
	Next to a bullet	3D05	331	nd	116J
	Next to a bullet	3D06	164	nd	63J
	Next to a bullet	3D07	140	nd	nd
	Center of grid	3D08	102	nd	61J
	Composite of 9 samples (center)	3D09	340	nd	104J
7	Composite of 9 samples (center)	4D01	312	nd	96J
6	Composite of 9 samples (center)	5D01	121	nd	nd
6	Composite of 9 samples (center)	6D01	241	nd	88J
6	Composite of 9 samples (center)	7D01	307	nd	81J
9	Composite of 9 samples (center)	8D01	199	nd	76J
	Next to a bullet	8D02	136	nd	81J
	Next to a bullet	8D03	1209	nd	66J
	Next to a bullet	8D04	225	nd	60J
	Next to a bullet	8D05	345	nd	101J
	Next to a bullet	8D06	169	nd	74J
	Next to a bullet	8D07	336	nd	73J
	Next to a bullet	8D08	213	172	116J
	Next to a bullet	8D09	293	nd	97J
	Next to a bullet	8D10	998	nd	67J
	Next to a bullet	8D11	228	54J	95J
	Next to a bullet	8D12	359	nd	86J
	Next to a bullet	8D13	183	nd	90J
	Next to a bullet	8D14	743	nd	nd
	Next to a bullet	8D15	156	nd	63J
	Next to a bullet	8D16	837	nd	98J
	Homogenized, bullet-fee	8D17	233	nd	58J
11	Composite of 9 samples (center)	9D01	514	nd	71J
	Composite of 9 samples (3" east of center)	9D02	371	38J	37J
9	Composite of 9 samples (center)	10D01	280	nd	47J
12	Composite of 9 samples (center)	11D01	340	nd	80J
	Composite of 9 samples (center)-duplicate	11D01dup	366	nd	111J
	Composite of 9 samples (3" east of center)	11D02	319	nd	50J
	Next to a bullet	11D03	307	38J	89J
	Next to a bullet	11D04	351	183	82J
	Next to a bullet	11D05	373	nd	61J
	Next to a bullet	11D06	735	54J	83J
	Next to a bullet	11D07	1050	nd	66J
	Next to a bullet	11D08	269	54J	68J
	Next to a bullet	11D09	470	45J	74J

MQL=Method Quantitation Limit. MDL=Method detection Limit. ND=Not Detected. J denotes an estimate since the value is above MDL but below MQL.

Table 3. OU 1071 SWMU 016 Back-area Investigation XRF Screening Results

No. of MD Positive Before Excavation	Sample Description	Sample ID	Pb conc. in ppm MQL/MDL 63/19	Cu conc. in ppm MQL/MDL 120/36	Zn conc. in ppm MQL/MDL 120/36
	Next to a bullet	11D10	455	45J	64J
	Next to a bullet	11D11	887	nd	111J
	Next to a bullet	11D12	469	nd	103J
	Next to a bullet	11D13	617	nd	69J
	Next to a bullet	11D14	620	nd	38J
	Next to a bullet	11D15	423	nd	66J
	Next to a bullet	11D16	537	nd	106J
	Next to a bullet	11D17	353	nd	70J
	Next to a bullet	11D18	1203	87J	60J
	Next to a bullet	11D19	367	275	108J
	Next to a bullet	11D20	468	nd	83J
	Next to a bullet	11D21	383	37J	95J
	Next to a bullet	11D22	4781	38J	nd
	Next to a bullet	11D23	987	nd	47J
	Next to a bullet	11D24	472	nd	79J
	Next to a bullet	11D25	632	nd	67J
	Next to a bullet	11D26	455	38J	90J
	Homogenized, bullet-free	11D27	367	nd	80J
8	Composite of 9 samples (center)	12D01	253	nd	54J
11	Composite of 9 samples (center)	13D01	218	nd	96J
11	Composite of 9 samples (center)	14D01	249	nd	73J
8	Composite of 9 samples (center)	15D01	251	nd	104
5	Composite of 9 samples (center)	16D01	374	68J	73J
4	Composite of 9 samples (center)	17D01	108	nd	63J
7	Center of grid	1U01	554	nd	127
	Composite of 9 samples (center)	1U02	524	nd	90J
7	Center of grid	2U01	112	nd	47J
	Composite of 9 samples (center)	2U02	575	131	126
0	Center of grid	3U01	56J	nd	54J
	Composite of 9 samples (center)	3U02	80	nd	65J
13	Composite of 9 samples (center)	4U01	608	42J	78J
7	Composite of 9 samples (center)	5U01	520	nd	49J
8	Composite of 9 samples (center)	6U01	869	nd	60J
11	Composite of 9 samples (center)	7U01	508	nd	113J
12	Composite of 9 samples (center)	8U01	430	nd	82J
5	Composite of 9 samples (center)	9U01	306	nd	77J
15	Composite of 9 samples (center)	10U01	988	nd	44J
	Composite of 9 samples (3" east of center)	10U02	572	nd	39J
	Next to a bullet	10U03	546	nd	57J
	Next to a bullet	10U04	669	nd	59J
	Next to a bullet	10U05	489	nd	59J
	Next to a bullet	10U06	835	nd	44J
	Next to a bullet	10U07	613	nd	43J
	Next to a bullet	10U08	930	nd	nd
	Next to a bullet	10U09	405	nd	62J
	Next to a bullet	10U10	1390	nd	56J
	Next to a bullet	10U11	562	nd	48J
	Next to a bullet	10U12	847	nd	57J
	Next to a bullet	10U13	1105	nd	54J
	Next to a bullet	10U14	787	nd	43J
	Next to a bullet	10U15	415	nd	nd
	Next to a bullet	10U16	495	nd	52J
	Next to a bullet	10U17	1111	nd	46J
	Next to a bullet	10U18	895	nd	nd
	Next to a bullet	10U19	426	nd	77J
	Next to a bullet	10U20	666	nd	73J
	Next to a bullet	10U21	1235	54J	63J
	Next to a bullet	10U22	440	nd	47J
	Next to a bullet	10U23	806	nd	nd
	Next to a bullet	10U24	449	nd	51J
	Next to a bullet	10U25	572	nd	nd
	Next to a bullet	10U26	714	nd	54J
	Next to a bullet	10U27	513	nd	83J
	Next to a bullet	10U28	671	nd	42J
	Next to a bullet	10U29	459	nd	62J

MQL=Method Quantitation Limit. MDL=Method detection Limit. ND=Not Detected. J denotes an estimate since the value is above MDL but below MQL.

Table 3. OU 1071 SWMU 016 Back-area Investigation XRF Screening Results

No. of MD Positive Before Excavation	Sample Description	Sample ID	Pb conc. in ppm MQL/MDL 63/19	Cu conc. in ppm MQL/MDL 120/36	Zn conc. in ppm MQL/MDL 120/36
	Next to a bullet	10U30	432	nd	39J
	Next to a bullet	10U31	485	nd	40J
	Next to a bullet	10U32	566	nd	59J
	Next to a bullet	10U33	365	nd	47J
	Next to a bullet	10U34	340	112J	62J
	Next to a bullet	10U35	495	nd	37J
	Next to a bullet	10U36	933	nd	46J
	Next to a bullet	10U37	564	nd	46J
	Next to a bullet	10U38	748	nd	56J
	Next to a bullet	10U39	489	nd	57J
	Next to a bullet	10U40	1221	nd	43J
	Next to a bullet	10U41	629	37J	39J
	Next to a bullet	10U42	1216	154	60J
	Next to a bullet	10U43	412	149	91J
	Next to a bullet	10U44	503	nd	37J
	Next to a bullet	10U45	1365	nd	nd
	Homogenized, bullet-free	10U46	499	nd	nd
14	Composite of 9 samples (center)	11U01	635	65J	39J
17	Composite of 9 samples (center)	12U01	849	nd	nd
	Composite of 9 samples (center)	12U01dup	988	nd	53J
	Composite of 9 samples (3" east of center)	12U02	502	nd	70J
	Next to a bullet	12U03	817	nd	67J
	Next to a bullet	12U04	572	nd	64J
	Next to a bullet	12U05	920	nd	nd
	Next to a bullet	12U06	472	nd	50J
	Next to a bullet	12U07	1106	nd	60J
	Next to a bullet	12U08	449	nd	49J
	Next to a bullet	12U09	787	nd	94J
	Next to a bullet	12U10	584	279	nd
	Next to a bullet	12U11	557	60J	96J
	Next to a bullet	12U12	624	nd	82J
	Next to a bullet	12U13	582	nd	45J
	Next to a bullet	12U14	385	nd	78J
	Next to a bullet	12U15	767	nd	nd
	Next to a bullet	12U16	472	nd	57J
	Next to a bullet	12U17	648	nd	51J
	Next to a bullet	12U18	873	nd	76J
	Next to a bullet	12U19	889	nd	76J
	Next to a bullet	12U20	1741	nd	116J
	Next to a bullet	12U21	437	nd	39J
	Next to a bullet	12U22	372	65J	nd
	Next to a bullet	12U23	664	nd	67J
	Next to a bullet	12U24	331	nd	36J
	Next to a bullet	12U25	380	nd	nd
	Next to a bullet	12U26	469	nd	65J
	Next to a bullet	12U27	334	nd	85J
	Next to a bullet	12U28	454	nd	69J
	Next to a bullet	12U29	520	nd	64J
	Next to a bullet	12U30	358	nd	78J
	Next to a bullet	12U31	1013	nd	60J
	Next to a bullet	12U32	399	nd	45J
	Next to a bullet	12U33	344	nd	49J
	Next to a bullet	12U34	878	nd	73J
	Next to a bullet	12U35	245	nd	53J
	Next to a bullet	12U36	401	nd	64J
	Next to a bullet	12U37	182	nd	73J
	Next to a bullet	12U38	483	nd	79J
	Next to a bullet	12U39	360	nd	85J
	Next to a bullet	12U40	178	nd	89J
	Next to a bullet	12U41	520	nd	47J
	Next to a bullet	12U42	472	nd	59J
	Next to a bullet	12U43	918	nd	47J
	Next to a bullet	12U44	468	nd	47J
	Next to a bullet	12U45	811	nd	77J
	Next to a bullet	12U46	1247	nd	93J
	Next to a bullet	12U47	1134	nd	36J

MQL=Method Quantitation Limit. MDL=Method detection Limit. ND=Not Detected. J denotes an estimate since the value is above MDL but below MQL.

Table 3. OU 1071 SWMU 016 Back-area Investigation XRF Screening Results

No. of MD Positive Before Excavation	Sample Description	Sample ID	Pb conc. in ppm MQL/MDL 63/19	Cu conc. in ppm MQL/MDL 120/36	Zn conc. in ppm MQL/MDL 120/36
	Next to a bullet	12U48	817	nd	49J
	Next to a bullet	12U49	416	nd	58J
	Next to a bullet	12U50	345	nd	nd
	Next to a bullet	12U51	529	nd	80J
	Next to a bullet	12U52	2168	nd	72J
	Next to a bullet	12U53	485	nd	50J
	Next to a bullet	12U54	195	nd	42J
	Next to a bullet	12U55	701	nd	44J
	Next to a bullet	12U56	1384	nd	70J
	Next to a bullet	12U57	287	nd	85J
	Next to a bullet	12U58	872	nd	64J
	Next to a bullet	12U59	992	nd	97J
	Next to a bullet	12U60	1260	nd	87J
	Next to a bullet	12U61	1331	nd	91J
	Next to a bullet	12U62	301	nd	75J
	Next to a bullet	12U63	2103	nd	72J
	Next to a bullet	12U64	756	nd	84J
	Next to a bullet	12U65	1127	nd	53J
	Next to a bullet	12U66	664	nd	76J
	Next to a bullet	12U67	2624	114J	85J
	Next to a bullet	12U68	301	nd	42J
	Next to a bullet	12U69	318	nd	57J
	Next to a bullet	12U70	635	38J	69J
	Next to a bullet	12U71	512	nd	111J
	Next to a bullet	12U72	392	nd	44J
	Next to a bullet	12U73	577	nd	86J
	Next to a bullet	12U74	778	nd	95J
	Next to a bullet	12U75	563	37J	83J
	Next to a bullet	12U76	373	nd	55J
	Next to a bullet	12U77	355	nd	49J
	Next to a bullet	12U78	484	nd	77J
	Next to a bullet	12U79	1777	nd	73J
	Next to a bullet	12U80	1214	nd	78J
	Homogenized, bullet-free	12U81	407	nd	56J
6	Composite of 9 samples (center)	13U01	520	nd	68J
10	Composite of 9 samples (center)	14U01	498	nd	65J
	Next to a bullet	14U02	263	nd	91J
	Next to a bullet	14U03	630	nd	133
	Next to a bullet	14U04	1230	nd	nd
	Next to a bullet	14U05	817	nd	79J
	Next to a bullet	14U06	1845	259	125
	Next to a bullet	14U07	694	51J	125
	Next to a bullet	14U08	1491	77J	96J
	Next to a bullet	14U09	680	nd	167
	Next to a bullet	14U10	715	nd	37J
	Next to a bullet	14U11	553	nd	87J
	Next to a bullet	14U12	1371	nd	97J
	Next to a bullet	14U13	1213	nd	50J
	Next to a bullet	14U14	1693	nd	77J
	Next to a bullet	14U15	1698	nd	96J
	Next to a bullet	14U16	655	nd	70J
	Next to a bullet	14U17	850	nd	69J
	Next to a bullet	14U18	480	nd	72J
	Next to a bullet	14U19	653	nd	57J
	Next to a bullet	14U20	581	nd	91J
	Next to a bullet	14U21	1168	nd	55J
	Homogenized, bullet-free	14U22	449	nd	81J
12	Composite of 9 samples (center)	15U01	440	nd	93J
17	Composite of 9 samples (center)	16U01	1176	nd	99J
17	Composite of 9 samples (center)	17U01	793	54J	98J
14	Composite of 9 samples (center)	18U01	274	nd	nd
1	Composite of 9 samples (center)	19U01	145	nd	99J

MQL=Method Quantitation Limit. MDL=Method detection Limit. ND=Not Detected. J denotes an estimate since the value is above MDL but below MQL.

- Lead (Pb) concentrations in homogenized 3 ft. by 3 ft. by 2 inches bullet-free soil from grids with highest number of metal detector responses are shown in Table 2 below.

Grid ID	Pb conc.
1D	472 ppm
8D	233 ppm
11D	367 ppm
10U	499 ppm
12U	407 ppm
14U	449 ppm

Table 4. XRF Lead Concentrations in Bullet-free Homogenized Soil Samples.

- The highest lead concentration (499 ppm) is approaching LANL soil SAL of 500 ppm.

	Disturbed Area	Undisturbed Area
No. of metal detector responses	8	10
Average Pb conc. in random grab samples (center of grid)	126 ppm	241 ppm
Average Pb conc. in random composite samples (composite of 9 samples taken at center of each 1 foot-square)	279 ppm	582 ppm
Average Pb conc. in homogenized bullet-free samples	357 ppm	452 ppm
Average Pb conc. in hot spot samples (next to a bullet)	624 ppm	740 ppm

Table 5. Comparison of XRF Lead Concentrations at Disturbed Area and Undisturbed Area.

- The number of metal detector responses is higher in the undisturbed area than in the disturbed area.
- The average lead concentrations in all samples are higher in the undisturbed area.
- All soil samples obtained immediately adjacent to a bullet have lead concentrations greater than the LANL SAL of 500 ppm.

Appendix E

Sampling Approach to Characterization of Back-area

by Kathy Campbell

TO: Distribution May 27, 1994

FROM: Kathy Campbell KC TSA-1/MS F600

SUBJECT: SAMPLING APPROACH TO CHARACTERIZING LARGE AREAS AT SMALL ARMS RANGE USING METAL DETECTOR SCREENING

Attached is a revision of the "sampling approach to characterization of back area at former small arms range" for screening purposes. It is based on sampling 5% or 10% of the 225 6'x6' squares in a 90'x90' area (almost 1/5 acre), and anticipates that decisions for further action in any such area will be based on the mean over that area. Should action be indicated, however, we should probably make actual remediation decisions on rather smaller areas, such as the 30'x30' areas of my original proposal.

Distribution:

John Williams, ERM, FAX 662-1398
Jan Novak, EES-1, FAX 665-3285
Dave Finnegan, CST-10, MS J514
Jim Aldrich, EES-1, MS D462

SAMPLING APPROACH TO CHARACTERIZATION OF BACK AREA AT FORMER SMALL ARMS RANGE (PRS 0-016): SITE SCREENING VERSION

In this version, decisions for further action (in the form of additional investigation on a smaller scale appropriate for actual remediation decisions) are based on an upper confidence bound for the mean lead contamination in 90' by 90' areas.

1) In each 90' by 90' area, survey twelve of the 225 possible 6'x6' squares, obtaining numbers of metal detector hits per square M_i, i=1, ..., 12.

2) Estimate the average number of metal detector hits per square ($\overline{M} = \frac{1}{12}\sum_{i=1}^{12} M_i$) and the variance ($s^2 = \frac{1}{11}\sum_{i=1}^{12}(M_i - \overline{M})^2$).

3) Compute a 97.5% upper confidence limit for this average as $\overline{M}_u = \overline{M} + 0.62s$. (The coefficient is based on the t distribution with 11 degrees of freedom, and also includes a "finite population correction" because we have observed about 5% of the whole area, not a negligible fraction.)

4) Estimate the average lead concentration in the 90'x90' area from Table 1 using both $\overline{M}$ and $\overline{M}_u$ for "metal detector hits per square". (Interpolate linearly between the given values of M. Numbers in the "average lead contamination" column are actually 97.5% upper confidence bounds for lead concentration given metal detector hits per square.)

5) If the variance is so large that using $\overline{M}$ would lead to a decision not to remediate but using $\overline{M}_u$ will lead to the decision to remediate, then (and only then) survey an additional twelve squares, recompute the mean and variance using all 24 samples ($\overline{M} = \frac{1}{24}\sum_{i=1}^{24} M_i$ and $s^2 = \frac{1}{23}\sum_{i=1}^{24}(M_i - \overline{M})^2$), and compute a new 97.5% upper confidence limit using the formula $\overline{M}_u = \overline{M} + 0.40s$. (The coefficient changes because we have more degrees of freedom for the t statistic, and a different finite population correction, and more samples.) Repeat step 4.

6) Base the final decision for the 90' by 90' area on the estimate of average lead concentration obtained by using the final value of $\overline{M}_u$, whether based on 12 or 24 squares. This number is an approximately 95% upper confidence level for the mean lead contamination in the decision unit. (500 ppm will fall at about $\overline{M}_u = 30$ counts per square.)

I suggest that the surveyed squares be selected at random within the 90'x90' area. For this purpose, number the 100 squares from 1 to 225, pick a random starting point in the attached Table 2 (close your eyes and point with a pencil), and read off 24 two-digit numbers from that point. (Go back to the beginning if you come to the end.) It is not critical that the squares be surveyed in exactly, just pace them off approximately, and shift as necessary to avoid trees, but surveyed squares shouldn't overlap.

TABLE 1. AVERAGE LEAD CONTAMINATION, GIVEN NUMBER OF METAL DETECTOR HITS PER 6'x6' SQUARE

METAL DETECTOR HITS PER SQUARE	AVERAGE LEAD CONTAMINATION
2	142.4
6	188.2
10	237.1
14	288.5
18	341.5
22	395.7
26	450.4
30	505.6
34	561.1
38	616.8
42	672.6
46	728.5
50	784.5
54	840.5
58	896.6
62	952.8
66	1008.9

TABLE 2. RANDOM NUMBERS BETWEEN 1 AND 225

24	42	169	186	36	164	180	167	123	159	29	193
6	172	88	205	76	53	108	162	147	29	1	79
39	129	164	67	65	120	51	4	133	214	170	19
197	172	133	24	164	144	204	199	114	58	45	13
145	71	127	142	30	108	150	209	195	46	216	73
184	201	7	36	35	56	177	99	55	121	121	111
132	124	3	210	219	122	73	79	159	156	38	76
102	188	71	129	58	80	121	15	56	177	154	74
160	129	187	37	135	223	179	48	205	141	159	14
90	92	175	71	191	16	91	98	172	7	163	147
185	207	94	121	108	48	125	143	193	72	171	174
177	26	173	37	148	118	128	96	91	145	63	38
46	136	25	201	188	194	152	210	155	144	52	162
112	205	33	167	49	88	170	199	15	6	186	90
96	178	94	96	218	194	46	75	139	166	17	68
81	104	36	131	51	39	75	93	80	26	149	20
207	8	219	123	15	42	155	1	213	41	2	152
72	88	50	180	137	136	170	134	203	150	194	132
144	80	30	172	88	44	4	48	14	177	58	173
113	218	215	154	169	94	55	165	182	101	189	209
101	150	185	21	139	166	8	140	127	74	152	7
3	95	16	55	129	16	112	38	13	19	1	104
206	8	110	111	64	163	205	186	154	194	152	66
68	87	84	20	150	138	112	68	128	194	21	44
197	63	204	120	120	86	68	152	14	41	22	215
38	20	169	201	151	214	194	221	95	166	48	90
69	23	38	197	146	190	72	49	167	108	106	103
14	131	83	37	176	35	102	222	10	222	80	175
35	204	76	23	45	97	27	127	192	102	190	182
22	90	105	167	199	34	96	184	151	141	201	78
39	139	37	203	40	171	149	40	147	119	45	26
33	66	44	153	55	155	186	117	85	103	129	38
42	77	127	184	20	78	154	63	147	51	159	87
182	129	59	97	2	216	153	152	56	114	208	131
110	23	18	177	181	87	206	152	109	6	76	57
8	7	103	76	149	24	218	103	169	74	50	10
102	49	72	192	141	185	66	16	80	125	176	199
23	139	12	51	73	20	55	91	222	183	169	66
83	170	33	168	52	47	9	101	40	36	12	90
191	72	148	38	195	115	28	58	1	8	46	122

Appendix F

Back-area Metal Detector Survey Grid Destination

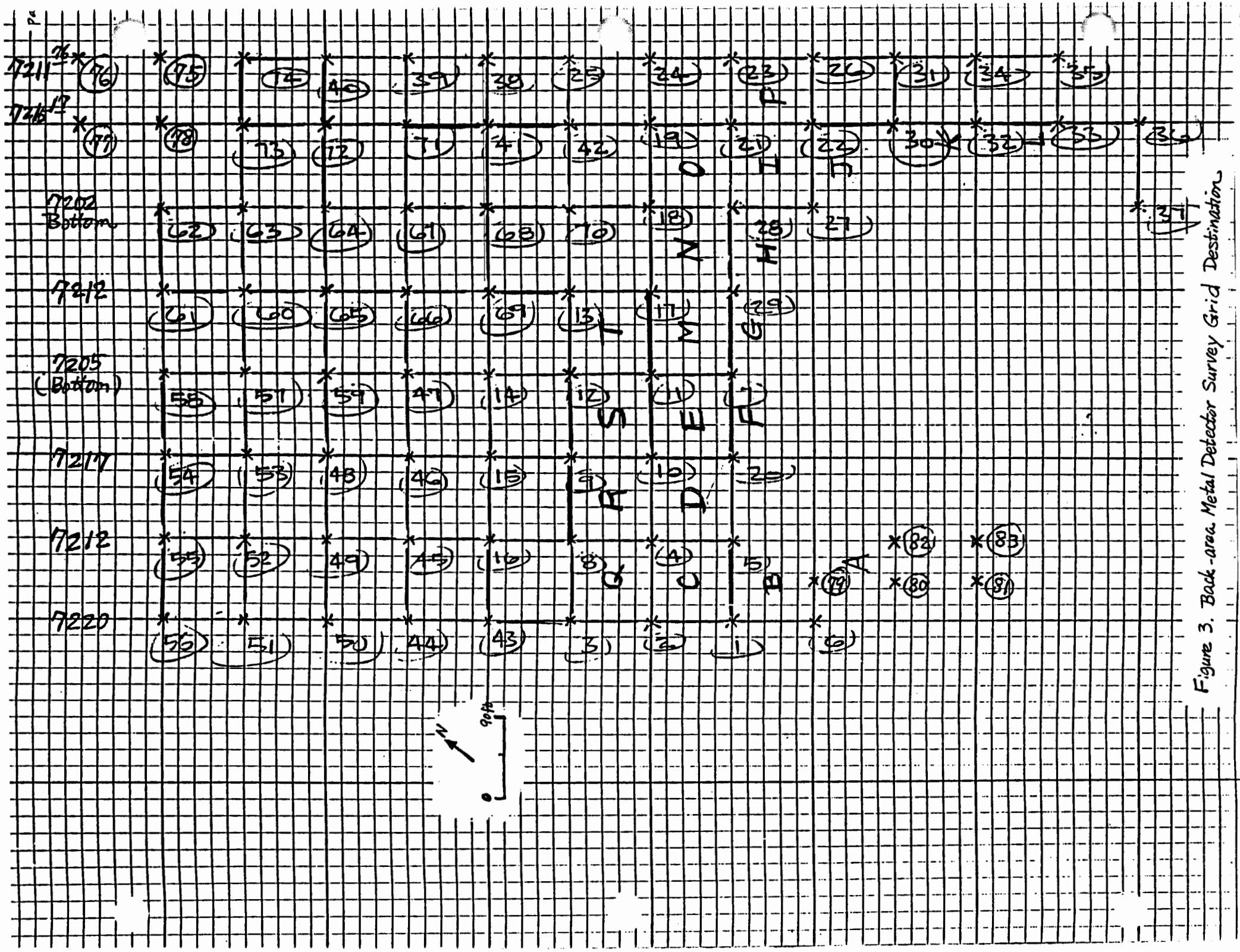


Figure 3. Back-area Metal Detector Survey Grid Destination

LANL ENVIRONMENTAL RESTORATION PROGRAM

Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 6/2/94 Survey Phase No._____ 90'x90' Grid Destination: A

Survey Team Members: M. Coyle/G. Moon

									2					
									1	6				
									1	1	2			
									7	7	6			
									5	8	7			
										3	7			
										6	2	5*		
										7	5	4		
										1	1	2		
											2	4	5*	
											0	2	15	
											0	0	6	
											2	1	5	
												1	2	9*
												4*	0*	3*

* denotes obstacles in grid (trees, rock, trash)

LANL ENVIRONMENTAL RESTORATION PROGRAM

Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 6/2/94 Survey Phase No. _____ 90'x90' Grid Destination: B

Survey Team Members: M. Amann/K. Louie

		23	20	34	33	50								
		20	27	40	31	48								
12	18	26	31	33	32	36								
24	20	25	30	23	28	25								
12	15	16	22	29	28	25								
10	12	19	22	9	30	32								
10	17	11	12	10	28	35								
8	15	17	15	13	26	25								
9	12	17	14	16	27	29								
7	9	16	14	10	6	7	3	6	12	16				
						7		13	20	30				
						2								
						9								
						15								
						6								

LANL ENVIRONMENTAL RESTORATION PROGRAM

Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 5/23+6/1/94 Survey Phase No._____ 90'x90' Grid Destination: C

Survey Team Members: M. Amann/G. Moon/K. Louie

4	9	15	10	20	22	25	22	19	22	28	21	17	34	35
6	6	11	12	13	11	19	11	10	15	22	20	11	13	17
8	8	10	17	16	17	15	31	27	20	16	12	12	14	14
15	10	17	9	26	15	12	18	35	20	17	13	8	12	17
13	8	16	19	17	9	23	14	18	20	21	12	10	22	16
16	11	17	13	16	16	15	21	21	17	12	17	24	23	17
15	13	16	15	17	20	11	12	13	16	15	17	15	8	4
20	25	25	18	13	17	15	19	11	16	16	17	14	20	3
14	10	15	20	17	17	8	17	26	13	14	5	1	4	16
8	22	17	13	14	18	16	11	12	10	3	12	6	4	8
5	15	13	21	17	13	17	16	14	12	14	10	16	30	7
17	15	15	14	27	29	16	28	17	30	40	28	40		34
17	19	15	16	15	18	8	29	29	32	40	27	33	35	25
8	9	5	6	6	10	6	25	28	23	33	32			40
19	4	11	11	8	13	10	25	36	30	32	38		31	40

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Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 6/3/94 Survey Phase No._____ 90'x90' Grid Destination: D

Survey Team Members: M. Amann/K. Louie

44				32	54	78	47	52	37	44	64	27	36	36
17	32	16	36	54	52	57	56	49	50	42	70	42	33	49
27	28	40	20	60	53	63	69	63	65	57	75	77	56	75
36	48	48		64	50	48	58	51	47	45	62	62	78	79
36	4	42		51	36	27	35	56	57	67	75	52	60	76
44	16	26		49	40	36	69	43	83	79	84	77	67	52
33	18		8	80	81	75	90	45	90	80	88	60	80	74
20	18	14		92	93	78	73	50	95	96	77	81	64	56
24	56	36	4	96	84	87	81	70	98	97	78	82	84	49
19	28		52	84	85	80	81		48	72	60	51	63	68
32	40	100		73	92	81	52					52	78	91
72		100	68	78	99	100								100
56	80			75	68									
	64	116												
73		8												

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Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 05-16-94 Survey Phase No._____ 90'x90' Grid Destination: E

Survey Team Members: Brecker/ Switzer

29	39	24	17	34	31	41	30	54	31	55	29	8	49	30
30	47	56	36	45	58	71	60	50	57	42	27	38	51	67
56	34	36	41	41	50	54	58	70	63	65	49	69	32	45
56	66	21	44	48	56	56	53	52	42	60	46	31	25	59
46	54	55	69	61	48	55	45	60	49	45	39	41	46	53
49	30	47	45	57	49	51	44	40	39	51	49	53	45	54
59	78	53	58	51	44	58	74	56	42	39	48	47	40	51
32	42	56	58	50	50	54	47	57	43	48	56	57	32	38
71	77	60	80	77	45	53	67	77	86	69	53	57	42	43
38	77	81	68	67	59	77	84	66	57	65	48	56	34	4
79	90	85	99	88	90	88	65	78	60	61	58	52	42	40
84	93	87	81	85	79	73	71	68	63	72	65	46	31	22
		80	70	83	78	84	80	82	77	86	93	72	9	7
				92	53	49	44	75	100	104	83	20	15	27
						64	63	74	94	71	49	8	8	9

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Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date:_____Survey Phase No._____90'x90' Grid Destination: F

Survey Team Members: Brecker/Switzer

										>40	>40			
										>40	>40	>40		

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Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 05-25-94 Survey Phase No. _____ 90'x90' Grid Destination: G

Survey Team Members: Brecker/Switzer

														60
			78											
							52							
											38			
														56

LANL ENVIRONMENTAL RESTORATION PROGRAM

Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 05-25-94 Survey Phase No._____ 90'x90' Grid Destination: H

Survey Team Members: Brecker/Switzer 6-2-94 Moon/Coyle

>30	27	29	30	17	19					13				
>30	23	30	30*	16*	8					11				
23*		16*	22							15				
17	15	8	12	12		10		19						
14	15	7								5				
29	>30	24**	15**	5	5*									
>30	29	30**	30**	16	10							6		
>30	>30	27	17	30	23	11	19			22				
>30	>30	>30	26	22										
28	>30	>30	28	29	14	20	11							
45		30	30	18	15	14				7				
		>30	30**	12		15								
				16	13	18	19							2
											11		9	

* Obstacles in grid (trees, shrubs, rock) **Metal scraps in grid

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Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 05-24-94 Survey Phase No._____ 90'x90' Grid Destination: I

Survey Team Members: S. Brecker/J. Switzer

0*			0		4									
2														
2	1	2	1	2	3	3	2	0	1	1	1	0	4	0
0														
0														
0														
3														
3														
2														
7	3	3					5	9		0*		9		5

* Denotes rocks and trees

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Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 06-01-91 Survey Phase No. _____ 90'x90' Grid Destination: J

Survey Team Members: Mike Coyle/Greg Moon

19	20	9			11**	10					9			
>30	35	4	7	5	23	17	4	12			16			
13	39	26	6	7	29	27**	10	10			30**	16		
		34	6*		10	25	9	15			15	19		
					12			>30	12	8	14	20		
								25	10	11	30	29**		
									7	8	27	27**		
												22	6	6
												14	13	13
												4	3	2*
												10		2
												3		2
												5	15*	10*
												8	16**	7
												7	6	6

* Obstacles in grid (tree, shrub, boulder) ** Metal debris in grid (barbwire, cans, bottle caps)

LANL ENVIRONMENTAL RESTORATION PROGRAM

Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 06-01-94 Survey Phase No._____ 90'x90' Grid Destination: K

Survey Team Members: Mike Coyle, Greg Moon

												8	16**	3
												28	18	5
												30**	27	26
												30**	30**	19**
												30**	30	9*
												26	14	8
												13**	23	6
												18	30*	10
												12**	17	10*
												19	1 2	7
												1	6*	8
												0	3	2
												0	1	3
												0	1	0
												8	8	1

LANL ENVIRONMENTAL RESTORATION PROGRAM

Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 06-01-94 Survey Phase No._____ 90'x90' Grid Destination: L

Survey Team Members: M. Coyle/G. Moon

												2	6	2
												5	4	5
												8	4	6
												10*	9	6
											7	20	17	
											11**	25	15	
											18**	11	8	
											14**	13**	7	
										9				

* Obstacles in grid (tree, boulders, shrubs) ** Metal debris in grid (barbwire, cans, bottle caps)

LANL ENVIRONMENTAL RESTORATION PROGRAM

Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 05-19-94 Survey Phase No._____ 90'x90' Grid Destination: M

Survey Team Members: K. Louie/M. Coyle

43	65	57	41	47	54	68	44	55	24	52	47	43	26	24
57	71	55	41	54	48	55	69	65	32	54	50	70	36	38
48	85	64	60	41	49	51	53	66	63	59	49	45	50	38
61	83	80	75	80	96	100	98	94	86	87	69	89	61	39
34	52	49	52	52	52	52	52	52	52	52	52	52	52	52
51	52	52	52	52	52	52	52	52	52	52	52	39	52	52
49	52	52	52	52	52	51	52	52		52	52	52	52	52
34							44	52						
18							52	50						
70							52	52						
32							52	51						
94							52	52						
82							52	48						
70							48	52						
2							52	48						

LANL ENVIRONMENTAL RESTORATION PROGRAM

Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 05-20-94 Survey Phase No._____ 90'x90' Grid Destination: N

Survey Team Members: G. Moon/M. Amann

12	3	0*	8	1*	0*	0*	4*	5*	15	9	7	6	4	12
21	11	5	6*	9*	0*	0*	1*	5*	5*	9*	8	15	12	10
33*	22	22	16	19	12	12*	1*	0*	2*	7*	10	16	20	16
36	42	16	13	31	24	24	24	0	0	0	20	16	16	18
22	16	0	0	0	0				0		0			6
32	10	4	0	0	0	0	0	0	0	8	0	2	2	10
16	0	2	2	2	0	0	6	0	0	0	0	4	6	0
38	20	2	0	0	0	10	6	0	0	0	0	0	0	4
25	32	52	50	44	38	38	30	15	2					
40				33	26	18								
40				40	30	24	21		12					
40				40	14	12								
40				40	23	17	17	24	21	27	7	6	4	0
40	40	40	40	40	40	20*	19	25	16	29	18	2	1	0
49	45	49	33	22	16	27	18	25	42	42	22	25	11	4

* Obstacles in grid (trees, rocks, logs)

LANL ENVIRONMENTAL RESTORATION PROGRAM

Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 05-20-94 Survey Phase No._____ 90'x90' Grid Destination: O

Survey Team Members: S. Brecker/J. Switzer

23	23	26	14	24	19	9	6	12	14	10	8	7	9	9
20	25	24	18	14	14	12	11	5	14	15	8	10	6	7
21	16	17	14	12	11	4	6	7	8	9	9	7	5	4
22	18	19	22	8*	15*	13	9	11	9	10	5	6	14	7
19	24	17	17	6	8*	8	7	13	12	12	13	17	11	15
26	21	8	9	8	11	7	8	8	9	6	7	14	10	9
25	9	10	10	6	10	9	6	10	6	8	9	9	7	11
12	10	5	14	4	5	5	6	5	11*	4*	3	6	18	17
10	11	4*	7*	5	3*	8	6	5	6	3*	4	7*	7	7
2	7	7	9	4	16	13*	15	15*	11*	3	3	5	5*	7*
15*	21	16*	15	7*	4*	7	12	12	13	7	5	6	3	5*
21*	12*	14	14	11	14	6	8	8	8	9	7	13	17*	22*
9*	5*	15	14	7	12	12	20*	22*	21	10	7	7	5	2
7	4	4	4	5	9	2*	4*	0	5*	0*	1*	3*	1*	1
6*	6*	4	4	3	9	3*	0*	0*	0*	3*	0*	2	1	2

* Rock or obstruction

LANL ENVIRONMENTAL RESTORATION PROGRAM

Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 05-24-94 Survey Phase No. Grid Designation: P

Survey Team Members: MJC/KL Layout/Detection

1							1							4
0	0	0	0	0	0	0	0							
														0
4	0	0	0	0	0	0	2	0	0	0	0	0	0	0
0														0
0														0
0														0
0								0	0					0
0														0
0														0
0	0	0	0	0	0	0	3	0	0	0	3	0	0	1

Note: Some debris throughout grid (aluminum cans, lids, barbwire, glass). Did not count as detects.

LANL ENVIRONMENTAL RESTORATION PROGRAM

Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 05-31-94 Survey Phase No._____ 90'x90' Grid Destination: Q

Survey Team Members: M. Amann/G. Moon

		27								1	1	0	1	1
13	12	33	11	12	11	7	6	8	6	9	7	3	3	2
20	9	11	9	10	6	6	17	23	25	30	33	30	27	18
5	11	7	9	11	19	16	10	16	25	0	0	0	17	14

LANL ENVIRONMENTAL RESTORATION PROGRAM

Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 05-24-94 Survey Phase No._____ 90'x90' Grid Destination: R

Survey Team Members: G. Moon/M. Amann

2														
0	6	10	13	2	6	5								
24	12	26	21	27	15	12	12	15	5			4	11	18
22	15	25	8	7	15	18	21	19*	29	12*	25	37	41	40
20	9	23	23	31	14	21	22	27		37	25	40		40
40	40	28	34		27	19	25	21	33		40		24	
				32	34	40	26	33		40				
				40	19									

* Obstacles in grid (logs, rocks, trees)

LANL ENVIRONMENTAL RESTORATION PROGRAM

Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 06-03-94 Survey Phase No._____ 90'x90' Grid Destination: S

Survey Team Members: M. Coyle/G. Moon

			4	0	0	1								
5	3	2	5	5	10	8	5	7						
26	22	>30	>30	>30	>30	>30	>30	29	18	8	7	29	>30	29
>30	>30	>30							>30	>30	29			

LANL ENVIRONMENTAL RESTORATION PROGRAM

Operable Unit 1071 SWMU 00-016 Inactive Firing Range

Back Area Metal Detector Survey

Date: 05-31-94 Survey Phase No._____ 90'x90' Grid Destination: T

Survey Team Members: M. Coyle/K. Louie

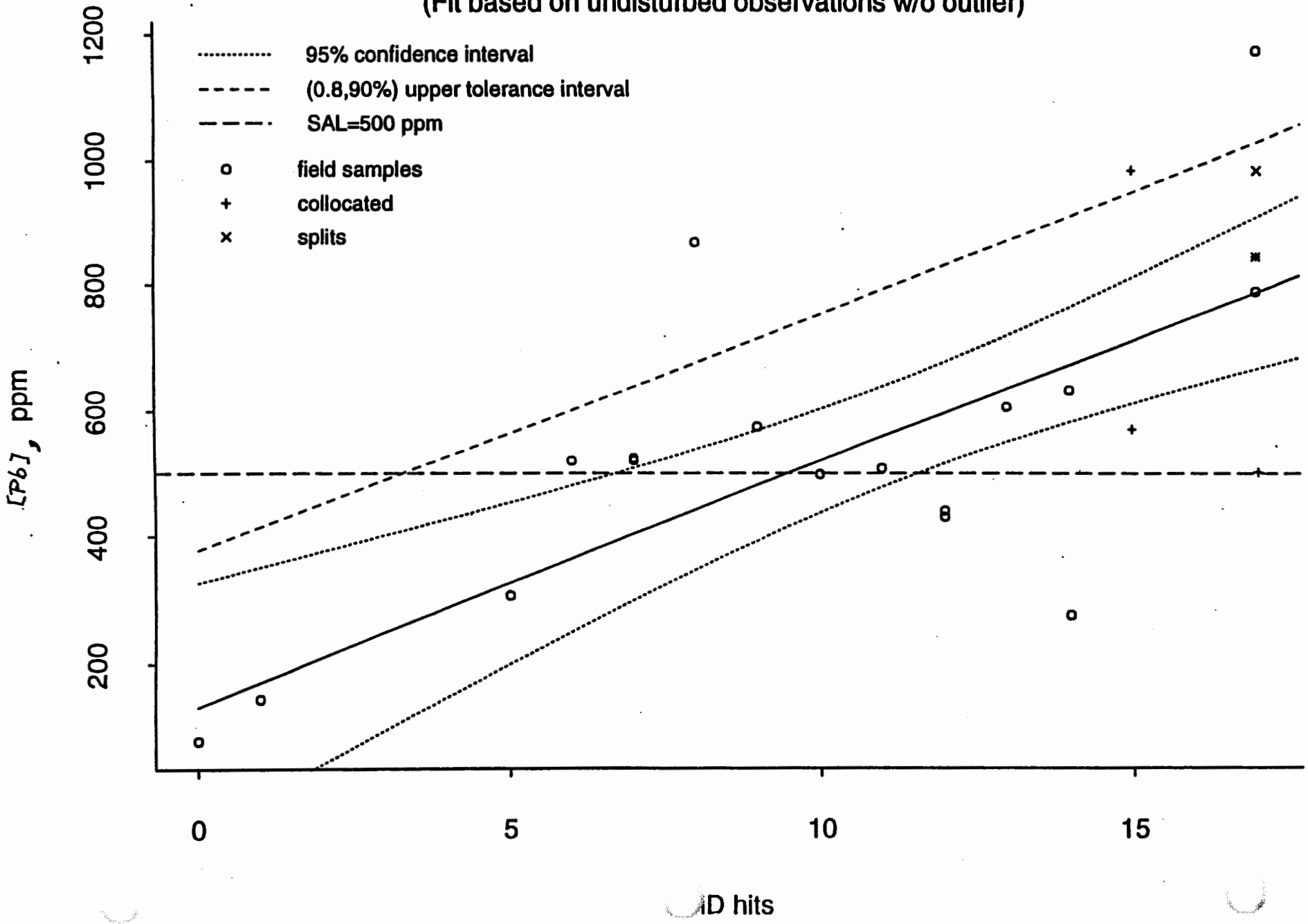
							0	1	1	0	0	0		
3						0	1	19	23	8	14	2		
31	15	3	5				6	28	27	21	8	5	1	
	36	35	25				4	29	33	29	16	6	6	0
			40	52	43	33	10				28	5	5	11
15							30					6	4	11

Appendix G

Figure 4.
Lead Concentration As a Function of MD Hits

Figure 4. Lead concentration as a function of MD hits

(Fit based on undisturbed observations w/o outlier)



Appendix H

Figure 5.
OU 1071 SWMU 016 Boundary Map

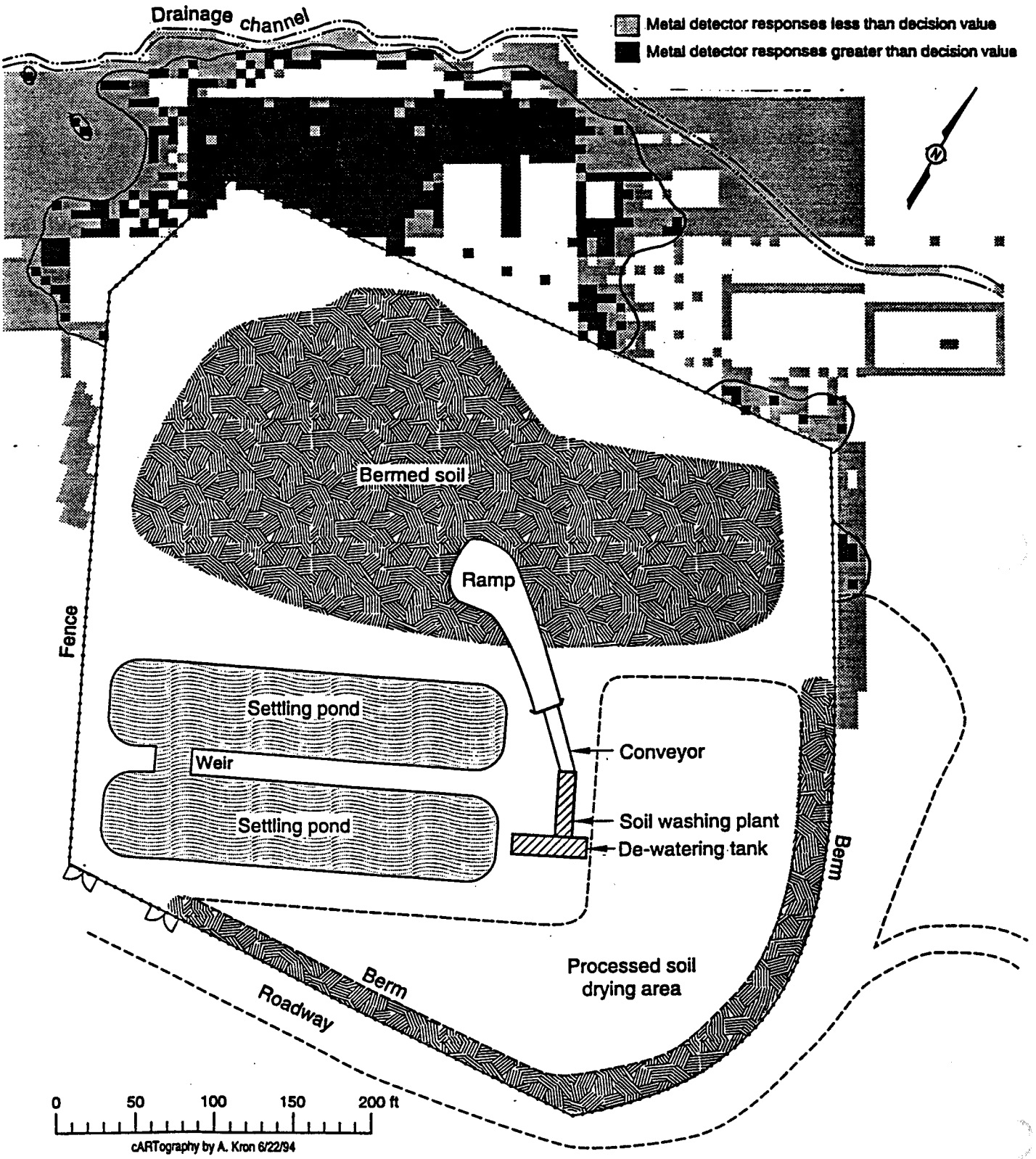


Figure 5. OU 1071 SWMU 016 Boundary Map

APPENDIX F-1 HUMAN HEALTH RISK ASSESSMENT

CALCULATION OF CLEANUP LEVELS

Copper and Zinc

This risk-based cleanup values for a residential exposure scenario for copper and zinc (Table 3.1-1) were calculated using current toxicity values and standard default parameters. These values and the standard equation used to calculate the risk based cleanup levels were obtained from the most recent guidance from EPA Region 9 (1998, ER ID 58751) are presented below.

Combined Pathway Exposures to Noncarcinogenic Chemicals of Potential Concern in Residential Soil

$$\textit{Cleanup Level (mg/kg)} = \frac{THQ \times BW_c \times AT_n}{EF_r \times ED_c[(1/RfD_o \times IRS_c/10^6 mg/kg)+(1/RfD_d \times SA_c \times AF_c \times ABS/10^6 mg/kg)+(1/RfD_i \times IRA_c/PEF)]}$$

SYMBOL	DISCRIPTION	VALUE AND UNITS
THQ	Target Hazard Quotient	1.0 (unit-less)
BW	Body Weight, child	15 kg
AT_n	Averaging Time	ED x 365 days
EF_r	Exposure Frequency, resident	350 days/year
ED_c	Exposure Duration, child	6 years
RfD_i	Reference Dose, inhalation	Not available (not in IRIS[1], or HEAST[2]) for copper or zinc
RfD_o	Reference Dose, oral	0.037 (mg/kg-d) for copper[2], 0.3 (mg/kg-d) for zinc[1]
RfD_d	Reference Dose, dermal	Same as RfD_o
SA_c	Exposed Surface Area, child	2,900 cm^2/day
AF_c	Adherence Factor, child	0.3 mg/cm^2
ABS	Skin Absorption, inorganics	0.01 (unit-less)
IRS_c	Soil Ingestion, child	200 mg/day
IRA_c	Inhalation Rate, child	10 m^3/day
PEF	Particulate Emission Factor	$1.315 \times 10^6 m^3/kg$

[1] IRIS = Integrated Risk Information System
[2] HEAST = Health Effects Assessment Summary Tables

There are no inhalation toxicity values available for copper and zinc. Route-to-route extrapolation from the oral to inhalation pathway is not performed for inorganic chemicals due to portal-of-entry effects and known differences in absorption efficiency between the oral and inhalation routes of

exposure. Therefore, the inhalation pathway, which is the last part of the denominator in the above equation, was not included in the calculation of the cleanup levels for copper and zinc.

Much uncertainty surrounds the determination of hazards associated with skin contact with soils. One important data gap is the lack of verified toxicity values (RfDs) for the dermal pathway. It is assumed that dermal toxicity values can be extrapolated from oral values. In doing so, it is recommended that a default value of complete (100%) oral absorption be assumed , thereby eliminating the need for oral toxicity value adjustment. Therefore, the oral RfDs of 0.037mg/kg-d for copper and 0.3 mg/kg-d for zinc were used as dermal RfDs in the calculation of the cleanup levels.

Lead

The cleanup level for lead, 400 mg/kg, is based on the July 14, 1994 Office of Solid Waste and Emergency Response (OSWER) Directive # 9355.4-12 titled: "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities" (EPA 1994, ER ID 59509). The directive states that the residential screening level for lead was calculated using the Environmental Protection Agency's (EPA) Integrated Exposure Uptake Biokinetic Model (IEUBK) using default parameters.

The directive further states:

With this interim directive, OSWER recommends using 400-ppm soil lead (based on application of the IEUBK model) as a screening level for lead in soil for residential scenarios at CERCLA sites and at RCRA Corrective Action sites. Residential areas with soil lead below 400 ppm generally require no further action. Therefore, the cleanup level used for lead at PRS 0-016 is 400 mg/kg.

No quantitative human health risk assessment was conducted for PRS 0-016

FATE AND TRANSFER

Fate and transfer information for copper, lead and zinc are presented here. This information is from the toxicological profiles published by the Agency for Toxic Substances and Disease Registry (ATSDR). These profiles are contained in the CD-ROM distributed by ATSDR (ATSDR 1997, ER ID 56531.3).

Copper

Copper occurs in the +1 and +2 oxidation states. Most copper deposited in soil will be strongly adsorbed and remain in the upper few centimeters of soil. Copper's movement in soil is determined by a host of physical and chemical interactions of copper with the soil components. In general, the copper will adsorb to organic matter, carbonate minerals, clay minerals, or hydrous iron and manganese oxides. Sandy soils with low pH have the greatest potential for leaching (ATSDR 1990, ER ID 56531.3). The pH of the soil in the area of the PRS 0-016 varies from 6.4 to 7.4 with the average pH being 6.97, which is essentially neutral (USDA 1992, ER ID 59597). Therefore, leaching of copper would not be a great concern at this site.

Copper binds to soil much more strongly than other divalent cations, and the distribution of copper in the soil solution is less affected by pH than other metals. In a study of competitive adsorption and leaching of metals in soil columns of widely different characteristics, copper eluted much more slowly and in much lower quantities than Zn, Cd, and Ni from two mineral soils and not at all from peat soil, which contained the greatest amount of organic matter. A study looked at pH-dependent adsorption of the bivalent transition metal cations (Cd, Cu, Pb, and Zn) in two mineral soils and two soils containing considerable organic matter. Adsorption increased with pH, and Cu and Pb were much more strongly retained than Cd and Zn. Reduction in absorptivity after removal of the organic matter demonstrated the importance of organic matter in binding copper (ATSDR 1990, ER ID 56531.3).

Copper shows a pronounced solubility in soil only in the oxidizing environment; in the reducing environment, solubility is low. Above pH 6, precipitation becomes the more dominant process for removing copper from water. Copper binding in soil may be correlated with pH, cation exchange capacity, and the organic content of the soil, the presence of iron oxides, and even the presence of inorganic carbon such as carbonates. Copper may also be incorporated in mineral lattices where it is unlikely to have ecological significance. Broad generalizations are not possible since the situation will differ among different soils. In soils with a high organic carbon content, however, copper will be tightly bound to organic matter. In sediment, copper is generally associated with mineral matter or tightly bound to organic material. As is common when a metal is associated with organic matter, copper is generally associated with fine, as opposed to coarse, sediment. (ATSDR 1990, ER ID 56531.3).

The potential for plant uptake of copper is low. There is abundant evidence that there is no biomagnification of copper in the food chain (ATSDR, ER ID 56531.3).

Lead

Lead occurs in the +2 and +4 oxidation states. Lead in the +2 oxidation state has some chemical similarities to calcium (Manahan 1989, ER ID 59377, p. 105). The fate of lead in soil is affected by the specific or exchange adsorption at mineral interfaces, the precipitation of sparingly soluble solid forms of the compound, and the formation of relatively stable organic-metal complexes or chelates with soil organic matter. These processes are dependent on such factors as soil pH, and organic matter content of soil, the presence of inorganic colloids and iron oxides, ion-exchange characteristics, and the amount of lead in soil. The accumulation of lead in most soils is primarily a function of the rate of deposition from the atmosphere. Most lead is retained strongly in soil, and very little is transported into surface water or groundwater. Lead is strongly sorbed to organic matter in soil, and although not subject to leaching, it may enter surface waters as a result of erosion of lead containing soil particulates. Lead may be converted to lead sulfate at the soil surface which is relatively soluble when compared with lead carbonate or phosphate. Inorganic lead may be bound into crystalline matrices of rocks and remain essentially immobile. Lead complexes and precipitates in soil and their transformation depend on the soil type. In soil with a high organic matter content and a pH of 6-8, (which is approximately the pH of the soil at PRS 0-016) lead may form insoluble organic lead complexes; if the soil has less organic matter at the same pH, hydrous lead oxide complexes may form or lead may precipitate out with carbonate or phosphate ions. Entrainment of soil particles is another route of lead transport. The downward movement of lead from soil to groundwater by leaching is very slow under most natural conditions (ATSDR 1993, ER ID 56531.3).

Plants and animals may bioconcentrate lead but biomagnification has not been detected. Although the bioavailability of lead in soil to plants is limited because of the strong absorption of lead to soil organic matter, the bioavailability increases as the pH and the organic matter content of the soil are reduced. Lead is not biomagnified in aquatic or terrestrial food chains. (ATSDR 1993, ER ID 56531.3).

Zinc

Zinc occurs in the environment primarily in the +2 oxidation state. It dissolves in acids to form hydrated Zn+2 cations and in strong bases to form zincate anions (probably Zn[OH] 4-2) (ATSDR 1994).

Zinc sorbs strongly onto soil particulates. Zinc can occur in both suspended and dissolved forms in surface water. Dissolved zinc may occur as the free (hydrated) zinc ion or as dissolved complexes and compounds with varying degrees of stability. Suspended (undissolved) zinc may

be dissolved following minor changes in water chemistry or may be sorbed to suspended matter (ATSDR 1994, ER ID 56531.3).

The mobility of zinc in soil depends on the solubility of the speciated forms of the element and on soil properties such as cation exchange capacity, pH, redox potential, and chemical species present in soil; under anaerobic conditions, zinc sulfide is the controlling species. Since zinc sulfide is insoluble, the mobility of zinc in anaerobic soil is low. In a study of the effect of pH on zinc solubility, it was showed that when the pH is <7, an inverse relationship exists between the pH and the amount of zinc in solution. As negative charges on soil surfaces increase with increasing pH, additional sites for zinc adsorption are activated and the amount of zinc in solution decreases. The active zinc species in the adsorbed state is the singly charged zinc hydroxide species (i.e., $Zn[OH]^+$). The amount of zinc in solution generally increases when the pH is >7 in soils high in organic matter. This is probably a result of either the release of organically complexed zinc, reduced zinc adsorption at higher pH, or an increase in the concentration of chelating agents in soil. Consequently, movement towards groundwater is expected to be slow (ATSDR 1994, ER ID 56531.3).

With respect to bioconcentration of zinc from soil by terrestrial plants, invertebrates, and mammals, bioconcentration factors of 0.4, 8, and 0.6, respectively, have been reported. The concentration of zinc in plants depends on the plant species, soil pH, and the composition of the soil. Plant species do not concentrate zinc above the levels present in soil (ATSDR 1994, ER ID 56531.3).

APPENDIX F-2 ECOLOGICAL SCOPING CHECKLISTS FOR TA 0: PRS 0-016

Part A: Scoping Meeting Documentation

Site ID	PRS 0-016	
Nature of PRS releases (indicate all that apply)	**Solid** **Liquid** **Gaseous** **Other, explain**	XXXX
List of Primary Impacted Media (indicate all that apply)	**Surface soil** **Surface water/sediment** **Subsurface** **Groundwater** **Other, explain**	XXXX XXXX
Vegetation class (based on FIMAD or other available sources, indicate all classes that apply)	**Water** **Bare Ground** **Spruce/fir/aspen/mixed conifer** **Ponderosa pine** **Piñon juniper/juniper woodland** **Grassland/shrubland** **Developed**	 XXXX XXXX
Is T&E Habitat Present? **List species if applicable.** **Are there proposed activities that might impact T&E species at the site?**	Yes. This PRS is 1.7 km and 1.3 km respectively from peregrine falcon and Mexican spotted owl nesting habitat. This PRS is entirely within an area in which the peregrine falcon can be conservatively assumed to forage at a relatively high frequency (Gil Gonzales memo to Lance Voss, 22 October 1998).	
Provide list and description **of Neighboring/** **Contiguous/** **Upgradient PRSs** (consider need to aggregate PRS for screening)	Several former mortar impact areas are located in the area of Rendija Canyon including C-0-020 approximately 1500 ft west; PRS 0-011(d) approximately 2500 ft. southeast; and PRSs 0-011(c,b,a, and e) located more than a mile away to the northeast. These neighboring PRSs are sufficiently isolated with no common release, transport or exposure pathways, therefore aggregation for assessment is not indicated	
AP 4.5 Part B Information Run-off score (out of 46) Terminal point of surface water transport	PRS 0-016 has an AP 4.5 runoff score of 6.9. The terminal point of surface water transport from the vicinity of PRS 0-016 is Rendija Canyon.	

Other Scoping Meeting Notes	PRS 0-016 is the site of a former small arms firing range. Releases would include solid metal in the form of bullets. Primary impacted media during operation was surface and subsurface soil of berms and area soils. Some contamination of the "back area' may have resulted from past grading of berm material toward the valley edge

Part B: Site Visit Documentation

Site ID	PRS 0-016
Date of Site Visit	10/16/98
Site Visit Conducted by	G. McDermott, L. Voss, T. McFarland

Receptor Information:

Estimate cover	% vegetated 10% % wetland % structures/asphalt, etc. 90%	Site along north and north facing slope into canyon potentially impacted by site activities. Site is currently a gravel covered lay-down yard.
Field notes on the vegetation class		
Field notes on T&E Habitat, if applicable	See Part A.	
Are ecological receptors present at the PRS? (yes/no/uncertain) Provide explanation	No. The site of the former firing range is entirely covered by base course and serves as a construction and contractors storage or lay-down yard. Receptors would be expected in the wooded north fringe of the site including small mammals, large mammals and bird species. One squirrel and a sharp shinned hawk were sighted during the field visit. Rabbit scat as well as jawbones and vertebrae of a deer were also observed.	

Contaminant Transport Information:

Surface water transport Field notes on the terminal point of surface water transport (if applicable)	Run-off from the former firing range consolidates into a single primary drainage feature off the back area of the site. This drainage terminates in a sediment plain along the ephemeral secondary drainage leading into Rendija Canyon. There is no distinct run-off channel into the secondary drainage which is well scoured and distinct.
Are there any other off-site transport pathways? (yes/no/uncertain). Provide explanation	No. The area of the former firing range is completely covered by base course and portions have been revegetated. Therefore, there is limited potential for off-site transport from covered area and the vegetated hillside.

Ecological Effects Information:

Physical Disturbance (provide list of major types of disturbances)	The area of the former firing range is disturbed and currently used as an equipment parking or storage area.
Are there obvious ecological effects? (yes/no/uncertain). Provide explanation	No. There are no observed ecological effects associated with the former firing range. The area is developed and entirely covered with base course – no receptors are present. Ecological effects resulting from site restoration are apparent in the "back area" were successful seeding has resulted in lush mixed grass development.

No Receptor/ No Pathways:

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

The range floor area of the firing range has been remediated and covered with base course and is currently being used as a parking area for earth moving equipment. As a result, there are no pathways for exposure, no receptors present, and little potential for off-site migration. This are of the PRS is therefore proposed for an ecological NFA.

Data Adequacy:

Do existing data provide information on the nature, rate and extent of contamination? (yes/no/uncertain) Provide explanation. (consider if the maximum value was captured by existing sample data).	Yes. Extensive grid based confirmation sampling and limited biased sampling in drainage areas are adequate to define the nature, rate and extent of contamination. In addition, phased sampling and field screening should have supported the acquisition of maximally contaminated samples.
Do existing data, process knowledge or observation indicate that other areas of contamination may be influencing the PRS in question or it's area of influence? (yes/no/ uncertain) Explain.	No. There are no other areas of contamination that influence this PRS.

Additional Field Notes:

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

Storage area provides no usable ecological habitat. The "back area" down slope to the secondary drainage is heavily vegetated with grasses apparently the result of the successful re-seeding and restoration activity. This is markedly different from the surrounding Ponderosa pine ground cover which is sparsely covered with grasses and is primarily composed of pine needle duff. Tree cover in the area includes limited scrub oak and 9-12" DBH (diameter breast height) Ponderosa pine

Part C: Ecological Pathways Conceptual Exposure Model

Provide answers to Questions A to R and use this information to complete the Ecological Pathways Conceptual Exposure Model (see 1 on page 12 of the checklist)

Question A:
Could soil contaminants reach receptors via vapors?
Volatility of the hazardous substance (volatile chemicals generally have Henry's Law constant >10^{-5} atm-me/mol and molecular weight <200 g/mol).

Answer (likely/unlikely/uncertain): Unlikely
Provide explanation: Site contaminants limited to non-volatile inorganic metals

Question B:
Could the soil contaminants identified above reach receptors through fugitive dust carried in air?
Soil contamination would have to be on the actual surface of the soil to become available for dust.
In the case of dust exposures to burrowing animals, the contamination would have to occur in the depth interval where these burrows occur.

Answer (likely/unlikely/uncertain): Unlikely
Provide explanation: Contaminant source area has been removed and covered with base course. Limited downgradient area appears to be relatively unimpacted as well as well vegetated

Question C:
Can contaminated soil be transported to aquatic ecological communities via surface erosion?
Use AP 4.5 run-off score and terminal point of surface water runoff to help answer this question.
If the AP 4.5 run-off score* equal to zero, this suggests that erosion at PRS is not a transport pathway. (* note that the runoff score is not the entire erosion potential score, rather it is a subtotal of this score with a maximum value of 46 points)
If erosion is a transport pathway, evaluate the terminal point to see if aquatic receptors could be affected.

Answer (likely/unlikely/uncertain): Unlikely.

Provide explanation: Low AP 4.5 score, covered with base course and revegetated resulting in limited potential for transport off-site to aquatic communities. Ephemeral aquatic communities may be present in Rendija Canyon.

Question D:

Is groundwater contaminated and potentially available to biological receptors through seeps or springs?

Known or suspected contaminant *presence in* groundwater.

The potential for contaminants to be carried via groundwater and discharge into habitats and/or surface waters.

Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with contaminated groundwater present within the root zone (~1 m depth).

Terrestrial wildlife receptors will generally only contact groundwater if it is discharged to the surface.

Answer (likely/unlikely/uncertain): Unlikely.

Provide explanation: No perched aquifers or springs are known to exist in the immediate vicinity of the site.

Question E:

May groundwater become contaminated from infiltration/percolation from contaminated subsurface material?

Suspected ability of contaminants to *migrate to* groundwater.

The potential for contaminants to reach groundwater then discharge into habitats and/or surface waters.

Might contaminants be taken up by terrestrial and rooted aquatic plants whose roots are in contact with potentially contaminated groundwater present within the root zone (~1 m depth)?

Terrestrial wildlife receptors will generally only contact groundwater if it is discharged to the surface.

Answer (likely/unlikely/uncertain): Unlikely.

Provide explanation: Unlikely due to the depth to the regional aquifer and relative immobility of lead in soil.

Question F:

Might erosion or mass wasting events be a potential release mechanism for contaminants from subsurface materials or perched aquifers to the surface?

Consider, particularly, the erodability of fill material and the geologic processes of canyon/mesa edges.

Answer (likely/unlikely/uncertain): Unlikely.

Provide explanation: Area is not subject to mass wasting events and the contaminant source term has been removed.

Airborne contamination

(terrestrial receptors)

Question G:

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

Contaminants must be present as volatiles in the air.

Consider the importance of inhalation of vapors for burrowing animals.

Foliar uptake of organic vapors is typically not a significant pathway.

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

Terrestrial/Emergent Plants: 0

Terrestrial Animals: 0

Provide explanation: No volatile COPCs were identified at the site.

Question H:

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

Contaminants must be present as particulates in the air or as dust for this pathway to be viable.

Exposure via inhalation of fugitive dust is particularly applicable to ground-dwelling species that would be exposed to dust disturbed by their foraging or burrowing activities or by wind movement.

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

Terrestrial/Emergent Plants: 1
Terrestrial Animals: 2

Provide explanation: Much of the contamination is surficial, and air entrainment of dust particles is possible.

Soil-borne contamination
(terrestrial receptors)

Question I:
Could soil-borne contaminants reach plants via root uptake or rain splash to leaf and stem surfaces from surface soils?
Contaminants in bulk soil may partition into soil solution, making them available to roots. Exposure of terrestrial plants to contaminants present in particulates deposited on leaf and stem surfaces by rain striking contaminated soils (i.e., rain splash).

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

Terrestrial Plants: 1

Provide explanation: Source term removal has taken place and site is covered with clean base course. No source contamination is indicated in vegetated "back area".

Question J:
Could soil-borne contaminants reach receptors through food web transport from surface soils?
Consider bioaccumulation and biomagnification. See list of potentially persistent bioaccumulators and biomagnifiers, presented in Table 1.
Animals: may ingest contaminated prey.

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

Terrestrial Animals: 2

Provide explanation: Residual lead at site is a potentially persistent bioaccumulator.

Question K:
Could soil-borne contaminants interact with receptors via incidental ingestion of surface soils?
Incidental ingestion of contaminated soil may occur while animals grub for food resident in the soil, or feed on plants/animals covered with contaminated soil, or while grooming themselves clean of soil.

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

Terrestrial Animals: 1

Provide explanation: Source term removal has taken place and site is covered with clean base course. No significant source contamination is indicated in vegetated "back area".

Question L:
Could soil-borne contaminants interact with receptors through dermal contact with surface soils?
Significant exposure via dermal contact would generally be limited to organic contaminants which are lipophilic and can cross epidermal barriers.

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

Terrestrial Animals: 1

Provide explanation: Source term removal has taken place and site is covered with clean base course. No significant source contamination is indicated in vegetated "back area". **Question M:**
Could contaminants interact with plants or animals through external irradiation?
External irradiation effects are most relevant for gamma emitting radionuclides.
Burial of contamination severely attenuates radiological exposure.

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

Terrestrial Plants: 0

Terrestrial Animals: 0

Provide explanation: No radionuclides were detected at the site.

Water borne contamination

(terrestrial and aquatic receptors)

Question N:

Could water and sediment-borne contaminants reach plants via direct uptake from water and sediment or rain splash to leaf and stem surfaces from surface sediment?

Contaminants may be taken-up by terrestrial plants whose roots are in contact with surface waters.

Terrestrial plants may be exposed to particulates deposited on leaf and stem surfaces by rain striking contaminated sediments (i.e., rain splash on sediments *not* soils). in an area that is only periodically inundated with water.

Contaminants in sediment may partition into soil solution, making them available to roots.

Aquatic plants are in direct contact with water.

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

Terrestrial Plants: 1

Aquatic Plants: 1

Provide explanation: Source term removal has taken place and site is covered with clean base course eliminating vegetation. No significant source contamination is indicated in vegetated "back area".

Question O:

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

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

Animals: may ingest contaminated prey.

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

Terrestrial Animals: 1

Aquatic Animals: 1

Provide explanation: Surface water is ephemeral at the site.

Question P:

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

If sediments are present in an area that is only periodically inundated with water, terrestrial receptors may incidentally ingest sediments.

Terrestrial receptors may ingest water-borne contaminants if contaminated surface waters are used as a drinking water source.

Aquatic receptors may regularly or incidentally ingest sediment while foraging.

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

Terrestrial Animals: 1

Aquatic Animals: 1

Provide explanation: Surface water is ephemeral at the site.

Question Q:

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

If sediments are present in an area that is only periodically inundated with water, terrestrial species may be dermally exposed during dry periods.

Terrestrial organisms may be dermally exposed to water-borne contaminants as a result of wading or swimming in contaminated waters.

Aquatic receptors may be directly exposed to sediments or may be exposed through osmotic exchange, respiration, or ventilation of sediment pore waters.

Aquatic receptors may be exposed through osmotic exchange, respiration, or ventilation of surface waters.

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

Terrestrial Animals: 1

Aquatic Animals: 1

Provide explanation: The ephemeral nature of surface water at the site, and the limited residual contamination present makes this an unlikely pathway.

Question R:
Could contaminants interact with plants or animals through external irradiation via water and sediment exposure?
External irradiation effects are most relevant for gamma emitting radionuclides.
Burial of contamination severely attenuates radiological exposure.
The water column acts to absorb radiation, thus external irradiation is typically more important for sediment dwelling organisms.
Provide quantification of pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 0
Aquatic Plants: 0
Terrestrial Animals: 0
Aquatic Animals: 0

Provide explanation: No radionuclides were detected at the site.

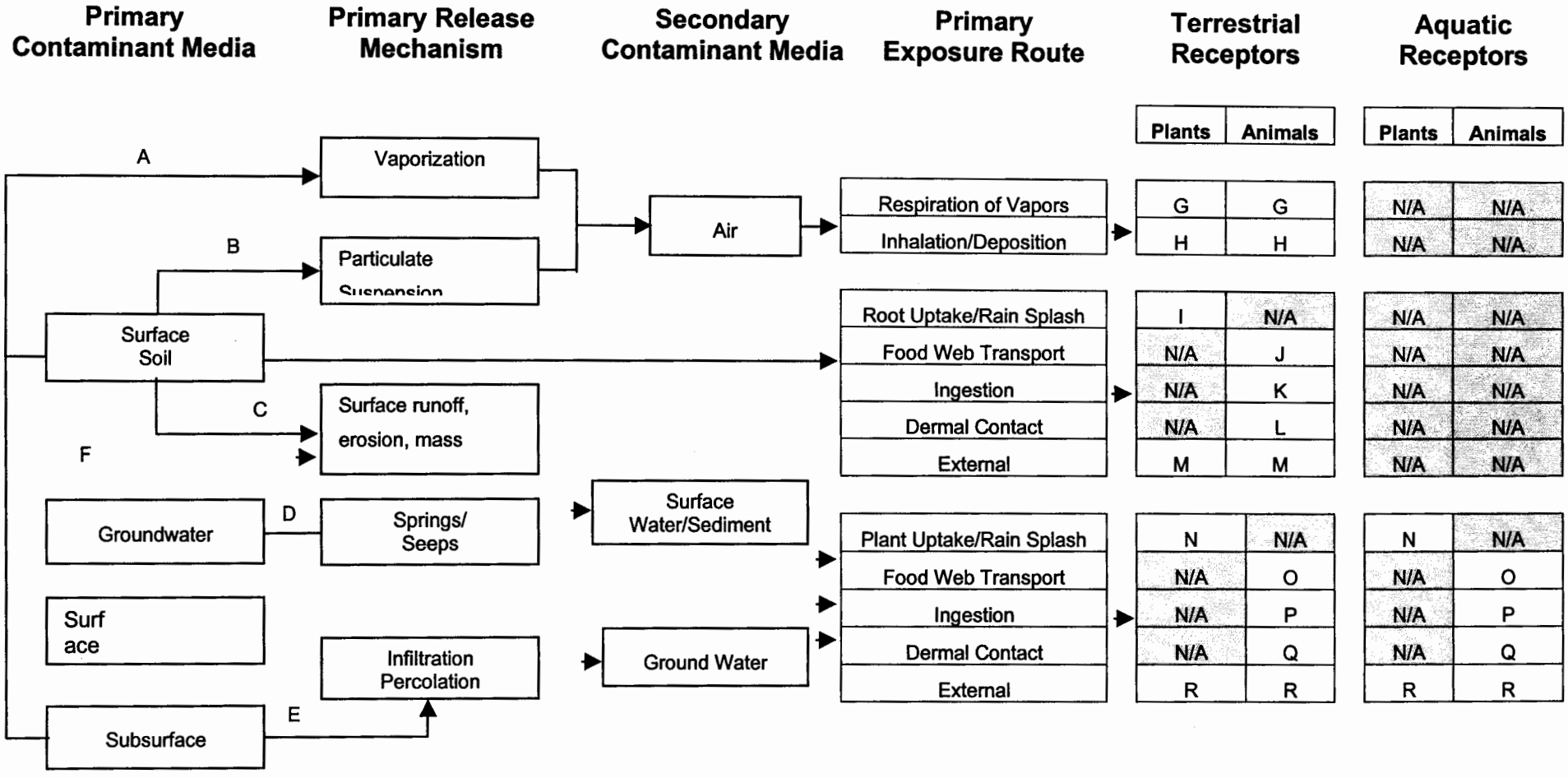
TABLE F2-2

LIST OF BIOACCUMULATING CHEMICALS

Volatile Organics	**PCBs/Pesticides**
Dichlorobenzene[1,4-]	All Aroclors
Trichlorobenzene[1,2,4-]	beta-BHC
Xylene (mixed isomers)	BHC-mixed isomers
	Chlordane
Semivolatile Organics	Chlorecone (Kepone)
Acenaphthene	DDT and metabolites
Anthracene	Dieldrin
Benzo(a)anthracene	Endosulfan
Benzo(a)pyrene	Endrin
Benzo(b)fluoranthene	Heptaclor
Benzo(g,h,i)perylene	Lindane
Benzo(k)fluoranthene	Methoxyclor
Bis(2-ethylhexyl)phthalate	Toxaphene
Butyl benzyl phthalate	
Chrysene	**Inorganics**
Dibenzo(a,h)anthracene	Aluminum
Di-n-butyl phthalate	Cadmium
Di-n-octyl phthalate	Copper
Fluoranthene	Lead
Fluorene	Mercury
Indeno(1,2,3-cd)pyrene	Nickel
Phenanthrene	Selenium
Pyrene	
Pentachloronitrobenzene	**Radionuclides**
Pentachlorophenol	Americium-241
	Cesium-137
Dioxins/Furans	Plutonium-238,239,240
Dibenzofuran	Radium-226,-228
2,3,7,8-tetrachloro-dibenzo(p)dioxin	Strontium-90
2,3,7,8-tetrachloro-dibenzo(p)furan	Thorium-228,-230,-232
	Uranium-234,-235,-238

FIGURE F2-1 Ecological Scoping Checklist

Ecological Scoping Checklist
Ecological Pathways Conceptual Exposure Model



Signatures and certifications:

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

Name (printed):	Lance Voss
Name (signature):	
Organization:	Neptune and Company, Inc.
Phone Number:	(505) 662-0730, Ext. 23
Date Completed:	10/16/98

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

Name (printed):	Greg McDermott
Name (signature):	
Organization:	Neptune and Company, Inc.
Phone Number:	(505) 662-0707, Ext. 21

ER ID= 57846

Los Alamos National Laboratory

ESH-20, Ecology Group
P.O. Box 1663, Mail Stop M887
Los Alamos, New Mexico 87545
(505) 665-6630/ FAX: (505) 667-0731

Date: October 22, 1998
Refer to: ESH-20/Ecol-99-0019

Lance Voss
Neptune & Company, Inc.
1505 15th Street, Suite B
Los Alamos, NM 87544

Dear Lance Voss:

SUBJECT: Review of PRS # 00-016 for Threatened and Endangered Species Habitat for the Purpose of Ecological Screening/Risk Assessment.

Resulting from your request, the purpose of this memo is to communicate whether threatened and endangered (T&E) species may be present in or adjacent to Environmental Restoration Potential Release Sites (PRS's) that are under consideration for ecological screening and/or risk assessment. Information about species present will help

(1) to establish whether contaminant pathways might exist to T&E species nesting within or in the vicinity of a PRS,
(2) to determine whether there are proposed activities relating to the ecoscreen/risk assessment that might impact T&E species at the PRS,
(3) to notify risk assessors, when necessary, to pay particular attention to relevant contaminant Ecological Screening Levels primarily for birds, and
(4) to notify risk assessors, when necessary, to pay particular attention to PRS aggregation issues relative to foraging patterns of T&E species.

Information about PRS 00-016 was reviewed to determine whether or not this site is in or near federally-listed T&E nesting habitat, in a Foraging Area and, if so, to indicate the relative amount of time spent foraging that can be expected at or in the vicinity of the specific PRS.

PRS location information maintained by FIMAD was intersected with T&E species habitat using GIS databases maintained by the Ecology Group, ESH-20. PRS 00-016 is 1.7 km from peregrine falcon nesting habitat and 1.3 km from Mexican spotted owl nesting habitat. The PRS is entirely within an area in which the peregrine falcon can be conservatively assumed to forage at a high frequency.

Your request did not propose any ground-disturbing activities.

If you need more detailed or extensive information, please do not hesitate to contact me.

Sincerely,

Gil Gonzales, Ph.D.
Biology Team Leader
Ecology Group

Cy: Elizabeth Kelly, TSA-11, K557
Jill Podolsky, ESH-20, MS M887
Steve Koch, ESH-20, MS M887

APPENDIX G ADMINISTRATIVE HISTORY

G-1.0 Summary of Administrative History of PRS 0-016

This appendix contains a history of activities presented in Table G-1.0 and supporting documentation.

TABLE G-1.0

ADMINISTRATIVE HISTORY AT PRS 0-016

Time	Activity
1947- early1960s	Atomic energy commission security personnel use site as small arms firing range.
Early 1960s-1992	Public uses site for recreational shooting.
1987	CEARP[1] survey of the site.
1991	USDA Forest Service conducts a study of the site by testing for lead in the firing range berms.
April 13, 1992	USDA Forest Service appraises National Response Center, US Coast Guard, of inactive firing range.
September 4, 1992	USDA Forest Service requests information and assistance from LANL
1992	Fence installed around PRS 0-016 by Johnson Controls International.
1993	USDA Forest Service agrees to transfer land to a private land developer.
May 1993	Verbal approval of VCA given by EPA and NMED at monthly meeting with LANL ER.
September 1993	VCA Plan proposing soil washing, revisions 0,1,and 2.
September 1993	Mobilization for soil washing operation began.
October 4, 1993	Notice of Intent (NOI) temporary permission granted by NMED.
October 15, 1993 – November 1, 1993	Back area is screened with metal detectors.
December 3, 1993	NOI temporary permission to discharge from 3/15/94 to 7/12/94 granted by NMED
January 12, 1994	Notice of Deficiency (NOD) for VCA Plan, revision 2, from EPA.
January 20, 1994	NMED grants permission to begin discharging on March 15, 1994.
February 7, 1994	VCA Plan proposing soil washing, revision3.
February 24, 1994	Response to NOD of VCA Plan.
February 1994	NMED gives verbal approval of VCA Plan.
1994	Site added to the HSWA Module.
March 14 – 15, 1994	Public Information Tours conducted.
April 1, 1994 – September 12, 1994	Extensive metal detector survey was conducted in back area.
April 29, 1994	EPA letter advising revised VCA Plan is acceptable as long as final report on remediation and confirmation analysis is submitted to EPA within 60 of receipt of analytical data.
May 9, 1994 - October 18, 1994	Soil washing operations were conducted, then shut down for winter.
July 1, 1994	Amendment to Forest Service Special Use Permit for Operable Unit (OU) 1071 allowing expansion of remediation into back area.
August 23, 1994	NMED advises that no discharge plan is required for soil washing activities because discharge conforms to ground water standards and does not contain any toxic pollutants as defined in WCCC Reg. 1-101.UU.
October 7, 1994	Forest Service Special Use Permit effective 11/94 to 11/95 to implement VCA Plan revision 0.

Table G-1.0
Administrative History At PRS 0-016

Time	Activity
April 10, 1995	Remobilization of soil washing operations following winter shutdown.
April 18, 1995	DOE/LANL request to move soil to firing range at TA-72 for needed berm material.
May 17, 1995	NMED letter indicates willingness to authorize use of lead contaminated material as berm/backstop material at TA-72 firing range pending additional information.
May 17, 1995 – June 6, 1995	Remobilization of soil washing operations discontinued and subsequently disassembled for final demobilization.
July 6, 1995	LANL responds to request for additional information regarding use of lead contaminated material as berm/backstop material at TA-72 firing range.
September 29, 1995	Federal Register Notice of Termination of Coverage Under a NPDES General Permit for Storm Water Discharges.
October 10, 1995	EPA recommends NMED deny LANL's request to authorize use of lead contaminated material as berm/backstop material at TA-72 firing range.
December 1, 1995	Meeting with NMED/HRMB to discuss site history/activities and site tour.
April 1996	Shaker Plant Pilot Study conducted.
July 1996 – September 1996	Shaker Plant operations conducted. 7,000yd^3 of feedstock processed yielding 1,235 yd^3 of bullet-size material.
May 1996	Right-of-Way confirmation samples collected.
September 1996	Range-floor confirmation samples collected.
March 1997	Final Range Floor confirmation samples collected following remobilization of Shaker Plant and final processing with crusher and vacuum.
January 1997 – March 1997	Impact crusher operation is conducted; material reduced from 1,200 to 80 cubic yards.
March 1997	Vacuum separation is conducted.
May 1997	LANL conducts a surface water assessment of the site.
August 1997	Back Area confirmation samples collected.
1997 to present	Private land developer regrades site and uses as construction staging area
September 1997	VCA Completion Report submitted to NMED
July 1, 1998	Rejection of VCA Completion Report by NMED

[1] CEARP = Comprehensive Environmental Assessment and Response Program.

57597

United States Department of Agriculture
Forest Service
Santa Fe National Forest
P.O. Box 1689
Santa Fe, NM 87504
505 988-6940

Reply To: 7400

Date: April 13, 1992

National Response Center
United States Coast Guard Headquarters
Rm 2611
2100 2nd St. SW
Washington, DC. 20593

To Whom it May Concern,

The Santa Fe National Forest is writing to advise you of a situation occurring on lands currently being administered by the Santa Fe National Forest. These lands were previously withdrawn from the Santa Fe National Forest by the Department of War in connection with the Manhattan Project, and were most recently managed by the Department of Energy as a shooting range. These lands are currently under consideration for exchange. The future use of the site could potentially be a residential area.

The Forest Service is providing this information pursuant to 42 U.S.C. 9663. As suggested by 40 CFR 300.405(d), the following information is being provided:

a) The site is referred to as the Cemetery Tract Shooting Range. It is located on Santa Fe National Forest administered lands. The site is adjacent to the City of Los Alamos, in Los Alamos County, New Mexico. The legal description is T19N, R6E, SE 1/4 of Section 4.

b) The type of material present on the site is lead slugs from small arms ammunition.

c) The size of the material ranges from large caliber bullets to grain size fragments. It is estimated that there are several tons of lead slugs in approximately 870 Cubic Yards of potentially contaminated material.

d) The shooting range has been in use since the early 1940's when the site was withdrawn from the Santa Fe National Forest by the Department of War for the Manhattan Project.

e) The DOE released the shooting area and adjacent land back to the National Forest in 1976, after it had been out of service for a while. The site has been used unofficially by the general public in the intervening years. Since that release to the National Forest the DOE declared this site a Solid Waste Management Unit (SWMU).

Since this site was declared a SWMU, it was required that we run a Total Concentrate Leaching Procedure (TCLP) test on soil samples from the site. We question how well this test replicates the natural conditions of the Cemetary Tract since no other waste was apparent, and the site has not been used as a landfill or dump to the best of our knowledge. Preliminary tests of soil samples collected from the site resulted in 11 out of 21 samples failing the TCLP test for leachability of heavy metals. This process is EPA's litmus test for contaminated soil to indicate if enough heavy metal is present to be leached under certain acidic conditions. The acidic level used in the test ranges from a pH of 2.83 to 2.92. In this instance, the samples that failed the test were from backstop berms in the old shooting range.

The TCLP test may be valid for sites that are located in areas or regions that have acid rains, acid dry deposition, or naturally high acid soil conditions, within close proximity to water. However, this is not the case for the old shooting range at Los Alamos. There is a deposit of lead slugs at the site that will leach sufficient amounts of lead to fail the TCLP test when subjected to an artificial acidic condition. The on-site soils at the old shooting range vary in pH from 6.4 to 7.4, with the average pH being 6.97 which is essentially neutral. Therefore, leaching of the lead shot is not likely unless some drastic change occurs at the site.

Possible ground water contamination is an issue raised by the New Mexico Environmental Department and the Environmental Protection Agency. The shooting range is located on top of a small ridge that is composed of the top member of the Bandelier Tuff (Tshirege Member), with associated soils. The thickness of this volcanic unit is about 600 feet. The Bandelier overlies the Puye Formation which is lithic tuff and lahar (mud flow) unit, which is about 700 feet thick. Both of these units overlie the Santa Fe Formation that is an arkosic sediment. The Santa Fe Formation would be the unit that would be the ground water bearing unit. It is unlikely that this unit would ever be adversely effected by the lead shot deposit setting about 1,300 feet above. It is possible, but unlikely, that a stratified water table would exist between the shooting range and the Santa Fe Formation.

The Forest Service, however, takes the position that a Comprehensive Environmental Response Liability and Compensation Act (CERCLA) release of a reportable quantity of a hazardous substance has not occurred at the site for the following reasons:

1) The ammunition is exempt from CERCLA requirements due to the consumer product exemption (42 USC 9601(a)).

2) The lead particles of the size found at the site are not required to be reported by 40 CFR 302.6(d).

3) The TCLP test does not replicate leachability found under the natural conditions occurring at this site.

Until we are advised otherwise, we will assume that we have complied with any possible 42 USC 9603 reporting requirements. We will also assume that until otherwise notified, the Cemetery Tract Shooting Range site will not be registered with the NRC or listed on the Federal Agency Hazardous Waste Compliance Docket. The national ramifications of this situation would be extraordinary since every formal and informal shooting range would be required to be reported under 42 USC. 9603.

Recognizing the potential use of the site, and it's current designation as a SWMU, it is the intention of the Forest Service to work with the Department of Energy to address how to best contain the material prior to the land being exchanged. Final disposition of this matter can not be resolved until there is an official resolution to CERCLA concerns.

If EPA does not agree with the position outlined in this notice, please notify me within 30 days.

Al Defler
FOREST SUPERVISOR

cc: OGC (Pitt)
DOE
RO ENG (H.Kringler)
Espanola Ranger District
EPA Region 6 (J. Burleson)
City of Los Alamos

RECEIVED SEP 18 1992

Jn d States Government ER ID 09803.2 **Department of Energy**

nemorandum

Albuquerque Field Office
Los Alamos Area Office
Los Alamos, New Mexico 87544

DATE: SEP 16 1992

REPLY TO ATTN OF: LESH:6SS-047

SUBJECT: Information Request from Forest Service

TO: Thomas Gunderson, EM-DO, LANL, MS K491

Attached is an information request from the Forest Service, which demands a response within 30 days of receipt, which will be October 10, 1992.

Please arrange for appropriate members of your staff to meet with Steve Slaten in his office at 9:00 a.m. on September 24, 1992, to discuss this request.

Joseph C. Vozella, Acting Chief
Environment, Safety and Health
Branch

Attachment

cc w/attachment:
Kelly Bitner, ERPO, AL
Allen Tiedman, ADO, LANL,
MS A120
Cheryl Mack, LC-General,
LANL, MS A187
Robert Vocke, EM-13, LANL,
MS M992
James Shipley, EE-AETO, LANL,
MS F641
David McInroy, EM-8, LANL, M992
~~MS K490~~
Jim Aldrich, EES-1, LANL,
MS D462

United States Department of Agriculture
Forest Service
Southwestern Region
517 Gold Avenue SW.
Albuquerque, NM 87102-0084
FAX: (505) 842-3800

ER ID 09803.3

Reply to: 7470

Date: SEP 4 1992

Jerry L. Bellows, Area Manager
Los Alamos Office
U.S. Department of Energy
528 35th Street
Los Alamos, NM 87544

CERTIFIED MAIL - RETURN
RECEIPT REQUESTED

Re: Request for Information Pursuant to CERCLA Section 104 (42 U.S.C. 9604) for the Cemetery Tract Land Exchange, section 4, T.19 N., R.6 E. (Los Alamos National Laboratory - Environmental Restoration Program Operable Unit 1071 - SWMU 0-016 inactive Firing Range), Espanola Ranger District, Santa Fe National Forest, Los Alamos County, New Mexico.

Dear Mr. Bellows:

The Forest Service, an agency within the United States Department of Agriculture, is currently investigating the source, extent, and nature of the release or threatened release of hazardous substances and/or wastes on or about the above-described proposed Cemetery Tract Land Exchange on the Espanola Ranger District, Santa Fe National Forest (Site). Our records indicate that the Site was operated by your agency and the Department of Defense from the 1940's to the 1960's. This investigation requires inquiry into the identification, nature, and quantity of materials that have been or are generated, treated, stored, released, or disposed of at, or transported to, the Site and the nature or extent of a release or threatened release of a hazardous substance at or from the Site.

This investigation is being conducted because of the land transfer requirements in section 120(h) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; 42 U.S.C. 9620(h)). The Forest Service also is seeking information relating to the willingness of your agency to assist in paying for, or to perform the required section 120(h) cleanup of the Site. Although the Forest Service does not admit that a 42 U.S.C. 9603 "release" has occurred, the National Response Center was "notified" of this situation by letter dated April 13, 1992 (enclosed as Enclosure B).

Pursuant to its authority under Section 104 of CERCLA, 42 U.S.C. 9604, Federal Executive Order 12580, and Title 7, Code of Federal Regulations, section 2.60 et seq., the Forest Service hereby requests you respond to the Information Request set forth in Enclsoure A, enclosed hereto within 30

20002154
US DOE/LAAO

days of the receipt of this letter. This Information Request is not subject to the approval requirements of the Paperwork Reduction Act of 1980, 44 U.S.C. 3501 et seq. Your response to this Information Request should be mailed to the address above.

As you know, compliance with the Information Request set forth in Enclosure A is mandatory. Although the Forest Service recognizes the budgetary concerns of your agency, clean up of the Cemetery Tract is a high priority for the Santa Fe National Forest as the Tract will soon be adjacent to a residential development, with concomitant risks to local populations, especially children. Therefore, despite your other priorities, (see Enclosure C, February 4, 1992 letter from Bellows to Jolly), the Forest Service strongly encourages you to give this matter your immediate attention and to respond to this Information Request within the time specified above.

If you have any technical questions relating to this Information Request, you may consult with the Forest Service prior to the time specified above. Technical questions should be directed to Dennis Inman (505) 842-3152 or Harry Kringler (505) 842-3829 at the above address. Your legal counsel may discuss this matter with Kenneth P. Pitt, USDA Office of General Counsel, 1405 Curtis Street, Suite 1450, Denver, CO, 80202 (303) 844-4031.

Sincerely,

LARRY HENSON
Regional Forester

Enclosures 4

cc:
ENG (A. Marty)
OGC-Denver (K. Pitt)
Santa Fe NF:R03F10A
Espanola RD:R03F10D06A
ENG (R.Bye)
(H.Kringler)
LM (D.Inman)

ENCLOSURE A

Definitions: The following definitions shall apply to the following words as they appear in this Enclosure.

1. The term "you" or "Respondent" shall mean the addressee of this Request, the addressee's officers, managers, employees, contractors, trustees, partners, successors, assigns, and agents.

2. The term "person" shall have the same definition as in Section 101(21) of CERCLA, 42 U.S.C. 9601(21).

3. The term "Site" shall mean and include the property on or about the proposed Cemetery Tract Exchange, section 4, T.19 N., R.6 E, SWMU 0-016, on the Espanola Ranger District, Santa Fe National Forest, in Los Alamos County, New Mexico, and any areas adjacent to or near this property that has been, or may have been, impacted by hazardous substances, wastes, pollutants or contaminants.

4. The term "hazardous substance" shall have the same definition as that contained in Section 101(14) of CERCLA, 42 U.S.C. 9601(14), and includes any mixtures of such hazardous substances with any other substances, including petroleum products. The known hazardous substances at the Site are lead metal from the shooting range.

5. The term "hazardous waste" shall have the same definition as that contained at 42 U.S.C. 6903(5).

6. The term "identify" means, with respect to a natural person, to set forth the person's name, present or last known business address and business telephone number, present or last known job title, position or business.

7. The term "identify" means, with respect to a document, or asset, to provide its location, worth, customary business description, its date, its number if any (invoice or purchase order number), and the substance or the subject matter.

8. The term "release" has the same definition as that contained in Section 101(22) of CERCLA, 42 U.S.C. 9601(22), and includes any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment, including the abandonment or discharging of barrels, containers, and other closed receptacles containing any hazardous substance, waste, pollutant or contaminant.

9. The term "disposal" has the same definition as that contained in Section 101(29) of CERCLA, 42 U.S.C. 9601(29) and Section 1004(3) of RCRA, 42 U.S.C. 6903(3), and includes the "discharge, injection, dumping, spilling, leaking, or placing of any . . . hazardous waste into or on any land or water so that such . . . . waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any wastes, including ground waters."

10. The terms "document" and "documents" shall mean any writing, recording, or stored information and includes, but is not limited to, writings of any kind, formal or informal, whether or not wholly or partially in handwriting, including by way of illustration and not by way of limitation, any invoice, manifest, bill of lading, receipt, enforcement, check, bank draft, canceled check, deposit slip, withdrawal slip, order, correspondence, record book, minutes, memorandum of telephone and other conversations including meetings, agreements and the like, diary, calendar, desk pad, scrapbook, notebook, bulletin, circular, form, pamphlet, statement, journal, postcard, letter, telegram, telex, report, notice, message, analysis, comparison, graph, chart, interoffice or intra-office communications, photostat or other copy of any documents, microfilm or other film record, any photograph, sound recording on any type of device, any punch card, disc or disc pack; any tape or other type of memory generally associated with computers and data processing (together with the programming instructions and other written material necessary to use such punch card, disc, or disc pack, tape or other type of memory and together with printouts of such punch card, disc, or disc pack, tape or other type of memory), and (a) every copy of each document which is not an exact duplicate of a document which is produced, (b) every copy of each document which has any writing, figure or notation, annotation or the like on it, (c) drafts, (d) enclosures to or enclosures with any document and (e) every document referred to in any other document.

11. The terms "and" and "or" shall be construed either disjunctively or conjunctively as necessary to bring within the scope of this Request any information which might otherwise be construed to be outside its scope.

12. The term "arrangement" means every separate contract or other agreement between two or more persons.

13. The term "transaction" or "transact" means any sale, transfer, giving, delivery, change in ownership, or change in possession, administration, or jurisdiction.

14. Words in the masculine shall be construed in the feminine, and vice versa, and words in the singular shall be construed in the plural, and vice versa, where appropriate in the context of a particular question or questions.

15. The term "property interest" means any ownership or operating interest in real, personal or usufructury property regardless of where located, including but not limited to, any ownership interest in real or personal property, mining, millsite, tunnelsite claims whether patented or unpatented, mineral rights, leased, outstanding, or reserved mineral rights, water rights, any easements or rights of way, any interest in the rental of property, any interest in any corporation or partnership, and/or any interest as either the trustee or beneficiary of any trust.

16. The term "analysis" means any sampling, testing or other measurement of any physical or chemical property or content, by any person or by any method. The term includes, but is not limited to, measurement of weight, mass, volume, density, temperature, corrosivity, reactivity, ignitability, extraction procedure toxicity, or chemical content.

17. The term "natural resources" shall have the same definition set forth at Section 101(16) of CERCLA, 42 U.S.C. 9601(16), and means "land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources".

18. All terms not defined herein shall have their ordinary meaning, unless such terms are defined in CERCLA, 42 U.S.C. 9601, et seq, or the regulations found at 40 C.F.R. Part 300 et seq, in which case the statutory or regulatory definitions shall apply.

QUESTIONS

1. Identify the person(s) answering these questions on behalf of Respondent.

2. Please indicate the name, title, rank, address, and phone number of the individual to whom any future correspondence regarding this matter should be directed.

3. For each and every question contained herein, identify all persons consulted in the preparation of the answer.

4. For each and every question contained herein, identify documents consulted, examined, or referred to in the preparation of the answer, or that contain information responsive to the question and provide accurate copies of all such documents.

5. If you have reason to believe that there may be persons able to provide a more detailed or complete response to any question contained herein or who may be able to provide additional responsive documents, please identify such persons and the additional information or documents that they may have.

6. For each and every question contained herein, if information or documents responsive to this Information Request are not in your possession, custody or control, then identify the persons from whom such information or documents may be obtained.

7. Identify all property interests and/or other activities by which Respondent's are related to past or present operations of the Site.

8. Identify all legal authorities by which Respondent operated or otherwise had property interests at the site.

9. Identify the bounds and nature of each and every property interests listed in response to the preceding Requests.

10. Identify all activities associated with Respondent's operation of all or a portion of the Site, including but not limited to operating a shooting range, training activities, excavation, unearthing, uncovering, digging, placement, disposal, and movement of rock and/or soil in and around the Site.

11. Identify the history and chronology of Respondent's operation of all or a portion of the Site.

12. Describe the acts or omissions of any persons, other than your employees, agents, or those persons with whom you had a contractual relationship, that may have caused the release or threat of release of hazardous substances at or near the site.

In addition:

a. Describe the care you exercised with respect to the hazardous substances and/or wastes found at the site.

b. Describe all precautions that you took against foreseeable acts or omissions of any such third parties and the consequences that could foreseeably result from such acts or omissions.

13. Identify all persons, including Respondent's employees, who have knowledge, information or documents about the generation, use, purchase, treatment, storage, disposal, transportation, or other handling of one or more hazardous substance to the site.

14. To the extent not identified in the previous question, identify any other persons who may have knowledge of the Site.

15. Describe all contractual relationships, formal or informal business relationships, or other arrangements that Respondent may have or may have had concerning any activities on this Site.

16. Provide all existing technical or analytical information about the site, including, but not limited to, data and documents relating to the presence, absence, nature, movement or environmental effects of lead shot, metals or compounds, or any other hazardous substances and or wastes from or on the Site.

17. To the extent not already identified and provided, identify and provide all existing information and documents relevant to why, and when the Site was listed as a Solid Waste Managment Unit.

18. To the extent not already provided, provide and identify the coordinates and elevations of all test wells drilled, or other monitoring or testing activities conducted, to date.

19. Identify all persons, including you, who may have operated, excavated, unearthed, transported, disposed of, arranged for, released, or otherwise handled hazardous substances and/or wastes at, on, or from the Site.

In addition:

a. State the dates on which such persons may have handled each such item or material;

b. Identify the persons and employees who handled or generated such item or material;

c. Describe the nature of the operations involved in the handling of such item or material.

d. Provide all documents or other information of which you are aware relating to the sources, disposal, and/or release of hazardous substances and/or wastes at or from the Site.

20. State whether you caused or contributed in any way whatsoever to the release or threatened release of any hazardous substance and/or waste at the site. If yes, describe the release or threatened release and how you caused it.

21. Identify each and every injury to natural resources at or around the Site of which you or your employees were or are aware.

22. Identify each and every injury to natural resources resulting from the release of a hazardous substance on or from the Site and the person(s) responsible for that release.

23. Provide all documents or other information of which you are aware relating to the investigation, discussion, or mention of potential injuries to natural resources resulting from the mining operations and associated activities at the Site.

24. Provide copies of financial records which document fees or other compensation paid or received for use of property interests and/or other activities through the date of transfer or ceasing of your operations at the site.

25. To the extent not requested above, identify all other documents which may be relevant to respondent's activities at the Site.

26. Briefly describe each and every document you decline to provide, and the reasons therefore.

United States Department of Agriculture
Forest Service
Santa Fe National Forest
P.O. Box 1689
Santa Fe, NM 87504
505 988-6940

Reply To: 7400

Date: April 13, 1992

National Response Center
United States Coast Guard Headquarters
Rm 2611
2100 2nd St. SW
Washington, DC. 20593

To Whom it May Concern,

The Santa Fe National Forest is writing to advise you of a situation occurring on lands currently being administered by the Santa Fe National Forest. These lands were previously withdrawn from the Santa Fe National Forest by the Department of War in connection with the Manhattan Project, and were most recently managed by the Department of Energy as a shooting range. These lands are currently under consideration for exchange. The future use of the site could potentially be a residential area.

The Forest Service is providing this information pursuant to 42 U.S.C. 9663. As suggested by 40 CFR 300.405(d), the following information is being provided:

a) The site is referred to as the Cemetery Tract Shooting Range. It is located on Santa Fe National Forest administered lands. The site is adjacent to the City of Los Alamos, in Los Alamos County, New Mexico. The legal description is T19N, R6E, SE 1/4 of Section 4.

b) The type of material present on the site is lead slugs from small arms ammunition.

c) The size of the material ranges from large caliber bullets to grain size fragments. It is estimated that there are several tons of lead slugs in approximately 870 Cubic Yards of potentially contaminated material.

d) The shooting range has been in use since the early 1940's when the site was withdrawn from the Santa Fe National Forest by the Department of War for the Manhattan Project.

e) The DOE released the shooting area and adjacent land back to the National Forest in 1976, after it had been out of service for a while. The site has been used unofficially by the general public in the intervening years. Since that release to the National Forest the DOE declared this site a Solid Waste Management Unit (SWMU).

Since this site was declared a SWMU, it was required that we run a Total Concentrate Leaching Procedure (TCLP) test on soil samples from the site. We question how well this test replicates the natural conditions of the Cemetary Tract since no other waste was apparent, and the site has not been used as a landfill or dump to the best of our knowledge. Preliminary tests of soil samples collected from the site resulted in 11 out of 21 samples failing the TCLP test for leachability of heavy metals. This process is EPA's litmus test for contaminated soil to indicate if enough heavy metal is present to be leached under certain acidic conditions. The acidic level used in the test ranges from a pH of 2.83 to 2.92. In this instance, the samples that failed the test were from backstop berms in the old shooting range.

The TCLP test may be valid for sites that are located in areas or regions that have acid rains, acid dry deposition, or naturally high acid soil conditions, within close proximity to water. However, this is not the case for the old shooting range at Los Alamos. There is a deposit of lead slugs at the site that will leach sufficient amounts of lead to fail the TCLP test when subjected to an artificial acidic condition. The on-site soils at the old shooting range vary in pH from 6.4 to 7.4, with the average pH being 6.97 which is essentially neutral. Therefore, leaching of the lead shot is not likely unless some drastic change occurs at the site.

Possible ground water contamination is an issue raised by the New Mexico Environmental Department and the Environmental Protection Agency. The shooting range is located on top of a small ridge that is composed of the top member of the Bandelier Tuff (Tshirege Member), with associated soils. The thickness of this volcanic unit is about 600 feet. The Bandelier overlies the Puye Formation which is lithic tuff and lahar (mud flow) unit, which is about 700 feet thick. Both of these units overlie the Santa Fe Formation that is an arkosic sediment. The Santa Fe Formation would be the unit that would be the ground water bearing unit. It is unlikely that this unit would ever be adversely effected by the lead shot deposit setting about 1,300 feet above. It is possible, but unlikely, that a stratified water table would exist between the shooting range and the Santa Fe Formation.

The Forest Service, however, takes the position that a Comprehensive Environmental Response Liability and Compensation Act (CERCLA) release of a reportable quantity of a hazardous substance has not occurred at the site for the following reasons:

1) The ammunition is exempt from CERCLA requirements due to the consumer product exemption (42 USC 9601(a)).

2) The lead particles of the size found at the site are not required to be reported by 40 CFR 302.6(d).

3) The TCLP test does not replicate leachability found under the natural conditions occurring at this site.

Until we are advised otherwise, we will assume that we have complied with any possible 42 USC 9603 reporting requirements. We will also assume that until otherwise notified, the Cemetery Tract Shooting Range site will not be registered with the NRC or listed on the Federal Agency Hazardous Waste Compliance Docket. The national ramifications of this situation would be extraordinary since every formal and informal shooting range would be required to be reported under 42 USC. 9603.

Recognizing the potential use of the site, and it's current designation as a SWMU, it is the intention of the Forest Service to work with the Department of Energy to address how to best contain the material prior to the land being exchanged. Final disposition of this matter can not be resolved until there is an official resolution to CERCLA concerns.

If EPA does not agree with the position outlined in this notice, please notify me within 30 days.

Al Defler
FOREST SUPERVISOR

cc: OGC (Pitt)
DOE
RO ENG (H.Kringler)
Espanola Ranger District
EPA Region 6 (J. Burleson)
City of Los Alamos

Department of Energy
Field Office, Albuquerque
Los Alamos Area Office
Los Alamos, New Mexico 87544

ER ID 09803.14

RECEIVED USFS
FEB-4 1992
REGION 3
Lands and Minerals

Mr. David F. Jolly, Regional Forester
U. S. Department of Agriculture
Forest Service
Southwestern Region
517 Gold Avenue, SW
Albuquerque, NM 87102-0084

Dear Mr. Jolly:

The Department of Energy (DOE), Los Alamos Area Office (LAAO), has received your December 6, 1991 letter regarding the Cemetery Tract Land Exchange. At this time I believe that a letter of this nature, a joint DOE and Forest Service letter to the Environmental Protection Agency, is not appropriate. There still remains a great deal of research by my staff to determine the viability of the removal option to the on-site firing range. Also, the LAAO and the Forest Service need to investigate and determine if other remediation opportunities exist for the Cemetery Tract Solid Waste Management Unit (SWMU).

The DOE's Environmental Restoration Program has limited resources that must first be devoted to SWMUs posing imminent threats to human health and the environment and compliance with environmental laws and permits. At this time the Cemetery Tract SWMU does not pose a threat of this nature and is not one of our highest priorities. However, the DOE will be investigating this site in the future.

If you have any questions regarding this issue, please contact Steve Slaten of my staff at (505) 665-5050.

Sincerely,

Jerry L. Bellows
Area Manager

LESH:1SS-005

2cc: Santa Fe.
cc: Eng. (A. Poeter
FAX'D cc: Paul Parker 2
NM: Rodham L.

C-1

ER ID = 28989

Los Alamos

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

DATE: September 23, 1993
IN REPLY REFER TO: EM-13:93-A144
MAIL STOP: M992
TELEPHONE: (505) 665-4230

Mr. Ted Taylor, Program Manager
Department of Energy
Los Alamos Area Office, A316
Los Alamos, NM 87545

Dear Mr. Taylor:

SUBJECT: REQUEST FOR APPROVAL TO BEGIN OPERABLE UNIT (OU) 1071 VOLUNTARY CORRECTIVE ACTION AT FORMER SMALL ARMS RANGE

Request that permission be given to conduct voluntary corrective action at former small arms range (solid waste management unit 0-016). The Environmental Protection Agency, and New Mexico Environment Department verbally approved the project at the May 1993 Environmental Restoration Program monthly meeting with these agencies. The attendees at the meeting were all provided a summary page that describes the soil washing process to be used at the site and the overall operation.

This will be funded from the Fiscal Year 94 allocation for OU 1071.

Sincerely,

Jim Aldrich
Programmatic Project Leader

JA/vvm

Enclosure: Field Work Approval Form

Cy: J. Shipley, EE-AETO, MS F641
T. Gunderson, EM-DO, MS J591
R. Vocke, EM-13, MS M992
P. Aamodt, EM-13, MS M992
L. Soholt, EM-13, MS M773
P. Treat, DOE-LAAO, MS A316
RPF, MS M707
CRM-4, MS A150

FIELD WORK APPROVAL FORM

This form must be completed prior to starting site characterization field work in Operable Units that do not have an Environmental Protection Agency-approved work plan.

I _____, DOE-LAAO, hereby APPROVE the field work as proposed in the accompanying memorandum for Operable Unit 1071 and as described in the DOE-approved voluntary corrective action plan for SWMU 0-016.

I _____, DOE/LAAO, DO NOT APPROVE the field work as proposed for Operable Unit 1071.

The reasons for disapproval are:

Signed: _____ Date: _____

ER ID = 57106.42

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

STATE OF NEW MEXICO
ENVIRONMENT DEPARTMENT

October 4, 1993

Jim Aldrich
LANL ER
c/o ERM Management Company
555 Oppenheimer, Suite 100
Los Alamos, New Mexico 87544

RE: Temporary Permission for 120 Days,
LANL Inactive Firing Range

Dear Mr. Aldrich:

Your Notice of Intent dated September 30, 1993 requested permission to discharge for a period not to exceed 120 days at LANL Environmental Restoration SWMU 0-016, Inactive Firing Range. The facility is located west of Guaje Pines Cemetery in Los Alamos, Los Alamos County.

The discharge is described as follows:

Soil washing apparatus will discharge water containing fine grained sediment into a lined holding pond. The soil washing apparatus is designed to remove lead from soil. After the completion of soil washing, water will be allowed to evaporate and lead will be placed in 55 gallon drums and transported to Johnson Controls, who will arrange to have the solids recycled. Soils remaining in the holding ponds after evaporation will be tested to ensure that they meet the TCLP limits for lead, copper and zinc. If testing confirms that soils contain less than the TCLP limits for lead, copper and zinc, the soils will be left on-site. Any soils exceeding the TCLP limits for lead, copper or zinc will be treated as a hazardous waste.

Temporary permission to discharge is hereby granted pursuant to Section 3-106.B of the NM Water Quality Control Commission (WQCC) Regulations for the above referenced discharge until February 4, 1994.

This approval is contingent on your discharging as described above and in your Notice of Intent and Voluntary Corrective Action Plan dated September 1993.

Bruce King
Governor

Judith M. Espinosa
Secretary

Ron Curry
Deputy Secretary

Harold Runnels Building
1190 St. Francis Drive
P.O. Box 26110
Santa Fe, NM 87502
Phone: (505) 827-2850
Fax: (505) 827-2836

This approval does not relieve you of your responsibility to comply with any other applicable federal, state, and/or local laws and regulations, such as zoning requirements and nuisance ordinances. Also this approval does not relieve you of liability should your operation result in actual pollution of surface or ground waters.

If you have any questions, please contact Marcy Leavitt of the Ground Water Section at the above address or phone 827-2900.

Sincerely,

Marcy Leavitt, Acting Bureau Chief
Ground Water Protection & Remediation Bureau

cc: Tito Madrid, District Manager, NMED Dist. 2

STATE OF NEW MEXICO
ENVIRONMENT DEPARTMENT

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

December 3, 1993

Jim Aldrich, Operable Unit Project Lender
Environmental Restoration Program
c/o ERM Management Company
555 Oppenheimer, Suite 100
Los Alamos, NM 87544

RE: Temporary Permission to Discharge

Dear Mr. Aldrich:

Your request of November 18, 1993, to change the dates of your permission to discharge without an approved discharge plan is hereby granted. The new dates will be from March 15, 1994, until July 12, 1994.

The discharge will be as described in your September 30, 1993, notice of intent and in my October 4, 1993, original approval letter (copy attached) and the same conditions will apply.

If you have any questions. please contact me at the address above or telephone me at this number 827-2900.

Sincerely,

Dennis McQuillan for

Marcy Leavitt, Chief
Ground Water Protection
and Remediation Bureau

ML:DJ:cne

cc: Tito Madrid, Manager, NMED District 2

Bruce King
Governor

STATE OF NEW MEXICO
ENVIRONMENT DEPARTMENT

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

January 20, 1994

Jim Aldrich
LANL ER
c/o ERM Management Company
555 Oppenheimer, Suite 100
Los Alamos, NM 87544

Re: Time Frame Change for Temporary Permission for LANL Inactive Firing Range

Dear Mr. Aldrich:

The New Mexico Environment Department (NMED) is in receipt of your letter dated November 19, 1993, requesting a change of dates for your approved 120 day temporary permission for lead removal from soil at the LANL Inactive Firing Range. You requested that the approved dates in your NMED approval letter dated October 4, 1993 be changed to allow the discharge to commence on March 15, 1994. The reason for this request is to allow the ground to thaw and to prevent the freezing of the water used to process the lead removal from the soil.

Your request to begin discharging on March 15, 1994 is hereby granted. Discharge shall be as described in your NOI dated September 30, 1993 and NMED's approval letter dated October 4, 1993.

If you have any questions please call Richard Ohrbom of my staff at 827-0219.

Sincerely,

Marcy Leavitt, Chief
Ground Water Protection and Remediation Bureau

ML/RO/ro

cc: Tito Madrid, NMED District II Manager

Bruce King
Governor

Judith M. Espinosa
Secretary

Ron Curry
Deputy Secretary

Harold Runnels Building
1190 St. Francis Drive
P.O. Box 26110
Santa Fe, NM 87502

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

JAN 14 11 42 AM '9

ER ID 38814.0

JAN 12 1994

Mr. Joseph C. Vozella, Chief
Environment, Safety and Health Branch
Department of Energy
Los Alamos Area Office
Los Alamos, New Mexico 87544

Re: Notice of Deficiency, Voluntary Corrective Action Plan for SWMU 0-016 (inactive firing range)
Los Alamos National Laboratory, NM0890010515

Dear Mr. Vozella:

The Environmental Protection Agency (EPA) has reviewed the stabilization action entitled "Voluntary Corrective Action Plan SWMU 0-016, Inactive Firing Range" dated September 28, 1993 and found it to be deficient. Enclosed is a list of deficiencies for which you have forty-five (45) days from receipt of this letter to address.

Final approval of this or any other final remedy is subject to public participation requirements and approval of a Class III permit modification. Because this area may someday be developed for residential use, EPA requests that Los Alamos National Laboratory seek public input and comment on the proposed clean-up levels for lead and the proposed remedy as soon as possible.

Should you have any questions, please contact Barbara Driscoll at (214) 655-7441.

Sincerely,

William K. Honker, P.E.
Chief
RCRA Permits Branch (6H-P)

Enclosure

cc: Benito Garcia, NMED
Robert Vocke, LANL EM-13

Printed on Recycled Pa

List of Deficiencies

1. LANL shall provide analytical methods for any laboratory analysis. LANL should ensure that lab anaylsis can be directly compared with field analysis using an XRF in order to demonstrate that field screening techniques are adequate for determining lead levels. If LANL demonstrates that results using XRF are comparable with laboratory analysis, then it is acceptable for the soil washing batch samples to be analyzed with an XRF and composite sampling to be used for final confirmation of cleanup.

2. 3.1 Background Sampling, p. 5 - At what depth will background samples be collected? What method will be used for sampling?

3. 3.2 Sampling during Soil Washing, p. 5 - How will analysis be conducted (field or laboratory) for the samples collected on a daily basis from the recirculating ponds?

4. A schedule of activities including timeframes for the confirmatory sampling results report shall be provided to EPA within the 45 day time-frame for the NOD Response.

5. LANL shall submit results of the confirmatory sampling in a phase report.

0-016

Dave's Yours Copy

DATE: FEB. 8, 1994

SANTA FE NATIONAL FOREST
1220 ST. FRANCIS DRIVE
P.O. BOX 1689
SANTA FE, NM 87504

FACSIMILE TRANSMISSION COVER SHEET

To: Name JIM ALDRIDGE FAX # 665-3285
Location LOS ALAMOS, NM

From: ENGINEERING GRETCHEN BARKMANN
Phone: (505) 988-6907 986-5121
FTS 476-6907

Total number of pages INCLUDING Cover Sheet 4

this is the report from analysis of our "Cemetary Tract" Shooting range SWMU. Let me know if you have questions on this - I'll probably have to forward them to the people in Albuquerque who developed this sampling effort.

Gretchen

Santa Fe National Forest Telecopier
Number is: (505) 986-5125

Caring for the Land and Serving People

Rec 3/20/92
DEx

NEW MEXICO BUREAU OF MINES AND MINERAL RESOURCES
SOCORRO, NEW MEXICO 87801

REPORT OF ANALYSES

Lab. no.	Identification	Total wt. gms	wt. Pb pieces	% large pieces	% Pb in pieces	% Pb in soil	Soil pH	Pb TCLP Soil	Pb TCLP Soil+pieces	wt Pb
81	CT-L-1	1683				0.0147	7.0	1.1		0.247
82	CT-S-9	1519				0.0066	6.4	0.3		0.100
83	CT-L-2	2200	82	3.7	76	0.1582	6.9	>5		3.48
84	CT-S-6	1867	15.5	0.8	9.1	0.0081	6.9	0.5	1.1	0.15
85	CT-S-12(B)	2164	22.9	1.0	88	0.1670	7.4	>5		3.61
86	CT-L-3(A)	1925.0	99.5	5.2	60	3.95	7.0	>5		76.03
87	CT-S-10	2008	148	7.4	91	5.05	7.0	>5		101.25
88	CT-L-4(B)	2014	27	1.3	90	0.2434	6.8	>5		4.90
89	CT-S-12(A)	1925	27	1.4	95	0.1474	7.0	>5		2.84
90	CT-L-3(B)	2644	252	9.5	69	3.88	6.9	>5		102.57
91	CT-L-4(A)	2048	21.3	1.0	92	0.4386	6.8	>5		8.98
92	CT-S-11	1974	35	1.8	92	0.1531	7.2	>5		3
93	CT-L-5	2056	30	1.5	91	0.3285	6.9	>5		6.13
94	CT-S-7	1737	24.5	1.4	73	0.0126	6.8	0.2	11.5	0.22
95	CT-S-13	2170	37	1.7	92	15.61	7.2	>5		338.74
96	CT-S-3	1573				0.0194	6.9	<.3		0.305
97	CT-S-8	1867	59	3.2	95	0.0328	6.8	1.4	35.5	0.612
98	CT-S-1	1291				0.0020	7.2	<.3		0.026
99	CT-S-2	1451				0.0078	7.1	0.5		0.113
100	CT-S-4	1753				0.0055	7.0	<.3		0.096
101	CT-S-5	1695				0.0074	7.1	0.5		0.125
Method of analysis						AA		EPA 1310		

21 samples → ATOMIC ABSORPTION

If this data appears in a presentation, report or publication, please acknowledge the NMBMMR Chemistry Laboratory.

Name, address and phone:
Alan Porter
USDA Forest Service
517 Gold Ave. SW
Alb. NM 87102
Charge: $ 2.50
Order No. 40-8371-2-0375

NMBMMR submitter:
Lynn Brandvold 835-5517
Approved by:

Date received: Feb. 25, 1992
Date completed: Mar. 17, 1992

RECEIVED
FEB 7 1994
SAN... ...ANIST

NEW MEXICO BUREAU OF MINES AND MINERAL RESOURCES
SOCORRO, NEW MEXICO 87801

REPORT OF ANALYSES on TCLP Tests for Lead on Soil Samples

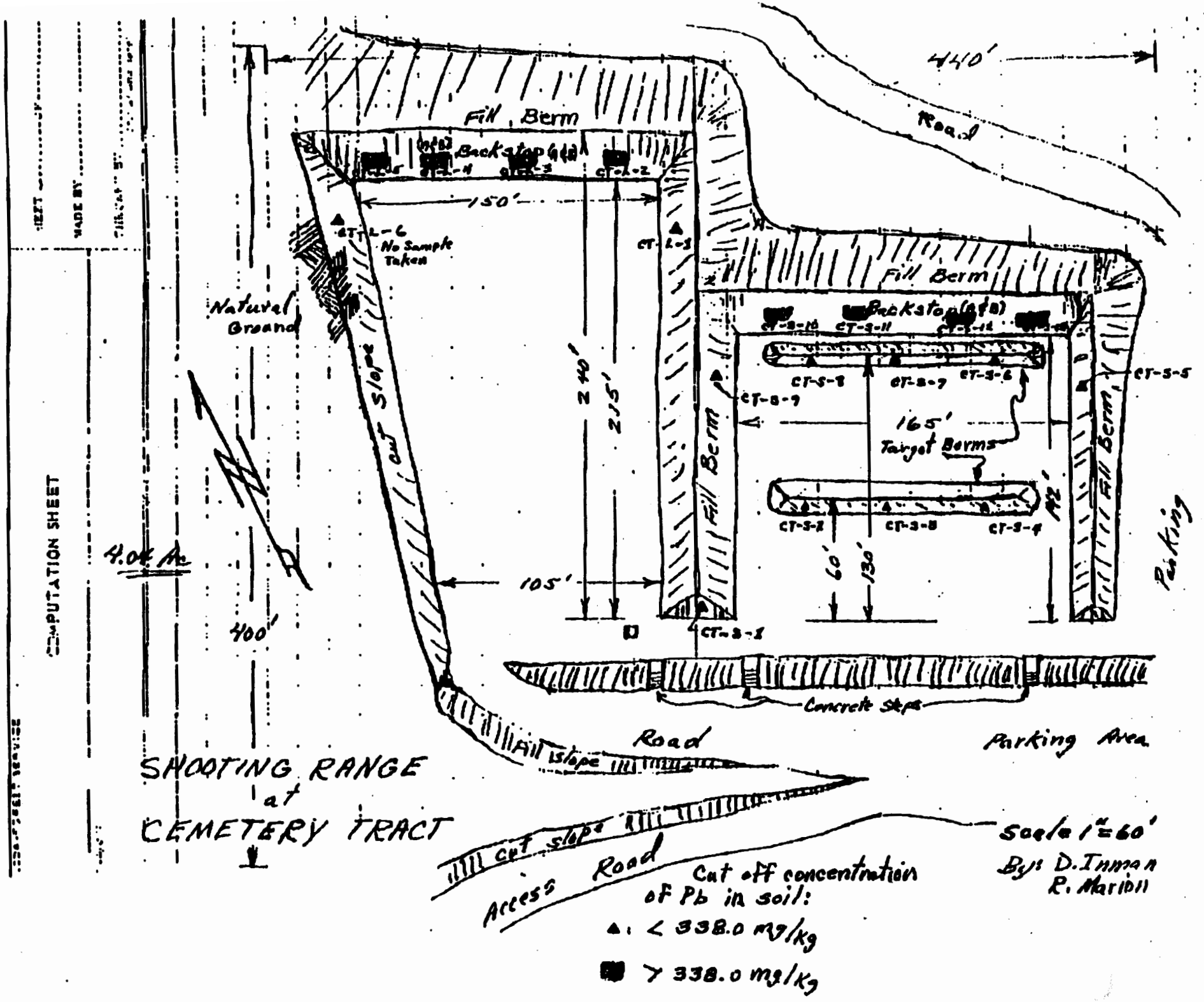
Lab. no.	Identification	Gravity Separation		>80 mes	<80 mes	>80 mesh	<80 mesh
		weight %	light fraction–Pb	weight %	weight %	Pb	Pb
85 A	CT-S-12 (B)	95	1.48 ppm				
85 B	CT-S-12 (B)	95	1.2 ppm				
88 A	CT-L-4 (B)		>5 ppm	78.4	21.6	>5 ppm	>5 ppm
89 A	CT-S-12 (A)			83.4	16.6	2.7 ppm	1.1 ppm
Method of analysis			EPA #1310			EPA Method 1310	

If this data appears in a presentation, report or publication, please acknowledge the NMBMMR Chemistry Laboratory.

Name, address and phone:
Alan Porter
USDA Forest Service
517 Gold Avenue, SW–Rm 1415
Albuquerque, NM 87102
Charges $72.00
Order Number 40-8371-2-0375

Date Completed 4/10/92

Approved by L.B.


SHEET
MADE BY
COMPUTATION SHEET
4.04 Ac
400'
Natural Ground
Fill Berm
Backstop (6'x8')
CT-L-4
CT-L-3
CT-L-2
150'
CT-L-6
No Sample Taken
CT-L-1
cut slope
240'
215'
105'
Fill Berm
CT-S-1
CT-S-9
CT-S-10
CT-S-11
CT-S-12
CT-S-8
CT-S-7
CT-S-6
CT-S-5
165'
Target Berms
CT-S-2
CT-S-3
CT-S-4
60'
130'
42'
Fill Berm
Parking
Concrete Steps
Road
Fill slope
Parking Area
SHOOTING RANGE
at
CEMETERY TRACT
cut slope
Access Road
440'
Road
Scale 1" = 60'
By: D. Inman
R. Marion
Cut off concentration
of Pb in soil:
▲: < 338.0 mg/kg
■ > 338.0 mg/kg

RUSH 94-847

Los Alamos

Los Alamos National Laboratory
Los Alamos, New Mexico 87544

INTERNAL/EXTERNAL DOCUMENTAPPROVAL

NOTE: Please furnish CRMO with two copies of this form. An approved copy will be returned to the originating office.

Attachment to NOD response for VCA plan for SWMU 0-016, Former Small Arms Range (2/25/94)

Document Date: Febrary 24, 1994

CHECK ONE: ☐ CLASSIFIED ☒ UNCLASSIFIED

Document Identification: EM/ER:94-A069

	MAIL STOP	AUTHORIZING OFFICIAL	SIGNATURE	APPROVE YES	APPROVE NO	DATE SENT
2	M992	David McInroy, Acting Program Manager	DMC	✓		2/24/94
1	M992	Paul Aamodt	P L Aamodt	✓		2/24/94
	M992					
	M992					
		Associate Director(s)				
6	K491	ESH Division Director Dennis J. Erickson	[illegible]	✓		2/25/94
	F674	OS-6 (Classification)				
		Budget Division				
		MAT				
5	J591	EMP Tom Baca	[illegible]			
		PA				
4	A183	Legal Counsel FEB 25 1994	Cheryl L Mack	✓		2/25/94
3	K490	Other EM-8	Kenneth M. Hargis	✓		2/25/94
	A150	CRMO (for dispatch)				
		Originator				

*Reason(s) for disapproval.

Please call Viola/Brenda at 667-3131, when ready for pickup. Needs to be delivered to DOE/LAAO

Form Number CRM-35 (6/85)
ST-2640

rlr/ERM form

DRC 2/25/94

ATTACHMENT TO NOD RESPONSE FOR VCA PLAN FOR SWMU 0-016, FORMER SMALL ARMS RANGE

February 25, 1994

ESH-8 CONCERNS

Barbara Driscoll with EPA Region VI has directed LANL to obtain public involvement for any voluntary corrective action (VCA) that can be construed as a final remedy if the VCA is more involved than the removal of contaminated material. EPA is concerned that VCAs may severely limit the public involvement processes associated with remediation and clean-up activites. Remediation performed under RCRA authority for corrective action would normally be conducted per RCRA Facility Investigation (RFI), Corrective Measures Study (CMS), and Corrective Measures Implementation (CMI) steps outlined in LANL's permit (Module VIII). EPA and public comment are associated with each of these steps.

The implementation of a final remedy for remediation requires a class 3 permit modification. Public involvement for a class 3 permit modification request includes: sending a description of the activity to be conducted to all persons on the facility mailing list; public notice in local newspapers describing the activity and announcing the 60 day public comment period; and the time and location of a public information meeting.

The VCA plan for the small arms firing range essentially is a final remedy. ESH-8 is concerned that the plan allows for very limited advance public involvement. Future VCA plans should include ample time for public notice, mailings, and meetings.

ESH-8 is also concerned with the approval of the New Mexico Environment Department (NMED) for this VCA plan. Jim Aldrich has indicated that Barbara Hoditschek with NMED has given verbal approval of this VCA. ESH-8 suggests that the cover letter to the NMED Hazardous and Radioactive Materials Bureau indicate that the plan has been previously discussed with NMED staff and that verbal approval of the plan has been received from Barbara Hoditschek.

ER ID 56802.3

Los Alamos

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

DATE: February 24, 1994
IN REPLY REFER TO: EM/ER:94-A069
MAIL STOP: M992
TELEPHONE: (505) 667-0819

Mr. Ted Taylor, Program Manager
Department of Energy
Los Alamos Area Office, MS A316
Los Alamos, NM 98544

Dear Mr. Taylor:

SUBJECT: RESPONSE TO NOTICE OF DEFICIENCY (NOD) OF VOLUNTARY CORRECTIVE ACTION (VCA) PLAN FOR SOLID WASTE MANAGEMENT UNIT (SWMU) 0-016, FORMER SMALL ARMS RANGE

The enclosed VCA Plan for SWMU 0-016, Former Small Arms Range, Revision 3, dated February 7, 1994, addresses technical and environmental issues involved in a plan to remediate SWMU 0-016. Revision 2 of this Plan was reviewed by the Environmental Protection Agency (EPA) and an NOD was issued to Joseph C. Vozella, LAAO, by William K. Honker, EPA, Region 6, on January 12,1994.

All of the deficiencies listed in the NOD have been addressed in Revision 3, and some new material has been added. A point-by-point response to the listed deficiencies is enclosed in this letter, with a draft letter of transmittal from Mr. Vozella to Mr. Honker.

The public will be notified of this VCA through a combination of site tours, media announcements, and placement of the VCA Plan in the Environmental Restoration Reading Room. Tours of the site will be held on Monday, March 14, 1994 at 9:00 a.m. and 4:00 p.m. The announcements for these tours will include a statement that the VCA Plan is available in the reading room.

Should you have any questions, please contact Jim Aldrich at 667-1495.

Sincerely,

David McInroy
Acting Program Manager
Environmental Restoration Program

DM/vvm

Enclosures: Voluntary Corrective Action Plan for SWMU 0-016 Former Small Arms Range, Revision 3
Draft Letter to William Honker

Cy: T. Baca, EM, MS J591
J. Shipley, EM, MS J591
P. Aamodt, EM/ER, MS M992
J. Aldrich, EES-1, MS D462
V. Maes, EM/ER, MS M992, (A.I. #A005)
RPF, MS M707
CRM-4, MS A150, (w/o enclosures)

RESPONSE TO NOTICE OF DEFICIENCY
VOLUNTARY CORRECTIVE ACTION PLAN
SWMU 0-016, INACTIVE FIRING RANGE

1. *"LANL shall provide analytical methods for any laboratory analysis"*

Analytical methods for laboratory analyses are cited in Section 4.3., paragraph 1. They include SW 7421 for Pb and SW 6010 for Cu and Zn.

"LANL should ensure that lab analysis can be directly compared with field analysis using an XRF in order to demonstrate that field screening techniques are adequate for determining lead levels. If LANL demonstrates that results using XRF are comparable with laboratory analysis, then it is acceptable for the soil washing batch samples to be analyzed with an XRF and composite sampling to be used for final confirmation of cleanup."

The five background soil samples will be analyzed using by both XRF and in the laboratory to verify that the accuracy and quality of the field screening technique is adequate. See Section 4.3., para. 3 and Table 1.

2. *"3.1 Background Sampling, p. 5 - At what depth will background samples be collected? What method will be used for sampling ?"*

Surface samples for soil will be taken from the top 6" of soil following LANL-ER-SOP-06.09, R0, Spade and Scoop Method for Collection of Soil Samples. See Sections 4.3., para. 5.

3. *"3..2 Sampling during soil washing, p. 5" - How will analysis be conducted (field or laboratory) for the samples collected on a daily basis from the recirculating ponds?'*

Samples will be analyzed by XRF during the soil washing process. See Section 4.3., para 6 and 7.

4. *"A schedule of activities including timeframes for the confirmatory sampling results report shall be provided to EPA within the 45 day timeframe for the NOD response."*

It is anticipated that soil washing will start on 15 March 1994 and will be completed in about 32 days, weather permitting. Verification sample collection will begin no earlier than 29 April 1994. Analytical results from the verification samples will be received no earlier than 12 May 1994. See Section 5.6.

5. *"LANL shall submit results of the confirmatory sampling in a phase report."*

A phase report on the VCA will be submitted to the EPA. See Section 4.1, paragraph 7.

DRAFT

ER ID 56802.1

Mr. William K. Honker
Chief, RCRA Permits Branch
US EPA, Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Dear Mr. Honker:

SUBJECT: RESPONSE TO NOTICE OF DEFICIENCY (NOD), VOLUNTARY CORRECTIVE ACTION PLAN FOR SWMU 0-016 FORMER SMALL ARMS RANGE

The deficiencies listed in the NOD, for SWMU 0-016 are addressed in the attached VCA Plan, Revision 3. A summary of responses to the listed deficiencies follows:

1. *" LANL shall provide analytical methods for any laboratory analysis"*

   Analytical methods for laboratory analyses are cited in Section 4.3., paragraph 1. They include SW 7421 for Pb and SW 6010 for Cu and Zn.

   "LANL should ensure that lab analysis can be directly compared with field analysis using an XRF in order to demonstrate that field screening techniques are adequate for determining lead levels. If LANL demonstrates that results using XRF are comparable with laboratory analysis, then it is acceptable for the soil washing batch samples to be analyzed with an XRF and composite sampling to be used for final confirmation of cleanup."

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5. *"LANL shall submit results of the confirmatory sampling in a phase report."* A phase report on the VCA will be submitted to the EPA. See Section 4.1, paragraph 7.

Should you have any questions, please contact Ted Taylor at (505)-665-7203.

Sincerely,

Joseph C. Vozella, Chief
Environment, Safety and Health Branch

JV/vvm

Enclosure: Voluntary Corrective Action Plan, SWMU 0-016 Former Small Arms Range, Revision 3

Cy: (w/o enclosure)
T. Baca, EM, MS J591
J. Shipley, EM, MS J591
P. Aamodt, EM/ER, MS M992
J. Aldrich, EES-1, MS D462
RPF, MS M707
CRM-4, MS A150, (w/o enclosure)

The attached document, "Voluntary Corrective Action Plan for SWMU 0-016, Former Small Arms Range, Revision 3" is true and accurate to the best of our knowledge. The document has been through internal and external formal reviews, including reviews by the Department of Energy, to ensure accuracy and in accordance with the Los Alamos National Laboratory (LANL) Environmental Restoration (ER) Program quality assurance procedure. The formal review comments and the resolutions to these comments are part of the public record and are available in the LANL ER Records Processing Facility. The document is being submitted to the Environmental Protection Agency as part of the requirements under the Hazardous and Solid Waste Amendments Operating Permit.

Jim Aldrich, EES-1, MS D462
Operable Unit Project Leader

24 Feb 94
Date

Pat Shanley, ESH-8, MS K490
ESH-8 Representative

2/25/94
Date

David McInroy, EM/ER, MS M992
Acting Program Manager
Environmental Restoration Program

2/24/94
Date

CERTIFICATION

I certify under penalty of law that this document 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 possiblility of fine and imprisonment for knowing violation.

Document Title:

Voluntary Corrective Action Plan SWMU 0-016, Former Small Arms Range, Revision 3

Name: _____ Date: 2/25/94

Dennis J. Erickson
Division Director
Los Alamos National Laboratory

Name: _____ Date: _____

Joseph Vozella, Chief
Environmental Safety & Health Branch
Los Alamos Area Office - DOE

LOS ALAMOS NATIONAL LABORATORY
ENVIRONMENTAL RESTORATION PROGRAM
OPERABLE UNIT 1071

VOLUNTARY CORRECTIVE ACTION PLAN
SWMU 0-016, FORMER SMALL-ARMS RANGE

Revision 3
7 February 1994

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1. INTRODUCTION

The United States Forest Service (USFS) and the County of Los Alamos have requested the cleanup of Solid Waste Management Unit (SWMU) 0-016, the former small arms range immediately west of Guaje Pines Cemetery, so that the land can be transferred from the USFS to a local developer as part of a larger public-private land exchange. This Voluntary Corrective Action (VCA) plan is being proposed, instead of following the Resource Conservation and Recovery Act Facility Investigation (RFI) / Corrective Measures Study (CMS) process as presented in the Operable Unit (OU) 1071 RFI Work Plan (LANL, May 1992), because of the time constraints placed on the Environmental Restoration (ER) Program by the pending land exchange. This plan will provide the basis for the implementation of the VCA in a manner that is consistent with the process outlined in the Installation Work Plan for Environmental Restoration (LANL, Nov 1993).

2. SITE BACKGROUND AND ENVIRONMENTAL SETTING

2.1. Detailed Description of SWMU 0-016

SWMU 0-016 is a former small-arms range located in the Santa Fe National Forest west of Guaje Pines Cemetery in Los Alamos, New Mexico (Figure 1). The site, which occupies nearly three acres, consisted of several small buildings and several earthen berms. At present, only concrete steps, pads, and the earthen berms remain.

2.1.1. Operational History

The small-arms range was constructed for use by security forces for the Atomic Energy Commission (AEC). Construction was done after January, 1947, when control of all Manhattan Project sites was transferred to the Atomic Energy Commission (AEC). The range was used by security forces for small-arms target practice until the present firing range in Sandia Canyon was built in the early 1960s. The site has been used unofficially by the general public in the intervening years. The Department of Energy (DOE) released the range and adjacent area to the USFS in 1976.

2.1.2. Physical Setting

The former range is located on a ridge lying between two small valleys which converge about one-quarter mile to the east (Figure 1). The ephemeral streams in these valleys feed into the upper end of Rendija Canyon. The terrain at the site varies from relatively flat on the ridge top to steep grades at the edges of the site which are associated with the valley walls.

With the exception of the areas with soil berms, the site is covered by a thin veneer of soil overlying the Bandelier Tuff. In places, weathered Bandelier Tuff crops out. Soil thickness increases in the colluvial soils on the adjacent valley slopes and is thickest in the alluvial deposits in the valley bottoms.

Ephemeral surface-water conditions occur in the adjacent drainages and are associated with snow melt runoff in the spring and localized thunderstorms during the period of July through September. The main aquifer beneath the site is approximately 1300 feet below the land surface and occurs within the Puye Formation and Santa Fe Group sediments.

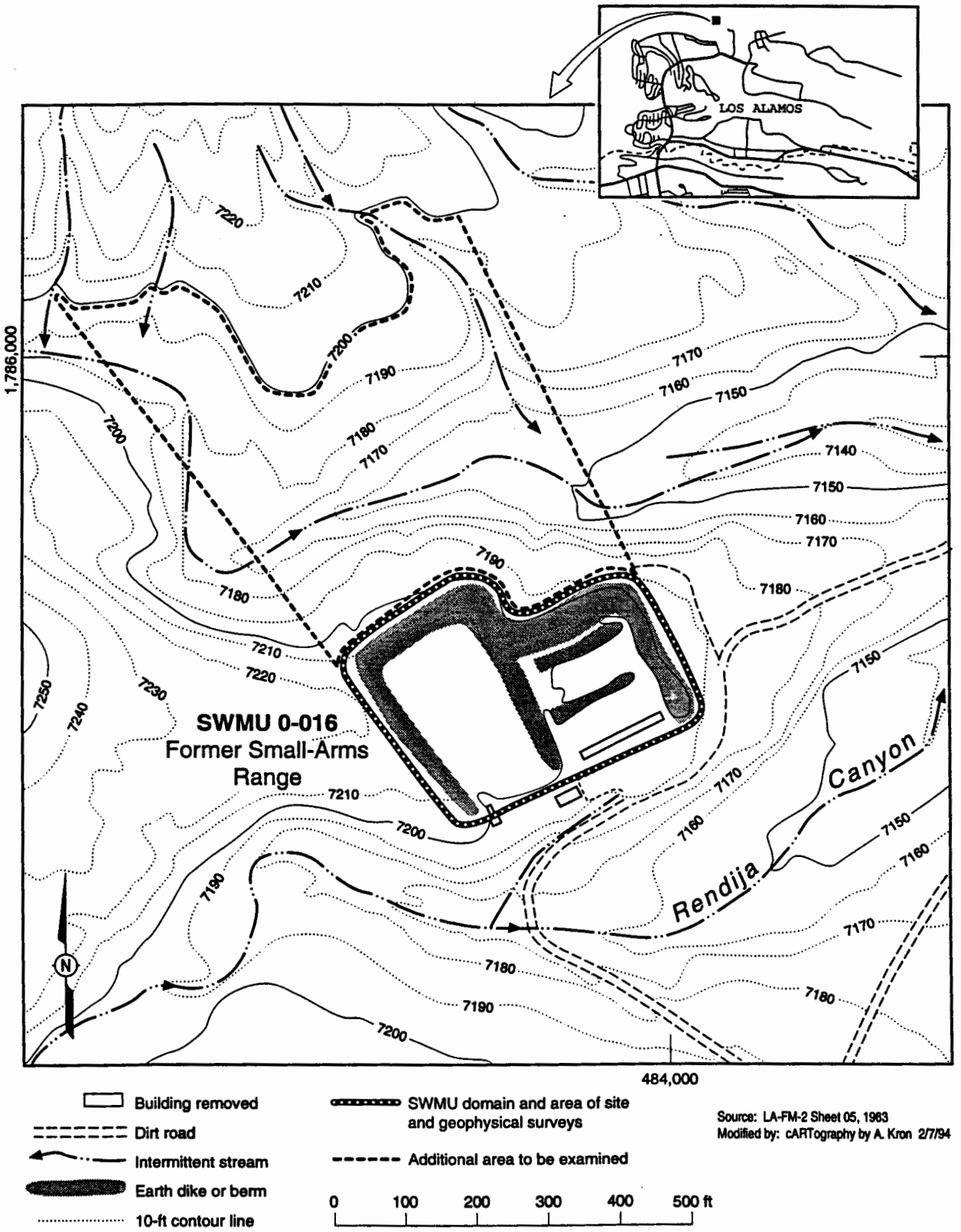


Figure 1. Location and site map of SWMU 0-016 (Former Small-Arms Range).

2.1.3 Regulatory Status of Unit

The site is a Hazardous and Solid Waste Amendments (HSWA) SWMU. This SWMU was not included in Table A of the original HSWA permit. This unit was identified in a permit modification request and new SWMU notification submitted to EPA in February 1993. This permit modification is currently under EPA review.

2.2. Summary of Previous Investigations

The USFS conducted a study of the area in 1991 in which 11 of 21 samples taken from the SWMU failed the TCLP test for heavy metals. (The data are not available, but a summary is given in Memorandum 7400, USFS, 1992, attached). This was attributed to the presence of lead bullets and fragments within the earthen berms. USFS Memorandum 7400 concludes that, because the TCLP test did not reproduce the essentially pH-neutral soil conditions at the site, the lead-contaminated soil does not constitute a release of a hazardous substance under the Comprehensive Environmental Response, Liability, and Compensation Act. The Forest Service further maintains in the memorandum that the lead in the earthen berms does not constitute a threat to the ground water in the area due to the great depth to water (approximately 1300 feet below ground surface).

Studies conducted by the Naval Engineering Laboratory indicate that metallic (elemental) lead (Pb) is the prime contaminant in small-arms firing ranges, but copper (Cu) and zinc (Zn) may also be found (Heath, *et. al.*, 1991). Other forms of lead, such as oxidized lead, are not commonly found in small-arms ranges and would not be expected to be present in the arid environment found in Los Alamos.

2.3. Types and Volumes of Waste Present

Given the purpose of the range, it is reasonable to assume that common military small-arms of the period were fired there. A variety of bullets, both bare lead and lead covered with metal jackets, in several rifle and pistol calibers have been found. Some of the bullets have shattered on impact, so that the material found varies from intact bullets to grain-sized fragments.

The SWMU domain is coincident with the boundaries of the former small-arms range and encloses nearly 3 acres (Figure 1). The target berms and part of the floor of the range covered by soil contain lead bullets, lead fragments, and particulate lead. The berms are estimated to contain about 3000 cubic yards of soil. The heaviest concentrations of bullets and lead fragments are in the target berms, but they are also present in reduced concentration in the side berms. The quantity of lead is unknown, but is expected to be no more than the volume of ten drums.

2.4. Potential Pathways of Contamination Migration

Contaminants associated with spent bullets, primarily lead, may have been released to the environment through infiltration, water entrainment and/or leaching/dispersion from the former small-arms range. As a result, contaminants that may be present in the soil can leach/ disperse through the vadose zone or be entrained by surface water and transported downstream by run-off. Unexploded cartridges may also be present at the site and may eventually be exposed by erosion.

Figure 2 presents the conceptual model for potential releases of contaminants from the former small-arms range and subsequent exposure of humans and terrestrial animals.

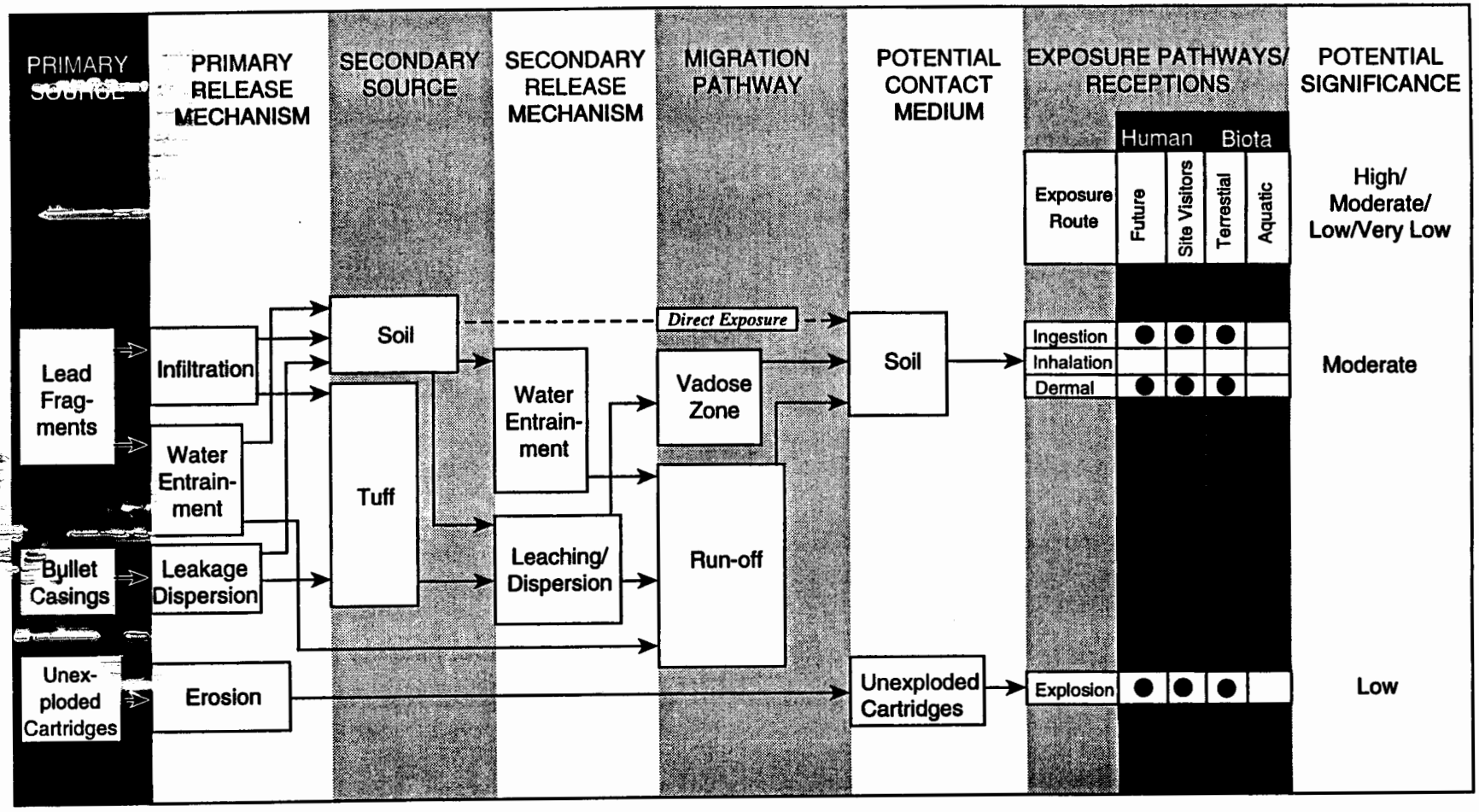


Figure 2. Conceptual model of SWMU 0-016.

In Figure 2, "future residents" refers to people who may live on the site some time in the future, and "site visitors" refers to people who walk through the site under current conditions. Terrestrial animals in the vicinity of the firing range may also be impacted.

2.5. Potential Impacts on Public Health and Environment

Based on the migration pathways described in Subsection 2.4, it is possible that contaminants are currently present in or will migrate to the soil. As a result, human exposure to contaminants from this SWMU may occur through incidental ingestion or dermal contact with soil. Unexploded cartridges present at the site would pose a potential explosion hazard should they be struck by a heavy object. Additionally, terrestrial animals may be exposed to site contaminants via incidental ingestion or dermal contact with soil.

3. VCA PLAN RATIONALE

The sampling plan for SWMU 0-016 presented in the OU-1071 RFI Work Plan calls for characterization of the site, not remediation. Since the sampling plan was completed, the USFS and a private developer have reached an agreement on a land exchange that includes the former small-arms range. To date, only the land adjacent to the range has been exchanged. The agreement calls for the range to be exchanged also, if it can be cleaned up within two years of the initial exchange. The USFS, the private developer, and the County of Los Alamos want the cleanup to be done in order to open the entire area for development, and have requested DOE to remediate the site immediately. Therefore, this VCA plan is being proposed, instead of following the RFI/CMS process as stated in the Operable Unit (OU) 1071 RFI Work Plan (LANL, May 1992).

3.1. Extent of Contamination

The nature of small-arms ranges dictates that lead bullets and lead fragments be largely restricted to the range itself, with the majority of the lead in the target berms. At SWMU 0-016, some bullets are also present in the area immediately behind the target berms. Thus, the extent of significant contamination is very limited.

Undoubtedly some shots were fired above the tops of the target berms, sending bullets miles beyond the small-arms range, but the number of bullets involved is most likely very small. Given the complete impracticality of addressing the issue of stray bullets scattered over tens of square miles, the domain of this VCA is limited to the range itself and the area immediately adjacent to it on the down-range side (area enclosed by dashed line on Figure 1)..

3.2. Remedy

Given the nature of the site, two remedies were considered: 1) Relocate the soil containing lead bullets and lead fragments to the berms on a currently active small-arms range, 2) Remove any bullets and lead particles from the soil to bring the lead concentration down to the level required for residential use. The first remedy was rejected as an option by Region 6 of the EPA, leaving the second remedy as the only option available.

The LANL screening action level (SAL) for lead in soils is 500 ppm. This SAL is derived from a generic facility risk assessment based on the assumption that sites will be designated for residential use. This is also the lower cleanup level for lead in soils in residential settings established by the U.S. Environmental Protection Agency (EPA) Office of Solid Waste and Emergency Response Directive 9355.4-02 (September, 1989) and the New Mexico Environment Department. The level of 500 ppm will be used as an upper limit for lead in soils for this VCA.

The only known, reasonably priced method of removing lead from soil is a soil washing process that has been successfully used at similar small-arms firing range sites in California and elsewhere. This process has been shown to reduce the lead concentration in soils to well below the 500 ppm screening action level (LANL, Nov 1993).

3.3. Site for Waste Treatment, Storage and Disposal

All of the equipment and the two ponds required for storing the water used in the treatment process will be located within the SWMU boundaries.

Waste storage/disposal is not required. Upon conclusion of the VCA, the site will contain approximately 3000 cubic yards of cleaned soil. The processed soil will be used by the new owner to raise the grade of the access road into the site. The new road will be finished with an asphalt surface.

The lead removed from the soil will be placed into 55-gallon drums and sent to a recycling center by Johnson Controls, Inc. Therefore, the quantity of removed lead is not a problem.

3.4. Permit Requirements

A discharge permit has been obtained for the process water that will be recirculated through two ponds from the New Mexico Environment Department, Ground Water Protection and Remediation Bureau. The water will be allowed to evaporate after the site is cleaned as a further safeguard for the environment.

An excavation permit is required for site operations. It was issued on 6 October 1993.

3.5. Impacts on Human Health and Environment, Cost, and Cleanup Schedule

Lead concentrations will be reduced below 500 ppm, thus bringing the soil within the required level for residential land use. This will ensure that there is no health risk to the future site residents or to the environment.

The total cost of environmental restoration of the site will be reduced by implementing the VCA because the cost of characterization has been eliminated. The funds originally designated for characterization can now be used to pay for part of the cleanup.

The remediation of SWMU 0-016 accelerates the final remedy for the site by about 8 years.

4. VOLUNTARY CORRECTIVE ACTION TASKS

4.1. Detailed Description of Corrective Action Activities

All of the earthen berms at the site and the top 2 feet of soil from the floor of the firing range will be processed to remove lead. The majority of lead is expected to be concentrated in the target berms located at the north end of the small-arms range. Although the berms that parallel the firing lines are presumed to contain only minor amounts of lead, they will also be processed to ensure that no lead-contaminated soil remains at the site.

Lead will be removed from the soil by a soil washing process that uses a modified sand and gravel plant to separate lead from the soil. The plant for treating the soil and the two ponds for storing the water used in the treatment process will be located within the SWMU domain (Figure 1). Soil will be transferred from the berms to the soil washing plant using front-end loaders. The soil will be sprayed with water, as necessary, to minimize the amount of lofted dust.

This soil washing process operates on the principle that most soil particles have average densities of 3 to 4 grams per cubic centimeter (g/cc), while particulate lead has an average density of 11.4 g/cc. This difference in average densities is used to physically separate, concentrate, and remove the fine particulate lead from the soil. Larger lead fragments and bullets will be separated from the coarse fraction of the soil by automated sieves.

The soil washing plant consists of a hopper feeder above a jigging box that is used to sort out coarser material from the soil and to retain larger lead fragments and bullets. After the larger lead fragments and bullets are removed, the remaining soil is fed into two sand screws which, in turn, feed the soil into a series of stacked power hydro-screens with 3/4", 1/4", and 1/8" openings. High-pressure water sprays are used to force the soil through these screens. The finer material that passes through these screens is then sent through a 3-foot diameter centrifugal separator. The centrifugal separator uses water and the greater density of lead to separate out the fine particulate lead.

The washed soil and associated water then flows along a drag tank where most of the soil is removed. Next, the water flows into two large recirculating ponds (200 ft. by 50 ft. each) that are used to separate out the fine soil suspended in the water and to act as reservoirs to recirculate the water used during the soil washing process. The recirculating ponds will be excavated during site preparation. The two recirculating ponds will be lined to prevent the release of any water used in the soil washing process.

Airborne lead will be monitored at the site for health and safety reasons and to gauge and prevent any release of airborne lead to the environment. High-volume air samplers will be positioned both upwind and downwind of the site. Samples from these air samplers will be gathered and analyzed for lead by XRF twice per day. If detectable amounts of lead are found to be released during the soil washing process, engineering controls will be undertaken to prevent further airborne release of lead. Since the soil is wetted during the washing process and dry soil will be sprayed with water before handling, it is unlikely that significant amounts of lead will be released to the air. It is expected that approximately 60 to 90 samples will be gathered from the high-volume air samplers and analyzed in the field during the soil washing process.

A Phase Report documenting the VCA, including all data and results, will be submitted to the EPA when the project is completed. Copies will be provided to the USFS and the future site owner.

4.2. Characterization of Materials for Disposal

The composition of the lead bullets and fragments is predominantly lead with minor amounts of other elements (Heath, *et. al.*, 1991). No characterization of the lead is either necessary or appropriate given the nature of the VCA. The extracted lead will be sent to a recycling center.

4.3. Criteria to Determine Effectiveness of VCA

Sampling and analysis will consist of a comprehensive series of field and laboratory analytical techniques. The soil will be sampled as it is processed throughout the course of the project to ensure that the soil washing procedure is effective and that no contaminants are released to the environment during or after the soil washing process. The soil analyses are summarized in Table 1. Chemical analyses for metals will be done using analytical method SW7421 for Pb and method SW6010 for Cu and Zn.

Field analyses for lead will be conducted using a Spectrace 9000 field portable X-ray fluorescence (XRF) instrument configured to detect lead in soils at low levels (below 100 ppm). The XRF and associated equipment will be housed in a portable field trailer set up at the site. A

120-volt power line will be run to the field laboratory to ensure a consistent and reliable source of electricity for the instrumentation.

Soil samples gathered for analyses in an approved environmental laboratory will be sent to the LANL ER Program Sample Coordination Facility for shipment and analysis, as established in the approved procedures published by the ER Program. The five background soil samples analyzed by a laboratory will also be analyzed by XRF to verify that field screening techniques yield comparable lead level results.

All samples will be analyzed for total lead. Confirmation samples will also be analyzed for copper and zinc, two other metals that commonly occur in above-background levels at small-arms ranges. These additional analyses will serve to provide further evidence that any soil contamination from the small-arms range has been remediated during the soil washing process.

Samples will be gathered from soils outside the SWMU boundary that are similar in composition to those found in the earthen berms. A minimum of 5 background soil samples will be collected from the top 6 inches of soil, following LANL-ER-SOP-6.09, "Spade and Scoop Method for Collection of Soil Samples". These background samples will be analyzed in the field for lead content and by an approved environmental laboratory for lead, copper, and zinc. The background samples will provide information on natural levels of lead in the area of SWMU 0-016.

Samples will be gathered from the soils processed by the washing apparatus on a regular basis. Depending on the rate at which soil is processed by the apparatus, samples will be taken at regular intervals ranging from 30 to 90 minutes. These soil samples will be used to represent a given batch of washed soil and will be analyzed for lead by XRF in the field. If any of these soil samples are above the cleanup level of 500 ppm, that batch of soil will be reprocessed until the lead levels are within satisfactory limits. Based upon initial contractor estimates of soil processing rates, it is expected that approximately 150 to 200 soil samples will be analyzed in the field during the soil washing process.

Soil from the recirculating ponds will be gathered daily and analyzed in the field by XRF to ensure that lead levels are below the cleanup levels. Previous experience with this plant has shown that little, if any, lead is released into the recirculating ponds.

4.4. VCA Verification Plan

The numerous discrete samples that will be analyzed during the soil washing process will provide more than adequate data to confirm that the processed soil meets the cleanup level. Post-processing samples will also be taken to increase the certainty that the cleaned soil meets the cleanup level. One sample will be taken from each pile of about 100 cubic yards of processed soil by running a sampling scoop from the bottom to the top of the pile. Since the expected volume of processed soil is around 3000 cubic yards, approximately 20 confirmation samples will be gathered. These samples will be analyzed for Pb, Cu, and Zn by an approved off-site analytical laboratory.

Additionally, 20 judgmentally selected soil samples will be taken from the top six inches of soil, following LANL-ER-SOP-6.09, "Spade and Scoop Method for Collection of Soil Samples". Seventeen sample locations will be randomly selected from the range floor and areas covered by the berms, and 3 samples will be taken from first-order drainages that capture the bulk of the surface water from the site. These samples will also be analyzed for Pb, Cu, and Zn by an approved off-site analytical laboratory (see Table 1).

TABLE 1
SUMMARY — SOIL ANALYSES FOR SWMU 0-016 VCA

Sample Type	Analytical Method	Quantity	Analytes	Text Section
Background	XRF (field)	20	Pb	4.3.
Background	Lab	5	Pb, Cu, Zn	4.3.
Pond soil	XRF (field)	80	Pb	4.3.
Washed Soil	XRF (field)	150-200	Pb	4.3.
Airborne Lead	XRF (field)	60-90	Pb	4.1.
Confirmation	Lab	40	Pb, Cu, Zn	4.4.

Notes:
All sample quantities are approximate and may vary slightly due to unforeseen field conditions.

A Spectrace 9000 field portable X-ray fluorescence (XRF) instrument will be used to analyze for lead in soils.

"Lab" denotes samples to be analyzed by an approved environmental laboratory.

4.5. Site Restoration Plan

The recirculating ponds will be filled and the site contoured to harmonize with the surroundings.

5. PROJECT MANAGEMENT

5.1. Staffing

Implementation of this VCA will be managed by James Aldrich, the Operable Unit Project Leader (OUPL), with assistance from Jan Novak, Assistant OUPL. Cyndy Kruger (ERM/Golder), will serve as the Field Manager. An outside contractor, Sierra Rock, Inc., is under contract to perform the soil washing.

5.2. DOE Approval

Implementation of this VCA was approved by the DOE on 23 September 1993. See FIELD WORK APPROVAL FORM, attached.

5.3. Regulatory Notification/Permit Modifications

The NMED and EPA have been notified of the planned VCA. A Class III permit modification will be submitted on completion of the project to remove the SWMU from the HSWA permit.

5.4. Stakeholder Notifications

A public tour of the site will be held prior to the start of soil processing activities. Public notifications will be placed in appropriate media and the tour will be conducted by the LANL ER Program Public Involvement Office.

The USFS and prospective future site owner have been notified of this VCA plan .

A public meeting will be held after the cleanup is completed to allow public comment on the VCA. A HSWA Class III permit modification will be submitted after the meeting.

5.5. Resource Requirements

The total cost of the VCA is estimated to be $333,000. This includes approximately $62,000 for site preparation, $105,500 for soil processing, $12,200 for sample analysis, $25,000 for site restoration, $5,100 for surveying, and $122,600 for site management.

5.6. Schedule

Site preparation was begun in the fall of 1993. Soil washing activities are expected to start in mid-March, 1994 and to require approximately 6 to 10 weeks to complete. All analytical results are expected within 40 days of the end of sample collection. Site restoration will be completed within 2 weeks of the time the last water has evaporated from the ponds.

6. REFERENCES

LANL (Los Alamos National Laboratory), May 1992. "RFI Work Plan for Operable Unit 1071 - Environmental Restoration Program," Los Alamos National Laboratory Report LA-UR-92-810.

LANL (Los Alamos National Laboratory), Nov 1993, "Installation Work Plan for Environmental Restoration", Los Alamos National Laboratory Report LAUR-93-3987.

Heath, J.C., L. Karr, V. Novstrup, and B. Nelson, 1991. "Environmental Effects of Small Arms Ranges", NCEL Technical Note N-1836, Naval Civil Engineering Laboratory, Port Hueneme, California.

7. ANNEXES

7.1. Implementation SOPs

See ENVIRONMENTAL RESTORATION STANDARD OPERATING PROCEDURES, Volumes I and II, November 17, 1993, Los Alamos National Laboratory

7.2. Quality Assurance Plan

See QUALITY PROGRAM PLAN AND QUALITY ASSURANCE PROJECT PLAN FOR ENVIRONMENTAL RESTORATION, May 1991, Los Alamos National Laboratory

7.3. Health and Safety Plan

See LANL, Nov 1993, Annex III, Health and Safety Program Plan.

7.4. Records Management Plan

See LANL, Nov 1993, Annex IV, Records Management Program Plan.

7.5. Public Involvement Plan

See LANL, Nov 1993, Annex V, Public Involvement Program Plan.

7.6. Field Work Approval

FIELD WORK APPROVAL FORM, signed 23 September 1993 (attached).

7.7. Other Documents

Memorandum no. 7400, dated 13 April 1992, USFS, Santa Fe National Forest, to the U.S. Coast Guard National Response Center (attached).

FIELD WORK APPROVAL FORM

This form must be completed prior to starting site characterization field work in Operable Units that do not have an Environmental Protection Agency-approved work plan.

I T. J. Taylor, DOE-LAAO, hereby APPROVE the field work as proposed in the accompanying memorandum for Operable Unit 1071 and as described in the DOE-approved voluntary corrective action plan for SWMU 0-016.

I _____, DOE/LAAO, DO NOT APPROVE the field work as proposed for Operable Unit 1071.

The reasons for disapproval are:

Signed: T. J. Taylor

Date: 9-23-93

United States Department of Agriculture
Forest Service
Santa Fe National Forest
P.O. Box 1689
Santa Fe, NM 87504
505 988-6940

Reply To: 7400

Date: April 13, 1992

National Response Center
United States Coast Guard Headquarters
Rm 2611
2100 2nd St. SW
Washington, DC 20593

To Whom it May Concern,

The Santa Fe National Forest is writing to advise you of a situation occurring on lands currently being administered by the Santa Fe National Forest. These lands were previously withdrawn from the Santa Fe National Forest by the Department of War in connection with the Manhattan Project, and were most recently managed by the Department of Energy as a shooting range. These lands are currently under consideration for exchange. The future use of the site could potentially be a residential area.

The Forest Service is providing this information pursuant to 42 U.S.C. 9663. As suggested by 40 CFR 300.405(d), the following information is being provided:

a) The site is referred to as the Cemetery Tract Shooting Range. It is located on Santa Fe National Forest administered lands. The site is adjacent to the City of Los Alamos, in Los Alamos County, New Mexico. The legal description is T19N, R6E, SE 1/4 of Section 4.

b) The type of material present on the site is lead slugs from small arms ammunition.

c) The size of the material ranges from large caliber bullets to grain size fragments. It is estimated that there are several tons of lead slugs in approximately 870 Cubic Yards of potentially contaminated material.

d) The shooting range has been in use since the early 1940's when the site was withdrawn from the Santa Fe National Forest by the Department of War for the Manhattan Project.

e) The DOE released the shooting area and adjacent land back to the National Forest in 1976, after it had been out of service for a while. The site has been used unofficially by the general public in the intervening years. Since that release to the National Forest the DOE declared this site a Solid Waste Management Unit (SWMU).

Since this site was declared a SWMU, it was required that we run a Total Concentrate Leaching Procedure (TCLP) test on soil samples from the site. We question how well this test replicates the natural conditions of the Cemetary Tract since no other waste was apparent, and the site has not been used as a landfill or dump to the best of our knowledge. Preliminary tests of soil samples collected from the site resulted in 11 out of 21 samples failing the TCLP test for leachability of heavy metals. This process is EPA's litmus test for contaminated soil to indicate if enough heavy metal is present to be leached under certain acidic conditions. The acidic level used in the test ranges from a pH of 2.83 to 2.92. In this instance, the samples that failed the test were from backstop berms in the old shooting range.

The TCLP test may be valid for sites that are located in areas or regions that have acid rains, acid dry deposition, or naturally high acid soil conditions, within close proximity to water. However, this is not the case for the old shooting range at Los Alamos. There is a deposit of lead slugs at the site that will leach sufficient amounts of lead to fail the TCLP test when subjected to an artificial acidic condition. The on-site soils at the old shooting range vary in pH from 6.4 to 7.4, with the average pH being 6.97 which is essentially neutral. Therefore, leaching of the lead shot is not likely unless some drastic change occurs at the site.

Possible ground water contamination is an issue raised by the New Mexico Environmental Department and the Environmental Protection Agency. The shooting range is located on top of a small ridge that is composed of the top member of the Bandelier Tuff (Tshirege Member), with associated soils. The thickness of this volcanic unit is about 600 feet. The Bandelier overlies the Puye Formation which is lithic tuff and lahar (mud flow) unit, which is about 700 feet thick. Both of these units overlie the Santa Fe Formation that is an arkosic sediment. The Santa Fe Formation would be the unit that would be the ground water bearing unit. It is unlikely that this unit would ever be adversely effected by the lead shot deposit setting about 1,300 feet above. It is possible, but unlikely, that a stratified water table would exist between the shooting range and the Santa Fe Formation.

The Forest Service, however, takes the position that a Comprehensive Environmental Response Liability and Compensation Act (CERCLA) release of a reportable quantity of a hazardous substance has not occurred at the site for the following reasons:

1) The ammunition is exempt from CERCLA requirements due to the consumer product exemption (42 USC 9601(a)).

2) The lead particles of the size found at the site are not required to be reported by 40 CFR 302.6(d).

3) The TCLP test does not replicate leachability found under the natural conditions occurring at this site.

Until we are advised otherwise, we will assume that we have complied with any possible 42 USC 9603 reporting requirements. We will also assume that until otherwise notified, the Cemetery Tract Shooting Range site will not be registered with the NRC or listed on the Federal Agency Hazardous Waste Compliance Docket. The national ramifications of this situation would be extraordinary since every formal and informal shooting range would be required to be reported under 42 USC. 9603.

Recognizing the potential use of the site, and it's current designation as a SWMU, it is the intention of the Forest Service to work with the Department of Energy to address how to best contain the material prior to the land being exchanged. Final disposition of this matter can not be resolved until there is an official resolution to CERCLA concerns.

If EPA does not agree with the position outlined in this notice, please notify me within 30 days.

Al Defler
FOREST SUPERVISOR

cc: OGC (Pitt)
DOE
RO ENG (H.Kringler)
Espanola Ranger District
EPA Region 6 (J. Burleson)
City of Los Alamos

LANL ER Site Tour
March 14 and 15, 1994
Public Information Process

LANL's Environmental Restoration Program planned and offered a tour of the old firing range cleanup site adjacent to Guaje Pines Cemetery in Los Alamos. The scheduled date for the tour was Monday, March 14. Because of a reporter's error, an unplanned news notice of the tour appeared in the Los Alamos Monitor which listed the tour as taking place on Tuesday, March 15. Therefore, the ER Program decided to accommodate anyone who showed up for the Tuesday tour by holding two sets of tours: Monday, March 14 and Tuesday, March 15.

People were invited to the March 14 tour in three ways:

Mailing: A card (attached) with the relevant information, was sent to the Laboratory's outreach mailing list of nearly 1800 people. The mailing was sent on Tuesday, March 1.

Advertisements: Ads(attached) were placed as follows:

Sunday, March 3 --
Los Alamos Monitor, display ad
Santa Fe New Mexican, display ad
Albuquerque Journal (newspaper of record) legal ad

Thursday, March 10 --
(Española) Rio Grande Sun, display ad

An unplanned news Digest Notice (attached) for a March 15 tour also ran in the Los Alamos Monitor on Sunday, March 13.

The reporter who covered the tour on Monday, March 14 wrote a news story (attached) which appeared in the Los Alamos Monitor on Tuesday, March 15.

Public Service Announcements (copy attached) were sent to the following radio stations by FAX on Friday, March 3:

Los Alamos:	KRSN and KNLA
Española:	KDCE
Santa Fe:	KTRC, KBOM, KIOT, KNYN
Albuquerque:	KOB-AM, KOB-FM, KLSK, KKJY, KRST, KOLT, KMGA
Taos:	KKIT

In preparation for the tour, a [illegible] people to the site. Also, the Los Alamos County Golf Course manager was contacted to request permission for members of the public to park in the golf course parking lot and for the van to pick up passengers there.

The following non-Laboratory and non-DOE people participated in the tours:

March 14 morning:
Denise Smith, LA County Commissioner and interested nearby homeowner
Steven Shankland, reporter, LA Monitor
Brad Parker, son of private developer Paul Parker
Bob Hill, neighbor who walks dogs frequently on the adjacent land
March 14 afternoon:
Sarah Williams, homeowner on the private development
Glenn VanDerpoel
Martin Gursky
Robert Remillard, US Forest Service
March 15 morning:
Leslie Delaney, building a home in Phase III of the private development
March 15 afternoon:
Georgia Strickfaden, owner, Buffalo Tours

During each tour, Jim Aldrich, the Operable Unit Project Manager gave a brief presentation and answered questions.

Answers to Questions Provided on the Tours:

Because the land had been used for target practice, the cleanup involves removing lead from the soil. The site will be cleaned to residential standards. The cleanup standard for lead is 500 ppm which is a health based risk level. Background lead levels in the site are about 60-70 ppm. The sampling found levels as high as 900 ppm. Other cleanup sites have reached cleaned levels as low as 170-200 ppm. The cleanup level for this site will depend on physical characteristics of the soil.

The groundwater has not been contaminated by the lead on the site because the groundwater is about 1000 feet below the surface. It is highly unlikely the water will penetrate to that level. Also, highly acidic conditions are required to break down lead, and conditions on this site are alkaline. Also, the the County water supply is sampled periodically. Any aberration in the water content would show up there. To date, the sampling has shown no unexpected amounts of lead in the water.

Sampling is conducted by the Laboratory. It is not unusual for the state and EPA to conduct independent sampling to verify results.

The cost of the project, as listed in the Work Plan, is $330,000. There were some comments over the cost of the project versus the benefits. It was explained that while it would be faster and cheaper to haul the contaminated soil to another contaminated site, the regulators determined that it is preferable for the soil be processed to residential standards before it is used for any other purpose, even a road bed.

After the cleanup, the site permit calls for the water in the ponds to evaporate. The developer's representative, however, asked if they could use the water to help compact the new road beds. Jim Aldrich said he would ask the NMED to modify the discharge permit. There was another question about water runoff. It was explained that runoff will be avoided because the ponds will be lined.

The equipment used in this cleanup was modified from a large piece of sand and gravel equipment. The equipment operates in two stages: first, by suspending the soil particles in water, then using gravity to release any lead particles which are collected for recycling. No chemicals are used in this process. The cleaned soil will be left for the private developer who intends to use it to raise a roadbed which will then be covered with asphalt.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

APR 29 1994

Mr. Joseph C. Vozella, Chief
Environment, Safety and Health Branch
Department of Energy
Los Alamos Area Office
Los Alamos, New Mexico 87544

Re: NOD Response on VCA at SWMU 0-016, Inactive Firing Range
Los Alamos National Laboratory (NM0890010515)

Dear Mr. Vozella:

The Environmental Protection Agency (EPA) has reviewed your response dated February 28, 1994 on the Voluntary Corrective Action for SWMU 0-016, an inactive firing range in Operable Unit 1071. The revised plan is acceptable with one modification that a final report on the remediation and confirmation analysis will be submitted to EPA within 60 days of receipt of analytical data.

In addition, EPA would like Los Alamos National Laboratory (LANL) to note that an additional remedy under section 3.2 would be removal and disposal of the contaminated material to a proper hazardous waste disposal facility. Relocation of the material to another small-arms range, as indicated in the text, would be a violation of RCRA waste management regulations.

LANL shall apply for a Class 3 permit modification for this unit as soon as possible. Should you have any questions, please contact Barbara Driscoll of my staff at (214) 655-7441.

Sincerely,

for William K. Honker, Chief
RCRA Permits Branch (6H-P)

cc: Benito Garcia, NMED
Jorg Jansen, ER Program Manager, LANL, M992

Printed on Recycled Paper

United States Department of Agriculture
Forest Service
Espanola Ranger District
P.O. Box R
Espanola, NM 87532

Caring for the Land and Serving People

Reply To: 1580

Date: July 1, 1994

Jan Novak
Los Alamos National Laboratory
Environmental Restoration Program
Group EES-1, Mail Stop D462
Los Alamos, New Mexico 87545

Dear Mr. Novak:

Attached for use and files is the Revised Plan which is to be attached to, and made part of the existing Special Use Permit dated 12-22-94. This amendment revises the Operation/Reclamation Plan for OU 1071, SWMU 0-016 Inactive Firing Range. Please provide John L. Williams of ERM/GOLDER LOS ALAMOS PROJECT TEAM with a copy of this revised plan. Please notify Jim Aldrich, LANL Operable Unit Project Leader, that you have been provided with the final revised plan which is attached.

you have any questions concerning the above, please call Robert Remillard at 667-2217 or 667-5120. Please notify Robert Remillard of the Los Alamos Forest Service Office prior to beginning any ground disturbing activities.

Sincerely,

LORI D. OSTERSTOCK
District Ranger

Small Arms Range Guaje Pines Cemetery
Solid Waste Management Unit 0-016
Revised Operation/Reclamation Plan.
June 30, 1994

INTRODUCTION

The following plan is to be made part of the restoration activities at the Department of Energy (DOE) Small Arms Range in the vicinity of Guaje Pines Cemetery, identified in the Voluntary Corrective Action Plan SWMU 0-016, Inactive Firing Range. This is a revision to the plan identified in the existing Special Use Permit dated 12-22-94. This revision is needed to outline operations in the area immediately northwest and downslope of the site. The criteria established here may require adaptation during operations if monitoring indicates it is warranted.

The restoration plan for the site is intended to remove lead from the soil to below action levels, restore and revegetate the site and create stable landforms for establishing and maintaining vegetation over the long term. In order to be able to reach the goals of this plan, specific requirements for topographic restoration will be taken into account when planning and excavating the site.

Changes requested by LANL or the Forest Service will be incorporated by amendment after mutual agreement between both parties.

A. Location.

The area is located immediately adjacent to an inactive firing range (SWMU 0-016), approximately 1.25 acre is included within the flagged boundary. The areas of concern are located on the ground with pin flags.

B. Scope of Operation

This amendment to the existing plan, is needed to complete the removal of lead contamination at the old DOE pistol range. Recent surveys have identified the need to expand restoration activities into an area adjacent to the pistol range. Trees will need to be removed from the area. Tree removal will take place on an area estimated to be approximately 1.25 acres in size. Total area in which activity may occur is approximately 2 acre. The activity will include removal of trees, removal of approximately 6 inches of soil, and revegetation of disturbed area. The new activity described in this plan includes tree removal and revegetation of the slope.

1. SITE ACTIVITY

1.1 Timber

(1) Tree and stump removal will be the first step in the process. The trees will be removed from the site, and stored in a designated area. Methods of tree removal which incorporate significant quantities of soil will not be used. Operator will be permitted to push the trees with a Dozer. The trees will be pushed or dragged to the designated storage area. The area to be cleared will be flagged with red flagging, no trees outside the flagged area are to be damaged or removed. Trees identified to be saved will be flagged in red. These trees or groups of trees will be protected during the cleaning operations. If any of these trees need to be removed due to operations, the operator will have to request permission from the Forest Service.

Unless otherwise agreed, salvage of merchantable timber/firewood will be conducted by the Forest Service after soil cleaning operations are completed. The intent of this decision is to avoid interference with the soil washing and other restoration activities.

If required by the Forest Service, 4 (four) sound 8" diameter or greater logs will be retained and scattered or placed at the direction of the Forest Service throughout the reclaimed area to provide micro-wildlife habitat.

1.2 Slash

(1) Slash removal will take place in a manner which does not incorporate significant amounts of soil. All slash will be removed from the area, and used as outlined below.

(2) Slash will be chipped and applied to disturbed areas as a mulch, no more than 3 inches in depth, after seeding.

(3) Unless otherwise agreed, stumps will be removed from the site, no burying of stumps is permitted.

1.3 Soil

(1) Environmental effects are minimized by disturbing the smallest practical area at any one time. If possible operations should be broken into blocks to minimize the amount of open area at one time. It is understood that this may not be possible because the area is small, but it should be considered during operations.

(2) Approximately six inches of soil will be pushed to the processing area within the pistol range site.

(3) Soil needed for reclamation will come from the stockpile of clean material which is located at the pistol range side, or from offsite sources.

1.3 Drainages

(1) The main ephemeral drainage will be lined with straw bales to prevent sediment from entering the stream channel. This barrier will be monitored by the operator to ensure it is preventing sediment from entering the stream channel.

(2) The main intermittent stream channel will not be blocked by operations, no equipment is allowed to enter the channel. A vegetation buffer will be maintained between the channel and the work area. This buffer area will be well designated with straw bales, and flagging if necessary.

Any exceptions to this plan will be carefully reviewed by the Forest Service, and appropriate measures taken to protect soil, water, and vegetation.

2.0 RECLAMATION PLAN

2.1 Topographic Restoration

(1) The overall goal of topographic restoration is to re-establish a stable, natural appearing landscape:

(2) **Topography:** All cutbanks and steep slopes will be knocked down and/or back filled with overburden material to create slopes similar to those that existed prior to activity.

2.2 Soil Replacement

(1) Unless otherwise agreed, soil will be applied to all slopes with a uniform thickness not less than 8 inches.

2.3 Soil Amendments

(1) Soil amendments will be added. Organic soil amendments may include the following:

A. Straw mulch, approximately 3000 pounds per acre, fertilize based on soils test, minimum treatment will be to fertilize using Nitrogen at a rate of 80 lbs./acre

B. Organic fertilizer product such as "Bio Sol", apply based on product specifications.

C. Wood Chips as described in item (1.2), and fertilize as described in (A.) above.

2.4 Seed Mix

(1) Seed mix (below) will be broadcasted prior to mulching.

Variety/Species	lbs/acre Pure Live Seed
Perennial rye (Lolium perenne)	8.8
Yellow Sweet clover (Melilotus spp.)	8.0 "
Hard fescue (Festuca ovina)	6.0 "
Russian wildrye (Elymus junceus)	12.8 "
Rabbit Brush (Chrysothamus nauseousous)	5.0 "
	40.6 lbs/acre

(2) It is the responsibility of the operator to obtain the required seed mix necessary for reclamation and site stabilization. Substitute species may be used if approved by the appropriate Forest Service specialist.

3.0 MONITORING OF OPERATION

(1) Monitoring will be conducted during all phases of the operations. Clearing operations, topographic restoration, soil stabilization, stream side protection, and revegatation monitoring will be performed on an as-needed basis during restoration. The operator will keep the Forest Service Representative (FSR) informed of all phases of the operation, and will notify the FSR of any problems that occur.

4.0 Additional Stipulations - These mitigation measures have been found to be effective on past operations of a similar nature :

A. Water Quality

1. Best Management Practices will be followed during all activities.

B. Public Health, Safety, and Protection of Property

1. During all activities associated with the project, permittee will take into consideration the public safety.

2. The permittee will prepare and adhere to a Safety Plan developed for implementation of this activity. The plan will include, trail use, public safety along trail, signing, equipment operations, etc.

3. All cut walls, pits, holes will be covered, fenced, flagged, o signed depending on potential hazard that may exist, so as to protect the public from injury.

4. All activities will be accomplished in accordance with OSHA safety regulations and all other Federal and State laws.

ER ID

August 23, 1994

Doris Garvey, Acting Group Leader
Los Alamos National Laboratory
ESH-8/WQ&H:94-366; Mail Stop K490
Los Alamos, NM 87545

Kenneth M. Hargis, Leader
Environmental Protection Group
Los Alamos National Laboratory
ESH-8/WQ&H:94-289; Mail Stop K490
Los Alamos, NM 87545

STATE OF NEW MEXICO
ENVIRONMENT DEPARTMENT

Re: No Discharge Plan Required for Soil Washing Activities at Abandoned Firing Range, Operable Unit 1071

Dear Ms. Garvey, Mr. Hargis:

The New Mexico Environment Department (NMED) has received your NOI's for the discharge of soil washing slurry from the Abandoned Small Arms Firing Range accordance with Section 1-201. of the NM Water Quality Control Commission (WQCC) Regulations. The facility is located at Operable Unit 1071, Los Alamos National Laboratory, Los Alamos County. The application satisfies the requirements of Section 1-201 of the WQCC Regulations.

Based on the presently available information in your NOI's a discharge plan is not being required for this discharge as long as the discharge is as described.

A discharge plan is not being required because it appears that the discharge conforms to the numerical ground water standards and does not contain any toxic pollutants as defined in WQCC Reg.1-101.UU, and therefore is exempt from the discharge plan requirement under WQCC Reg.3-105.A.

The exempt discharge is briefly described as follows:

Soil slurry produced by the washing of lead projectile contaminated soil at the abandoned small arms firing range and accumulated in the drag tank and lined lagoons which recirculate the process water, will be removed by vacuum trucks and discharged from the trucks at three sites within the Los Alamos National Laboratory boundary. Removal of the slurry is necessary to maintain adequate water capacity in the lagoons for the soil washing operations. Any soil

Bruce King
Governor

Judith M. Espinosa
Secretary

Ron Curry
Deputy Secretary

Harold Runnels Building
1190 St. Francis Drive
P.O. Box 26110
Santa Fe, NM 87502
(505) 827-2850
FAX (505) 827-2836

slurry exceeding the ground water standards or TCLP standards for lead, copper or zinc will not be discharged on to the ground. Soil slurry discharge will be restricted to the following areas and will be contained within bermed areas to prevent surface runoff:

1. Operable Unit 1071, Abandoned Firing Range, TA-16

2. TA-53

3. Sigma Mesa

Although a discharge plan is not being required for this discharge, you are not relieved of liability should your operation result in actual pollution of surface or ground waters. Further, this decision by the NMED does not relieve you of your responsibility to comply with any other applicable federal, state, and/or local laws and regulations, such as zoning requirements, plumbing codes and nuisance ordinances.

If at some time in the future you intend to change the amount, the character, or location of your discharge so that it will not be as described, or if observation or monitoring shows that the discharge is not as described, you must file a new request for exemption with the Ground Water Section.

If you have any questions, please contact either Richard Ohrbom of the Ground Water Section staff at 827-0219 or the Program Manager of the Ground Water Section at 827-2900.

Sincerely,

Glenn Saums for Marcy Leavitt

Marcy Leavitt, Chief
Ground Water Protection &
Remediation Bureau

ML/RO/ro

cc: Tito Madrid, NMED District II Manager
Glenn Saums, Program Manager, SWQB

United States Department of Agriculture
Forest Service
Espanola Ranger District
Los Alamos Office
475 20th St. #B.
Los Alamos, NM
87544

Caring for the Land and Serving People

ER ID = 62031

Reply To: 1580

Date: October 7, 1994

Mr. Jim Aldrich
Field Project Leader
Los Alamos National Laboratory
EES-1. Geology/GeoChemistry
MS D462
Los Alamos, New Mexico 87545

Dear Mr. Aldrich:

Attached as requested is the Special Use Permit to complete the work on the Solid Waste Management Units located on lands administered by the Santa Fe National Forest. Please sign all three copies and return all copies to the Los Alamos Forest Service Office for final signature and approval.

If you have any question concerning the above, please call Robert Remillard at 667-2217.

Sincerely,

LORI D. OSTERSTOCK
District Ranger

FS-2700-25 (12/91)

U.S. DEPARTMENT OF AGRICULTURE Forest Service	Holder No.	Issue Date	Expir. Date
	-	11/01/94	11/01/95
TEMPORARY SPECIAL-USE PERMIT (FSH 2709.11, sec. 54.6)	Type Site(s) 411	Authority 002	Auth. Type 0022
Authority: 36 CFR 251.50, et seq.,	Region/Forest/District 03 / 10 / 06		State/County 35/ 028
This authorization is revocable and nontransferable and is a license for the use of federally-owned land. It does not grant any interest in real property.	Cong. Dist. 03	Latitude - -	Longitude - -

U.S. DEPARTMENT OF ENERGY LOS ALAMOS AREA OFFICE
hereinafter called the Holder, is hereby authorized to use, subject to the terms and conditions of this permit, Nation Forest System land identified within the unit area and described as

OPERABLE UNIT: 1071, TA:0 SWMU'S C-0-020, 0-011(B/E AND C), 0-016 as shown in Exhibit A

The holder is authorized to conduct the following activities on the permitted area:

ATTACHMENT - PROPERTY SPECIFIC SAMPLING PLAN, LOS ALAMOS NATIONAL LABORATORY WILL BE RESPONSIBLE FOR ACTIVITIES IDENTIFIED IN THE ATTACHED PLANS (EXHIBIT(S) A) INCLUDING THE STORM WATER POLLUTION PREVENTION PLANS, AND/OR IDENTIFIE IN THE DOCUMENT TITLED RFI WORK PLAN FOR OPERABLE UNIT 1071.

The holder is authorized to install the following temporary improvements on the permitted area: **NA**

TERMS AND CONDITIONS

1. Use under this permit shall begin on **NOVEMBER 1, 1994** and end on **NOVEMBER 1, 1995**. The permit shall not be extended.
2. The fee for this use is **NO FEE 36 CFR 251.57 (C)**. It shall be paid in advance and is not refundable.
3. The holder shall conduct the authorized activities according to the attached approved plans and specifications, Exhibit(s) **A**.
4. The holder shall not install any improvements not specifically identified and approved above.
5. No soil, trees, or other vegetation may be destroyed or removed from National Forest System lands without specifi prior written permission from the authorized officer.
6. The holder shall comply with all Federal, State, county, and municipal laws, ordinances, and regulations which ar applicable to the area or operations covered by this permit.
7. The holder shall maintain the improvements and premises to standards of repair, orderliness, neatness, sanitation and safety acceptable to the authorized officer. The holder shall fully repair and bear the expense for all damage, other than ordinary wear and tear, to National Forest System lands, roads and trails caused by the holder activities.
8. The holder shall be liable for any damage suffered by the United States resulting from or related to use of this permit, including damages to National Forest resources and costs of fire suppression.
9. The holder has the responsibility of inspecting the use area and adjoining areas for dangerous trees, hanging limbs, and other evidence of hazardous conditions which would pose a risk of injury to individuals. After securi permission from the authorized officer, the holder shall remove such hazards.
10. The holder shall hold harmless the United States from any liability from damage to life or property arising from the holder's occupancy or use of National Forest lands under this permit.

.. The holder agrees to permit the free and unrestricted access to and upon the premises at all times for all lawful
1 proper purposes not inconsistent with the intent of the permit or with the reasonable exercise and enjoyment
ɔ holder of the privileges thereof.

2. This permit is subject to all valid existing rights and claims outstanding in third parties.
3. This permit may be revoked upon breach of any of the conditions herein or at the discretion of the authorized officer. Upon expiration or revocation of this permit, the holder shall immediately remove all improvements exce those owned by the United States, and shall restore the site within 30 days, unless otherwise agreed upon in writing. If the holder fails to remove the improvements, they shall become the property of the United States, bu that will not relieve the holder of liability for the cost of their removal and restoration of the site.

14. This permit is not transferable. The holder shall not sublet occupancy of the authorized premises and improvemen to third parties.
15. Any changes to this permit, its provisions or requirements may be subject to appeal per 36 CFR 251.
16. This permit is accepted subject to the conditions set forth herein, condition(s) NA and Exhibit(s) NA attached to and made a part of this permit.
17. The above clauses shall control if they conflict with additional clauses or provisions.

HOLDER

FOR THE UNITED STATES DEPARTMENT OF ENERGY

_____

EARL BEAN ACTING AREA MANAGER
LOS ALAMOS AREA OFFICE

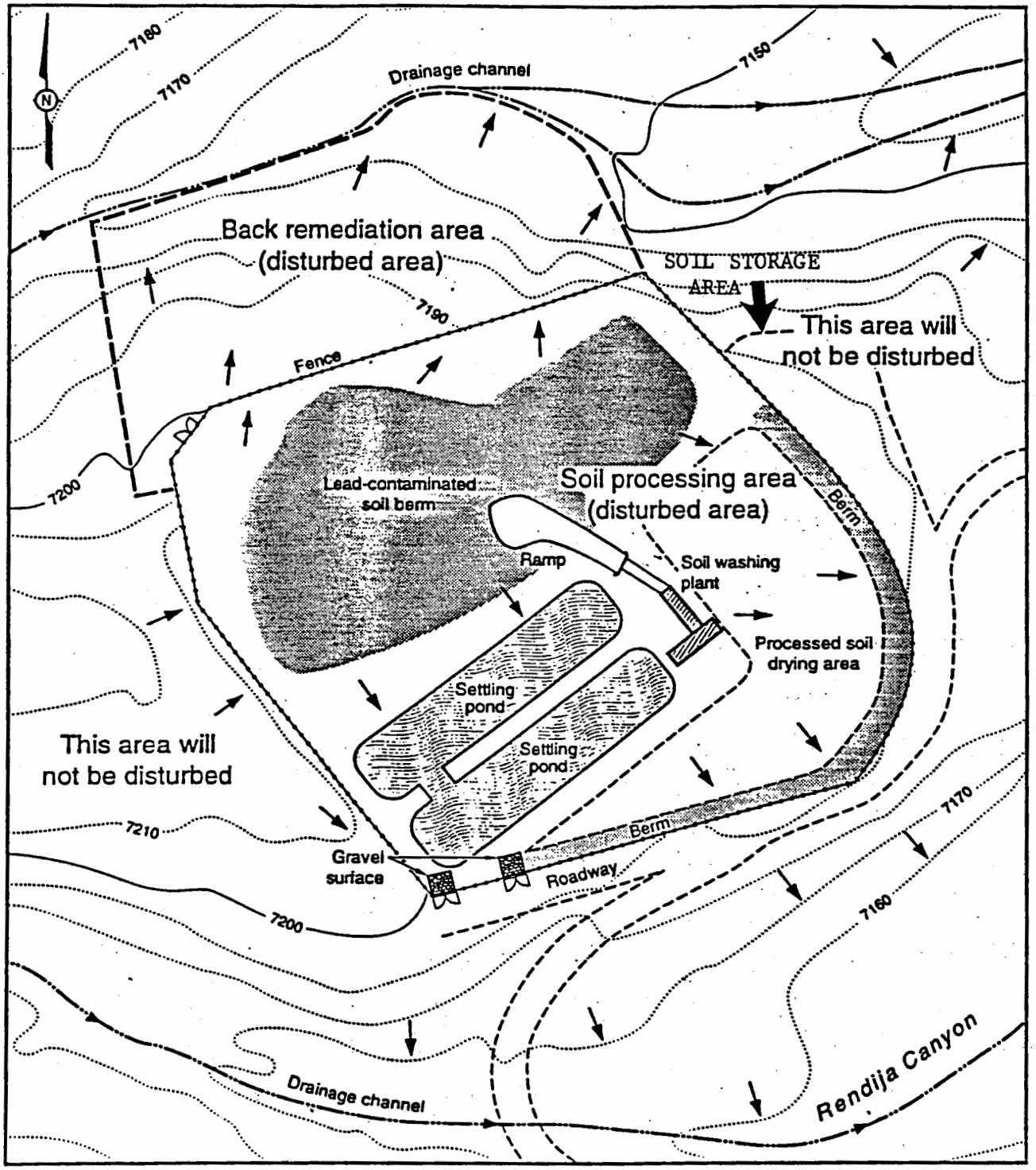
Date: _____

U.S. DEPARTMENT OF AGRICULTURE
Forest Service

By: _____

LORI D. OSTERSTOCK
DISTRICT RANGER

Date: _____



→ Arrow indicates direction of surface water flow

0 100 200 ft

cARTography by A. Kron 8/16/94

Inactive Firing Range, soil washing site, and back remediation area, SWMU 0-016 (OU 1071).

VOLUNTARY CORRECTIVE ACTION PLAN

SWMU 0-016, INACTIVE FIRING RANGE

1.0 Introduction

Solid Waste Management Unit (SWMU) 0-016 is a former small arms range located west of Guaje Pines Cemetery in Los Alamos, New Mexico. The site, which occupies about two acres, consisted of several small buildings and two earthen berms. At present, only concrete steps, pads, and the earthen berms remain. The target berms contain lead bullets, lead fragments, and particulate lead.

The site was used by Los Alamos National Laboratory (LANL) from the late 1940s to the 1960s for small arms target practice. The earthen berms are estimated to contain about 1800 cubic yards of soil. The soil cover is relatively thin at the site outside of the berms, and much of the SWMU 0-016 ground surface is formed by the Bandelier Tuff. This relatively thin soil cover will reduce the additional volume of soil for soil washing. The objective of this voluntary corrective action (VCA) plan is to reduce the level of lead in the earthen berms and associated soil to levels that would allow the site to be released for public use.

The United States Forest Service (USFS) and the County of Los Alamos have requested the cleanup of the range so that the land may be transferred from the USFS to a local developer, as part of a larger public-private land exchange. This VCA plan is being proposed, instead of following the RFI/CMS process as stated in the Operable Unit (OU) 1071 RFI Work Plan (LANL 1992), because of the time constraints placed on the Environmental Restoration (ER) Program by the pending land exchange.

This VCA plan proposes that the lead be removed from the berms using a soil washing process that has been successfully used at similar small arms firing range sites. This process has been shown to reduce the lead concentration in soils to well below the 500 ppm screening action level (e.g., Saracino and Parent, attached). Soil samples will be taken throughout the soil washing process to gauge its effectiveness and to ensure that no hazardous materials escape to the environment.

1.1 Previous Studies

The USFS conducted a study of the area in 1991. At that time 11 of 21 samples taken from the SWMU failed the TCLP test for heavy metals. This was believed to be due to the presence of lead bullets and fragments within the earthen berms. The USFS stated that the TCLP test did not reproduce the essentially pH-neutral soil conditions at the site and that the lead-contaminated soil did not constitute a release of a hazardous substance under the Comprehensive Environmental Response, Liability, and Compensation Act. In addition, they stated that the lead in the earthen berms does not constitute a threat to the ground water in the area due to the great depth to water (approximately 1300 feet below ground surface). The results of this study were reported by the USFS to the U.S. Coast Guard National Response Center in a letter dated 13 April 1993 (attached).

Studies conducted by the Naval Engineering Laboratory indicate that metallic (elemental) lead is the prime contaminant in small arms firing ranges (Heath *et al.*, attached). Other forms of lead, such as oxidized lead, are not commonly found in small arms ranges and would not be expected to be common in the arid environment found in Los Alamos.

All samples will be analyzed for lead. Ten percent of the samples collected will also be analyzed for compounds commonly found in small arms ranges. This list will include lead, copper, and zinc, the three most common contaminants found in small arms ranges (Heath *et al.*, attached). These additional analyses will serve to provide further evidence that any soil contamination from the small arms range has been remediated during the soil washing process.

1.2 Cleanup Levels

The LANL screening action level (SAL) for lead in soils is 500 ppm. This SAL is derived from a generic facility risk assessment based on the assumption that sites will be designated for residential use. This is also the lower cleanup level established by the U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response Directive 9355.4-02 and the New Mexico Environment Department's approved level for lead in soils. The level of 500 ppm will be used as an upper boundary for lead in soils for this VCA.

It is expected, based upon previous experience with this soil washing process, that cleanup levels well below the 500 ppm level for lead in soil will be achieved at SWMU 0-016.

2.0 Soil Washing Process

Lead will be removed from the earthen berms at SWMU 0-016 by a soil washing process that uses a modified sand and gravel plant to separate metallic lead from the soil. Soil will be transferred from the berms to the soil washing plant using front-end loaders. The soil will be sprayed with water if significant amounts of dust are created during this transfer.

All of the earthen berms at the site and up to one foot of soil from the floor of the firing range will be processed to remove lead. While lead is expected to be concentrated in the berms located at the rear of the small arms range (the backstop berms), this additional soil processing will help to ensure that no lead-contaminated soil will remain at the site.

This soil washing process operates on the principle that most soil particles have average densities of 3 to 4 grams per cubic centimeter (g/cc), while particulate lead has an average density of 11.4 g/cc. This difference in average densities is used to physically separate, concentrate, and remove the fine particulate lead from the soil. Larger lead fragments and bullets will be separated from the coarse fraction of the soil by automated sieves.

The soil washing plant consists of a hopper feeder above a jigging box that is used to sort out coarser material from the soil and to retain larger lead fragments and bullets. After the larger lead fragments and bullets are removed, the remaining soil is fed into two sand screws which, in turn, feed the soil into a series of stacked power hydro-screens with 3/4", 1/4", and 1/8" openings. High-pressure water sprays are used to force the soil through these screens. The finer material that passes through these screens is then sent through a 3-foot diameter centrifugal separator. The centrifugal separator uses water and the greater density of lead to separate out the fine particulate lead.

The washed soil and associated water then flows along a drag tank where most of the soil is removed. Next, the water flows into two large recirculating ponds (200 ft. by 50 ft. each) that are used to separate out the fine soil suspended in the water and to act as reservoirs to recirculate the water used during the soil washing process. The recirculating ponds will be excavated during site preparation. The two recirculating ponds will be lined to prevent the release of any water used in the soil washing process to the environment.

The lead removed from the screens and the centrifugal separator will be placed into 55-gallon drums. The lead will then be sent by Johnson Controls, Inc., to a recycling center.

3.0 Sampling and Analysis

Sampling and analysis will consist of a comprehensive series of field and laboratory analytical techniques. The soil will be sampled as it is processed throughout the course of the project to ensure that the soil washing procedure is effective and that no contaminants are released to the environment during or after the soil washing process. The soil analyses are summarized in Table 1.

Field analyses for lead will be conducted using a Spectrace 9000 field portable X-ray fluorescence (XRF) instrument configured to detect lead in soils at low levels (below 100 ppm). The XRF and associated equipment will be housed in a portable field trailer set up at the site. A 120-volt power line will be run to the field laboratory to ensure a consistent and reliable source of electricity for the instrumentation.

Soil samples gathered for analyses in an approved environmental laboratory will be sent to the LANL ER Program Sample Coordination Facility for shipment and analysis, as established in the approved procedures published by the ER Program.

All samples will be analyzed for lead. A minority of the samples collected (approximately 10%) will also be analyzed for compounds commonly found in small arms ranges. This list will include copper and zinc.

3.1 Background Sampling

Soil samples will be gathered from areas outside the SWMU boundary from soils similar in composition to those found in the earthen berms. Approximately 20 background soil samples will be collected. These background samples will be analyzed in the field and approximately five will be analyzed by an approved environmental laboratory. The background samples will provide information on natural levels of lead in the area of SWMU 0-016.

3.2 Sampling during Soil Washing

Soil samples will be gathered from the soil washing apparatus on a regular basis. Depending on the rate at which soil is processed by the apparatus, samples will be taken at regular intervals ranging from 30 to 90 minutes. These soil samples will be used to represent a given batch of washed soil and will be analyzed by XRF in the field. If any of these soil samples are not below the cleanup level of 500 ppm, that batch of soil will be reprocessed until the lead levels are within satisfactory limits. Based upon initial contractor estimates of soil processing rates, it is expected that approximately 150 to 200 soil samples will be analyzed in the field during the soil washing process.

Soil from the recirculating ponds will be gathered and analyzed on a daily basis to ensure that lead levels are below the cleanup levels. Previous experience with this plant has shown that little, if any, lead is released into the recirculating ponds.

3.3 Airborne Lead Sampling

Airborne lead will be monitored at the site for health and safety reasons and to gauge and prevent any release of airborne lead to the environment. High-volume air samplers will be positioned both upwind and downwind of the site. Samples from the high-volume air samplers will be gathered and analyzed by XRF on a twice-daily basis. If detectable amounts of lead are found to be released during the soil washing process, engineering controls will be undertaken to prevent further airborne release of lead. Since the soil is wetted during the washing process and dry soil will be sprayed with water before handling, it is unlikely that significant amounts of lead will be released to the air. It is expected that approximately 60 to 90

samples will be gathered from the high-volume air samplers and analyzed in the field during the soil washing process.

3.4 Confirmation Sampling

Samples from the washed soil will be gathered after the soil washing process. These samples will be sent to an approved laboratory and used to confirm field analyses. One composite sample will be taken for about every 100 cubic yards of soil processed. Since the expected volume of soil is somewhat less than 2000 cubic yards, approximately 20 confirmation samples will be gathered and analyzed.

4.0 Material Disposition

Upon conclusion of the VCA, the site will contain approximately 2000 cubic yards of washed soil and the water contained in the two recirculating ponds. If the confirmation sampling shows the soil contains lead below the cleanup level, it will be left on-site for use by the new owner. The new owner will use the soil to raise the grade of the access road into the site and will then cover the road with asphalt.

The water in the two recirculating ponds will be allowed to evaporate to prevent discharge of liquid water to the environment. Recirculating pumps and sprays may be used to accelerate the evaporation.

REFERENCE CITED:

Los Alamos National Laboratory (LANL) 1992. "RFI Work Plan for Operable Unit 1071 - Environmental Restoration Program," Los Alamos National Laboratory Report LA-UR-92-810, Los Alamos, New Mexico. (LANL 1992)

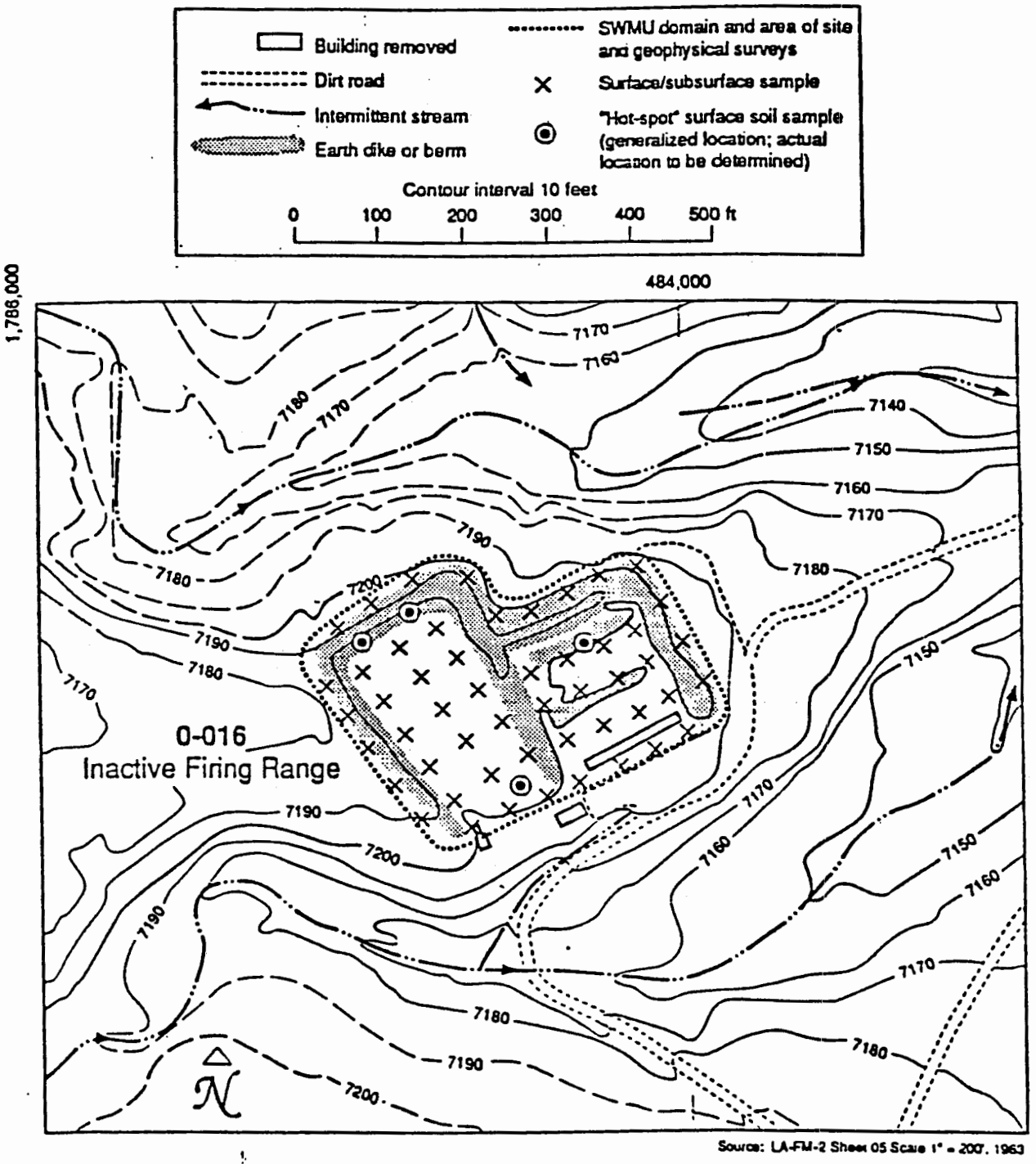


Figure 5-15. Sampling locations at SWMU 0-016 (Inactive Firing Range).

Los Alamos National Laboratory Environmental Restoration Program
PROPERTY-SPECIFIC SAMPLING PLAN

Operable Unit: 1071 **TA:** 0 **SWMU Nos:** 0-011(b/e and c)
AOC No: C-0-020

OUPL: Jim Aldrich **Phone No:** 667-1495

Regarding: Property belonging to the U.S. Forest Service and adjacent to Tract A of the Cemetery Tracts (Guaje Pines Cemetery, Los Alamos, New Mexico 87544 **Property Address:** none

Owner: U.S. Forest Service **Owner's Address:**

The following field sampling activities are anticipated to take place at the subject property during an approximate time frame from April 15, 1993, to September 30, 1994. Note that these dates are approximate only. Generally, the field investigation shall be conducted by some or all of the following field methods: (1) conducting non-intrusive field surveys; (2) surface and/or subsurface sampling; (3) other miscellaneous sampling activities if required; and (4) site restoration to any sampling disturbances of the property.

SITE ACCESS: The road into Rendija Canyon may be regraded in places to make it safe for vehicular traffic to the SWMUs.

FIELD SURVEYS: Specifically, the following types of field surveys shall be conducted at the subject property:

- **A visual site inspection** will be performed by the field sampling team. This activity will be conducted to assess any conflicts with proposed sampling locations or special considerations specific to the property.
- **Land survey** equipment (i.e., distance and elevation measuring devices) and personnel will be on-site to locate and stake sampling points during sampling activities.
- **Geomorphologic Mapping** will occur in order to locate sediment catchments in the main drainage channels closest to the downstream domain boundaries. Mapping will be completed on a scale of 1:2000.

ORDNANCE SEARCH AND REMOVAL: A domain-wide search of SWMUs 0-11 (b/e and c) and AOC C-0-020 will be conducted by an explosive ordnance disposal (EOD) team using a metal detector and magnetometer to locate unexploded ordnance, shells, shell material, and other metal objects related to the impact of mortars. A follow-on geophysical survey will be conducted as a quality control measure to verify that all ordnance explosive waste has been located. The search will be conducted on a grid system and will be adequately detailed to detect objects 1 inch in diameter and larger that may be buried at depths up to 3 feet. A Department of Defense or Laboratory team with ordnance expertise will work with the survey crew to remove objects as they are located.

SURFACE SAMPLING: Specifically, the following methods of surface sampling shall be conducted at the subject property. For more detailed information on the techniques and procedures to be followed, refer to the Sampling Analysis Plan (SAP) in the RFI work plan for this OU.

TABLE 1
Summary Table
Soil Analyses for SWMU 0-016 VCA

Sample Type	Analytical Method	Quantity	Analytes	Text Section
Background	XRF (field)	20	Pb	3.1
Background	Lab	5	Pb	3.1
Washed Soil	XRF (field)	150-200	Pb	3.2
Airborne Lead	XRF (field)	60-90	Pb	3.3
Confirmation	Lab	20	Pb	3.4
Confirmation	Lab	20	Cu, Zn	3.0

Notes:

All sample quantities are approximate and may vary slightly due to unforeseen field conditions.

A Sprectrace 9000 field portable X-ray fluorescence (XRF) instrument will be used to analyze for lead in soils.

"Lab" denotes samples to be analyzed by an approved environmental laboratory.

- **surface soil samples:** approximately 50 samples of soil and sediment will be collected from the three sites by the field sampling team at locations as determined from the geomorphic mapping results. Soil samples will be taken from the uppermost 6 inches of surface material at each sampling point and sediment trap samples from the depths specified by the geomorphologist, following the procedures described in LANL-ER-SOP-6.09, Spade and Scoop Method for Collection of Soil Samples. This type of soil sample will be gathered using a stainless steel or Teflon scoop. These samples will either be collected on a predetermined grid pattern or on a judgmental basis. The samples will be analyzed for the following constituents, as appropriate:

    - TAL Metals
    - Explosives

SITE RESTORATION OF SAMPLING DISTURBANCES: Specifically, the following types of activities are anticipated for restoration of sampling disturbances, as appropriate:

- **Backfilling excavations and surface grading:** Any excavations created during sampling activities will be backfilled/compacted with soil to restore the site to original grade. The ground surface will be graded smooth to match pre-existing grades.

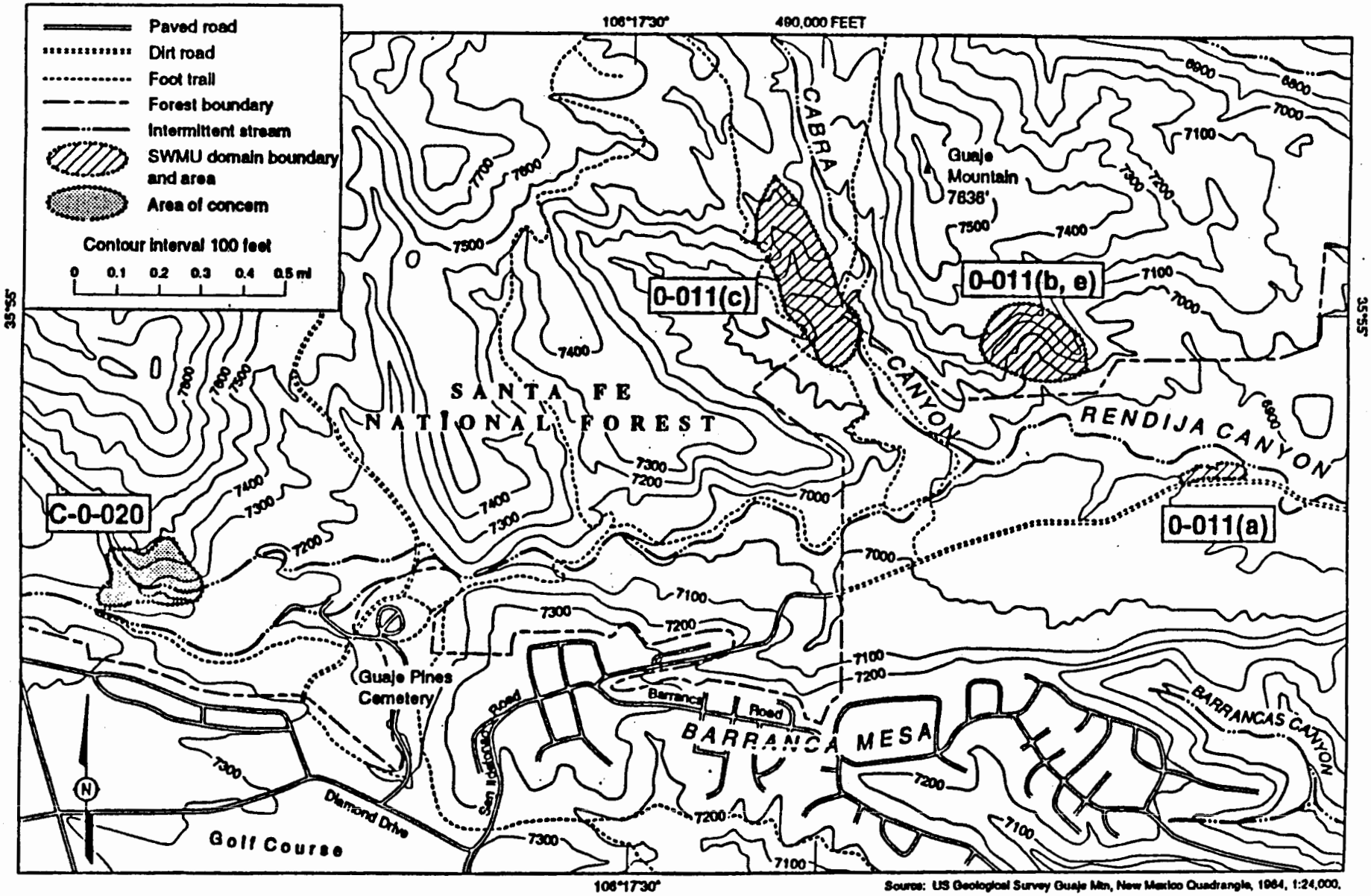
- **Repair and/or replace fences:** Any damage to fences during sampling activities will be repaired to match the pre-existing condition of the fence.

- Any other types of restoration that may be required.

The following notes are expressed provisions of the property-specific sampling plan and access agreement:

(1) **MINOR MODIFICATIONS:** Sampling quantities, depths, activity durations, are approximate only and are subject to modification in the field as necessary to achieve sampling goals.

(2) **MAJOR MODIFICATIONS:** Changes to sampling strategy such as surface versus subsurface or sampling excavations are possible during the field sampling program. In the event that this type of major modification is required, LANL/DOE shall obtain the property owner's oral agreement and follow-up with written documentation of the changes within 10 work days. Both LANL/DOE and the property owner will sign the written documentation to formalize the modification to the agreement.



Area map showing locations of PRSs 0-011(a, b, c, e) and C-0-020.

STORM WATER POLLUTION PREVENTION PLAN

Site Description

Project Name: OU1071, SWMU 0-016, Inactive Firing Range

Project Location: 0.2 miles west of the Guaje Pines Cemetery in Rendija Canyon, Los Alamos, NM

Description: This project consists of the removal of lead bullets, shot, and casings contained in the soil of the inactive firing range, and the area to the northwest of the firing range. Lead is the only potential pollutant source on site. Soil disturbing activities include: clearing and grubbing; installing a stabilized construction entrance, perimeter, and other erosion and sediment controls (straw bail barrier and soil berm); grading; excavation for the settling ponds; and road construction.

Runoff Coefficient: The final coefficient of runoff for the site will be c = 0.20

Site Area: The area of the site is approximately 6.2 acres all of which will be disturbed by construction activities.

Sequence of Activities: The order of activities will be as follows:

1. Install construction entrance;
2. Clear and grub for earth berm and settling ponds;
3. Install earth berm along south-east perimeter of site;
4. Place straw bails end-to-end along the south side of the north drainage channel at the base of the back remediation area slope to prevent sediment from entering the stream channel;
5. Continue clearing and grading;
6. Stock pile lead-contaminated topsoil and earthen berms;
7. Seed and lay down straw on the sloped north section of the site (back area);
8. Process lead-contaminated soil;
9. Remove earth berm and fill in settling ponds; and
10. Release site to the U.S. Forest Service or transfer site to Parker Construction Company.

Receiving Waters: The entire site will drain into two ephemeral tributaries to Rendija Canyon. One drainage channel is located adjacent to the north of the site. The second drainage channel is located approximately 200 feet to the south of the site.

Controls (Erosion and Sediment Controls)

Stabilization Practices

Temporary Stabilization - As the process soil stockpile is gradually removed for processing, the underlying area will be temporarily graded and stabilized with a straw mulch. The process area will be a

location of constant activity and there will be minimal temporary stabilization utilized. Portions of the soil processing area which will receive less activity may be covered with a straw mulch to reduce erosion. In addition, sediment and storm water catchment will be provided as described below.

The sloped area on the northwest side of the site will be lined on the downslope edge with straw bales placed end-to-end to act as a silt fence and prevent sediment from entering the stream channel. This stabilization will be performed by JCI prior to the removal of topsoil.

Permanent Stabilization - For the approximate 2-acre sloped area on the northwest side of the site, the disturbed area will mulched with straw at approximately 3,000 lbs/acre after seeding. Fertilizer will be added based on soils testing with a minimum treatment of 80 lbs/acre of nitrogen. Wood chips may be added after seeding in lieu of straw mulch up to a maximum depth of 3 inches. The permanent seed mix will consist of 8.8 lbs/acre of perennial rye, 8.0 lbs/acre of yellow sweet clover, 6.0 lbs/acre of hard fescue, 12.8 lbs/acre of russian wildrye, and 5.0 lbs/acre of rabbit brush. The stabilization will be performed by JCI following soil removal and replacement of clean soil.

Structural Practices

Earth Dike - An earth dike will run along the south, east, and northeast perimeter of the soil processing site. The soil processing site will be graded so that all drainage is contained by this dike. The toe of the dike will be graded to direct flow to the northeast end of the dike where a small catchment area will temporarily hold the water. A sump pump will intermittently pump the water and suspended sediment from this area to the two settling ponds used in the processing of the site soils.

Settling Ponds - Two settling ponds (connected at the southwest ends by a shallow weir), approximately 300 feet long by 50 feet wide, will be used during the soil processing and will also be used for receiving storm water runoff and suspended sediment pumped from the catchment area at the northeast end of the perimeter dike. Accumulated sediment will be removed intermittently from the settling ponds during processing and at the completion of the soil processing. After draining, the settling ponds will be filled in and graded.

Other Controls

Waste Disposal

Waste Materials - All waste materials will be collected and stored in a securely lidded metal dumpster provided by Johnson Controls Inc., a licensed solid waste management company in Los Alamos, New Mexico. The dumpster will meet all local and state solid waste management regulations. All trash and construction debris from the site will be deposited in the dumpster. The dumpster will be emptied approximately once per week or more often if necessary, and the trash will be hauled to the Los Alamos County Landfill. No construction waste materials will be buried on site. All personnel will be instructed regarding the correct procedure for waste disposal. Notices stating these practices will be posted in the support trailer and Daren Johnston, the field team leader and manager of day-to-day site operations, will be responsible for ensuring that these procedures are followed.

Hazardous Waste - All hazardous waste materials will be disposed of in the manner specified by state and

local regulation or by the manufacturer. Site personnel will be instructed in these practices and Mr. Johnston, the field team leader and manager of day-to-day site operations, will be responsible for ensuring that these practices are followed.

Sanitary Waste - All sanitary waste will be collected from two portable units at a minimum of once per week by L&L Portable, a licensed Los Alamos sanitary waste management contractor, as required by local regulation. The sanitary waste will be transported for disposal at TA-46 facility.

Off-Site Vehicle Tracking

A stabilized construction entrance has been provided to help reduce vehicle tracking of sediments. Dump trucks hauling material from the construction site will be covered with a tarpaulin.

Timing of Controls/Measures

As indicated in the Sequence of Major Activities, the earth berm, and stabilized construction entrance will be constructed prior to any clearing or grading of the site. Once construction activity ceases permanently in the back area, that area will be stabilized by revegetation with seed and mulch. The soil processing area will also be stabilized by revegetation to a minimum vegetation density of 70 percent with seed and mulch once construction activity ceases permanently. Due to the site being located in an arid region, seed and mulch will be applied during the wet season after site activity ceases. The settling ponds in the soil processing area will be filled to grade. The bermed area along the southeast perimeter of the site will be leveled to grade. Stabilized portions of the equipment/materials storage area which receive less activity may be covered with a straw mulch to reduce erosion. The site will be released to the U.S. Forest Service or transferred to a residential development contractor following soil remediation activities. The soil processing area of the site will be used by the contractor as an equipment/materials storage area prior to development.

Certification of Compliance with Federal, State and Local Regulations

The storm water pollution prevention plan is in compliance with all Federal, State, and local regulations.

Maintenance/Inspection Procedures

Erosion and Sediment Control Inspection and Maintenance Practices

The following are inspection and maintenance practices that will be used to maintain erosion and sediment controls:

- Less than one-half of the site back area will be denuded at one time;
- All control measures will be inspected at least once each week and following any storm event of 0.5 inches or greater;

- All measures will be maintained in good working order. If a repair is necessary, it will be initiated within 24 hours of report;
- Built up sediment will be removed from the earth berm when it reaches 10 percent of the design capacity or at the end of the job;
- Holding ponds will be inspected and any breaches promptly repaired;
- Temporary seeding and planting north of the fence will be inspected for bare spots, washouts, and healthy growth;
- A maintenance inspection report will be made after each inspection;
- Mr. Johnston, site field team leader, will select three individuals who will be responsible for inspections, maintenance and repair activities. and completion of the inspection and maintenance report and;
- Personnel selected for inspection and maintenance responsibilities will receive training from Mr. Johnston, and they will be trained in all the inspection and maintenance practices necessary for keeping the erosion and sediment controls used on site in good working order.

Non-Storm Water Discharges

It is expected that the only non-storm water discharges that will occur from the site during the construction period will be from the water line flushings. All non-storm water discharges will be directed into the holding ponds.

Inventory For Pollution Prevention Plan

The materials or substances listed below are expected to be present on site during remediation:

- Detergents
- Petroleum Based Products (diesel fuel, gasoline, hydraulic fluid, etc.)
- Wood
- Masonry Block
- Sheet Metal

Spill Prevention

Material Management Practices

The following are the material management practices that will be used to reduce the risk of spills or other accidental exposure of materials and substances to storm water runoff.

Good Housekeeping - The following good housekeeping practices will be followed on site during the construction project:

- An effort will be made to store only enough petroleum based product (diesel fuel, gasoline, hydraulic fluid, etc.) required to do the job;
- All materials stored on site will be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof or other enclosure;
- Products will be kept in their original containers with the original manufacturer's label;

- Substances will not be mixed with one another unless recommended by the manufacturer;
- Whenever possible, all of a product will be used up before disposing of the container;
- Manufacturer's recommendations for proper use and disposal will be followed; and
- The site field team leader will perform daily inspections to ensure proper use and disposal of materials on site.

Hazardous Products - The following practices are used to reduce the risks associated with hazardous materials:

- Products (diesel fuel, gasoline, hydraulic fluid, etc.) will be kept in original containers unless they are not resealable;
- Original labels and material safety data sheets will be retained (they contain important product information); and
- If surplus product must be disposed of, manufacturers' or local and state recommended methods for proper disposal will be followed.

Product Specific Practices

Petroleum Related Products - All on-site vehicles and equipment will be monitored for leaks and receive regular preventative maintenance to reduce the likelihood of leakage. Petroleum products will be stored in tightly sealed containers which are clearly labeled.

Spill Control Practices

The following materials may be present on site which have the potential for release:

- Diesel fuel (used in the front-end loader and bull dozer);
- Gasoline (used in generators and chain saws); and
- Hydraulic fluid (used in the front-end loader and bull dozer).

The procedures to be followed in the event of a consequential spill of fluid from operating equipment are detailed in the following subsections. Regardless of the magnitude of any spill, the area will be cleaned and the waste will be properly disposed. Spills that have negligible consequence on the environment, such as occasional drips from a slowly leaking line into the dry soil, need not be reported. Spills that have greater environmental impact, and particularly those that occur during a heavy rain, that have the potential to penetrate more than a few inches into the soil, or that could migrate off site, will be reported.

The determination of whether to report a spill should be made by the personnel in the field. If in doubt, the spill should be reported and described to Emergency Management and Response (EM&R) Group personnel as described below. EM&R personnel may conclude that the spill is negligible and require no further action, or they may chose to visit the site to inspect the spill which may require the preparation of a spill report. Any required follow-up activities will be performed at the direction of EM&R personnel.

Diesel Fuel - In the event that it is necessary to re-fuel the front-end loader or bull dozer at the site, all caps, hoses, and nozzles will be inspected for breakage and proper functioning prior to fuel transfer. If a hand pump is used to transfer diesel fuel, one person will service the pump and a second person will monitor the discharge into the fuel tank. The fuel hose nozzle will be carried with the outlet facing up until the nozzle is over the receiving tank.

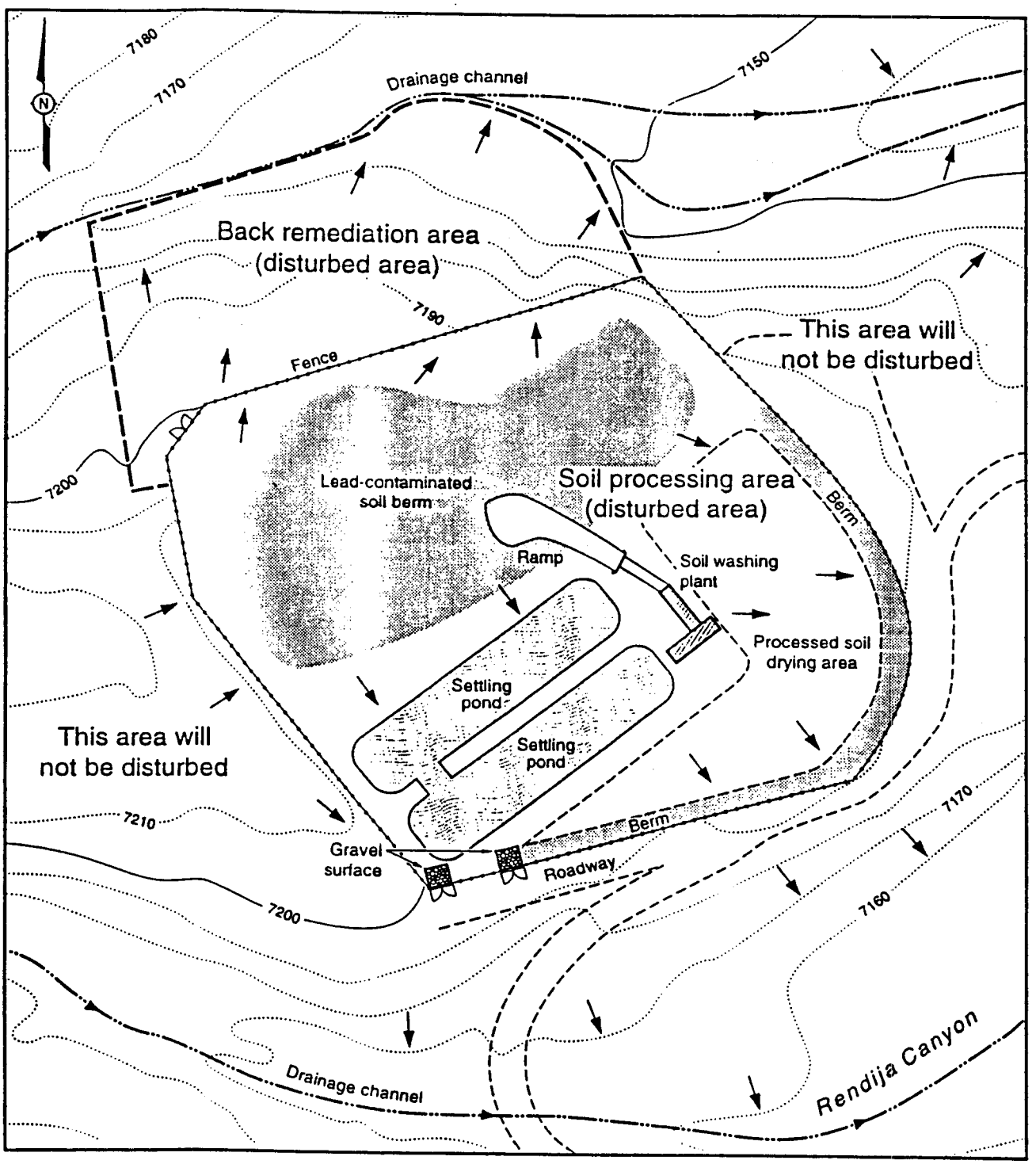
Gasoline - Gasoline powered generators and chain saws will be used at the project site. Prior to dispensing gasoline, all caps, hoses, and nozzles will be inspected for breakage and proper functioning. The gas can hose nozzle will be carried with the outlet facing up until the nozzle is over the receiving tank.

Hydraulic Fluid - Hydraulic fluids contained within the hydraulic lines of the front-end loader and the bull dozer will not be transferred or handled during site activities. As a precautionary measure, plastic sheeting will be placed beneath these machines during storage.

In the event that any of these fluids spill during the handling, storage, or re-fueling process, the following procedures will be implemented:

- Absorbent materials will be applied to the spill with shovels;
- Upon sufficient spill containment, absorbent materials will be collected, drummed, and held in an on-site temporary drum storage area. Waste Profile Request (WPR) forms will be completed to characterize the materials, and appropriate waste disposal request forms will be submitted requesting transportation of drummed waste to appropriate LANL waste management areas;
- The EM&R Group will be contacted at 667-6211 (after hours 667-7080) for further instructions; and
- A spill report will be completed and submitted to EM-8, Mail stop K490, to the attention of Mike Alexander.

Should a quantity exceeding 5 gallons of any of these fluids be released, the area affected by the spill will be sampled. Visibly stained materials will be cleaned or removed and drummed. All the procedures listed above will be performed for all spills. The following additional procedure will be performed for a hydraulic fluid release. All equipment operations will cease upon the occurrence of a hydraulic fluid release and the hydraulic lines shall be repaired, inspected, and in good working condition before operations resume.



→ Arrow indicates direction of surface water flow

0 100 200 ft

cARTography by A. Kron 8/16/94

Inactive Firing Range, soil washing site, and back remediation area, SWMU 0-016 (OU 1071).

Pollution Prevention Plan Certification

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who may 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 violations.

Signature:_____

Jim Aldrich, OU1071 OUPL (Date)

Contractor's Certification

I certify under penalty of law that I understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit that authorizes the storm water discharges associated with industrial activity from the construction site identified as part of this certification.

Signature	For	Responsible for
_____ JCI Supervisor Date:_____	JCI P. O. Box 50 Los Alamos, NM 87544	General Contractor and Temporary and Permanent Stabilization
_____ Robert Beaver Sr. Sierra Rock Inc., President Date:_____	Sierra Rock, Inc. P. O. Box 4623 Los Alamos, NM 87544	Stabilized Construction Entrance, Earth Berm, and Settling Ponds

OU1071, SWMU 0-016, INACTIVE FIRING RANGE

STORM WATER POLLUTION PREVENTION PLAN

INSPECTION AND MAINTENANCE REPORT FORM

TO BE COMPLETED EVERY 7 DAYS AND WITHIN 24 HOURS OF
A RAINFALL EVENT OF 0.5 INCHES OR MORE

INSPECTOR:_____ DATE:_____

INSPECTOR'S QUALIFICATIONS:

_____
_____
_____
_____

DAYS SINCE LAST RAINFALL:_____ AMOUNT OF LAST RAINFALL:_____INCHES

STABILIZATION MEASURES

AREA	DATE LAST DISTURBED	DATE OF NEXT DISTURBANCE	STABILIZED? (YES/NO)	STABILIZED WITH	CONDITION
SOIL WASH AREA					
BACK AREA					

STABILIZATION REQUIRED:

_____
_____
_____
_____

TO BE PERFORMED BY:_____ ON OR BEFORE:_____

OU1071, SWMU 0-016, INACTIVE FIRING RANGE

STORM WATER POLLUTION PREVENTION PLAN

INSPECTION AND MAINTENANCE REPORT FORM

STRUCTURAL CONTROLS

DATE:_____

EARTH BERM:

FROM	TO	IS BERM STABILIZED?	EVIDENCE OF WASHOUT OR OVER TOPPING? (Y/N)
EASTERN EDGE	WESTERN EDGE		

MAINTENANCE REQUIRED FOR EARTH BERM:

_____

_____

_____

TO BE PERFORMED BY:_____ ON OR BEFORE:_____

SILT FENCE (STRAW BAILS):

FROM	TO	IS FENCE STABILIZED?	EVIDENCE OF WASHOUT OR OVER TOPPING? (Y/N)
EASTERN EDGE	WESTERN EDGE		

MAINTENANCE REQUIRED FOR SILT FENCE (STRAW BAILS):

_____

_____

_____

TO BE PERFORMED BY:_____ ON OR BEFORE:_____

STABILIZED CONSTRUCTION ENTRANCE:

DOES MUCH SEDIMENT GET TRACKED ON TO ROAD?	IS THE GRAVEL CLEAN OR IS IT FILLED WITH SEDIMENT?	DOES ALL TRAFFIC USE THE STABILIZED ENTRANCE TO LEAVE THE SITE?	COMMENTS

MAINTENANCE REQUIRED FOR STABILIZED CONSTRUCTION ENTRANCE:

_____

_____

_____

TO BE PERFORMED BY:_____ ON OR BEFORE:_____

OU1071, SWMU 0-016, INACTIVE FIRING RANGE

STORM WATER POLLUTION PREVENTION PLAN

INSPECTION AND MAINTENANCE REPORT FORM

STRUCTURAL CONTROLS

DATE:_____

NORTH SETTLING POND:

DEPTH OF SEDIMENT IN NORTH POND	CONDITION OF POND SIDE SLOPES	ANY EVIDENCE OF OVERTOPPING OF THE EMBANKMENT?	COMMENTS

MAINTENANCE REQUIRED FOR NORTH SETTLING POND:

_____

_____

_____

_____

TO BE PERFORMED BY:_____ ON OR BEFORE:_____

SOUTH SETTLING POND:

DEPTH OF SEDIMENT IN SOUTH POND	CONDITION OF POND SIDE SLOPES	ANY EVIDENCE OF OVERTOPPING OF THE EMBANKMENT?	COMMENTS

MAINTENANCE REQUIRED FOR SOUTH SETTLING POND:

_____

_____

_____

_____

TO BE PERFORMED BY:_____ ON OR BEFORE:_____

OU1071, SWMU 0-016, INACTIVE FIRING RANGE

STORM WATER POLLUTION PREVENTION PLAN

INSPECTION AND MAINTENANCE REPORT FORM

CHANGES REQUIRED TO THE POLLUTION PREVENTION PLAN:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

REASONS FOR CHANGES:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who may 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 violations.

SIGNATURE:_____ DATE:_____

CY G. Hill
C. Newton
E525

State of New Mexico
ENVIRONMENT DEPARTMENT
Hazardous & Radioactive Materials Bureau
525 Camino De Los Marquez
P.O. Box 26110
Santa Fe, New Mexico 87502
(505) 827-4358
Fax (505) 827-4389

GARY E. JOHNSON
GOVERNOR

MARK E. WEIDLER
SECRETARY

EDGAR T. THORNTON, III
DEPUTY SECRETARY

May 17, 1995

Mr. Larry Kirkman
DOE/LAAO
528 35th Street
Los Alamos, New Mexico 87545

Dear Mr. Kirkman:

The New Mexico Environment Department (NMED) has received Los Alamos National Laboratory's (LANL) proposal to remove lead (in the form of spent projectiles) contaminated soil from Solid Waste Management Unit (SWMU) 0-016 (an inactive firing range undergoing Voluntary Corrective Action (VCA)) to an active firing range (SWMU 72-001) located at TA-72, as berm/backstop material. This proposal, as NMED understands it, would be in lieu of utilizing clean soil for the same use.

NMED concurs with LANL that the use of this lead contaminated material for the same purpose that it has previously been used for in the past prior to cleaning the soil for non-RCRA regulated use makes sense.

NMED is willing to authorize the use of this lead contaminated material as a beneficial product (berm/backstop material) at SWMU 72-001, TA-72, if LANL provides information to the conditions listed below. Please provide the requested information to Ms. Barbara Hoditschek as soon as possible to allow for an expedited decision.

1. The soil in question be verified as being free of any other regulated RCRA constituents.

2. Specific conditions under which the active firing range at SWMU 72-001, TA-72, would no longer be considered an active firing site. For example, define normal use criteria for the firing range and a minimum use below which LANL would close the firing range and proceed to remediate the lead soil.

3. Certification that the active firing range at SWMU 72-001, TA-72, is being utilized for the intended purpose and not just being used as a convenient storage

facility for contaminated soil.

4. Yearly status report on SWMU 72-001, TA-72, activities and the status of the lead-soil berms

5. Specifics of SWMU 72-001, TA-72, berm/backstop material management which assures that no migration of the contaminant will occur. This should include any sampling methodologies for lead and/or total metals at the site to support the proposed deferred corrective action on the lead-soil.

NMED believes that this decision represents a common sense approach which maximizes the taxpayer's dollar in meeting the requirements of the regulations, and is in the best interest of the general public, the regulated entity, and the regulatory agencies.

Should you wish to discuss this issue further, please contact me at (505)827-4358 or Ms. Barbara Hoditschek at (505) 827-4308.

Sincerely,

Benito J. Garcia

Benito J. Garcia
Bureau Chief
Hazardous and Radioactive Materials Bureau

CC: E. Kelley, Ph.D., Director, WWMD
B. Hoditschek, HRMB
S. Dinwiddie, HRMB
R. Kern, HRMB
B. Driscoll, U.S. EPA
J. C. Vozella, AAMEP, LAAO
T. Taylor, AAMEP, LAAO
C. Fesmire, AAMEP, LAAO
B. Koch, AAMEP, LAAO
J. White, ESH-19
T. Baca, EM, LANL, MS-J591
J. Jansen, EM/ER, LANL, MS-M992
ESH-19, (95-0178), LANL, MS-K490
RPF, LANL, MS-M707
J. Levings, ERPO, AL

cc w/attachment:
E. Merrill, EM-452, HQ
T. Taylor, AAMEP, LAAO
J. Mack, AAMEP, LAAO
C. Fesmire, AAMEP, LAAO
J. White, ESH-18, LANL, MS-K497
D. McInroy, EM/ER, LANL, MS-M992
RPF, LANL, MS-M707
D. Griswold, ERD, AL
T. Sena, EPD, AL

cc w/o attachment:
W. Spurgeon, EM-452, HQ
J. Vozella, AAMEP, LAAO
J. Plum, AAMEP, LAAO
J. Nunz, AAMEP, LAAO
B. Koch, AAMEP, LAAO
T. Baca, EM, LANL, MS-J591
C. Newton, CST-18, LANL, MS-E525
G. Rael, ERD, AL

EK ID= 46257

United States Government

Department of Energy

memorandum

Albuquerque Operations Office
Los Alamos Area Office
Los Alamos, New Mexico 87544

DATE: MAY 25 1995

REPLY TO ATTN OF: LAAMEP:5BK-010

SUBJECT: NMED HRMB Request for Information Prior to Decision Concerning SWMU 0-016: Movement of Lead Contaminated Soil to TA-72

TO: Jorg Jansen, Program Manager, EM/ER, LANL, MS-M992

Attached is a letter from NMED HRMB indicating willingness to authorize a proposal from Joseph Vozella, dated April 18, 1995, to move lead contaminated soil from SWMU 0-016 to TA-72, provided additional information is submitted. The letter from Benito Garcia, dated May 17, 1995, requests that five items of information be submitted to Barbara Hoditschek as soon as possible. Please ask your staff to prepare a draft response to this request for DOE review by June 7.

Although NMED has not specified that management of the berm material from SWMU 0-016 at TA-72 should include periodic removal of bullets for recycling by sifting, DOE recommends that such processing be considered. Such an approach to management of lead would demonstrate to the State a proactive effort towards waste minimization and control of lead contaminated soil.

If you have any questions regarding this matter, please call me at 665-7203, or Bonnie Koch of my staff at 665-7202.

for Joseph C. Vozella

Theodore J. Taylor
Program Manager
Environmental Restoration
Program

Attachment

cc:
See page 2

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:
Refer to: EM/ER:95-313

Mr. Benito J. Garcia
Hazardous and Radioactive Materials Bureau, Bureau Chief
New Mexico Environment Department
525 Camino de los Marquez
Santa Fe, NM 87502

SUBJECT: MOVEMENT OF SOIL CONTAINING LEAD BULLETS FROM INACTIVE FIRING SITE, SOLID WASTE MANAGEMENT UNIT (SWMU) 0-016 TO ACTIVE FIRING SITE AT TECHNICAL AREA (TA) 72, SWMU 72-001

Dear Mr. Garcia:

Thank you for your prompt attention to our request to move soil containing lead bullets from the inactive firing site, SWMU 0-016, to an active firing site at TA-72, SWMU 72-001. The soil containing lead bullets will be used for berms and backstops the same way purchased soil would be used.

The letter you sent indicating your willingness to authorize this use of lead soil at TA-72 requested that five conditions or questions be met. These questions and our response are presented below.

1. The soil in question be verified as being free of any other regulated Resource Conservation and Recovery Act (RCRA) constituents.

The analytical results that have been obtained for the soil at the site (SWMU 0-016) during remediation are total Pb, Cu and Zn for washed soil, Toxicity Characteristic Leaching Procedure for these metals, and target analyte list (TAL) metals for 4 filtrate samples of the recirculating pond water (used during the soil washing process). The filtrate does not show any of the TAL metals in solution at levels that would indicate that the unwashed soil has RCRA metals that dissolve in essentially neutral pH water. Silver and cadmium were below the detection limits (0.01 mg/L or lower). Chromium was <0.004mg/L for 3 filtrates and 0.006mg/L for the fourth. Mercury was less than or

equal to 0.02 ug/g for total (unfiltered) samples. These data confirm the presence of lead at the site based on historical use of the site as a small arms firing range. The unwashed soil does not have any hazardous constituents other than lead from the bullets.

2. Specific conditions under which the active firing range at SWMU 72-001, TA-72, would no longer be considered an active firing site. For example, define normal use criteria for the firing range and a minimum use below which Los Alamos National Laboratory (Laboratory) would close the firing range and proceed to remediate the lead in soil.

The normal use of the range is weekly, as members of the Protection Technologies Los Alamos (PTLA) security force must maintain a minimum level of proficiency with firearms. The Qualification and Special Training records are maintained in an open file, subject to inspection by external auditors. The need for this range is expected to be as long as the mission of the Laboratory includes nuclear weapons engineering. Greater than 25 more years of continuing that mission is probable. The size of the Laboratory could shrink, but that would have no effect on the requirements for a well trained security force.

3. Certification that the active firing range at SWMU 72-001, TA-72, is being utilized for the intended purpose and not just being used as a convenient storage facility for contaminated soil.

There will be no stockpiling of lead contaminated soil from SWMU 0-016 at the active firing range. All of the soil moved will be placed in berms. The purpose of the berms is to receive bullets, which will control the disposition of lead. Some of the berms will be receiving bullets directly or fragments of ricocheted bullets, protecting personnel in training. The size of the berms is engineered to meet both bullet containment and personnel safety requirements.

4. Yearly status report on SWMU 72-001, TA-72, activities and the status of the lead-soil berms.

Training files and maintenance work orders will be the defensible evidence that the range continues to be used for required training, and that the area is being managed. An annual inspection of the berms will be the basis for reporting the status of the berms, however the range manager for PTLA will be ordering maintenance work as needed, based on continuing observations.

5. Specifics of SWMU 72-001, TA-72, berm/backstop material management which assures that no migration of the contaminant will occur. This should include any sampling methodologies for lead and/or total metals at the site to support the proposed deferred corrective action on the lead-soil.

CY: G. Allen
C. Newton
E525

State of New Mexico
ENVIRONMENT DEPARTMENT
Hazardous & Radioactive Materials Bureau
525 Camino De Los Marquez
P.O. Box 26110
Santa Fe, New Mexico 87502
(505) 827-4358
Fax (505) 827-4389

GARY E. JOHNSON
GOVERNOR

MARK E. WEIDLER
SECRETARY

EDGAR T. THORNTON, III
DEPUTY SECRETARY

May 17, 1995

Post-it™ Fax Note 7671	Date 9/10/95	# of pages ▶ 2
To Jan Novak	From Andy Crowder	
Co./Dept.	Co. ERM/Golder	
Phone #	Phone #	
Fax # 665-4632	Fax #	

Mr. Larry Kirkman
DOE/LAAO
528 35th Street
Los Alamos, New Mexico 87545

Dear Mr. Kirkman:

The New Mexico Environment Department (NMED) has received Los Alamos National Laboratory's (LANL) proposal to remove lead (in the form of spent projectiles) contaminated soil from Solid Waste Management Unit (SWMU) 0-016 (an inactive firing range undergoing Voluntary Corrective Action (VCA)) to an active firing range (SWMU 72-001) located at TA-72, as berm/backstop material. This proposal, as NMED understands it, would be in lieu of utilizing clean soil for the same use.

NMED concurs with LANL that the use of this lead contaminated material for the same purpose that it has previously been used for in the past prior to cleaning the soil for non-RCRA regulated use makes sense.

NMED is willing to authorize the use of this lead contaminated material as a beneficial product (berm/backstop material) at SWMU 72-001, TA-72, if LANL provides information to the conditions listed below. Please provide the requested information to Ms. Barbara Koditschek as soon as possible to allow for an expedited decision.

1. The soil in question be verified as being free of any other regulated RCRA constituents.

2. Specific conditions under which the active firing range at SWMU 72-001, TA-72, would no longer be considered an active firing site. For example, define normal use criteria for the firing range and a minimum use below which LANL would close the firing range and proceed to remediate the lead soil.

3. Certification that the active firing range at SWMU 72-001, TA-72, is being utilized for the intended purpose and not just being used

Just being used as a convenient storage

facility for contaminated soil.

4. Yearly status report on SWMU 72-001, TA-72, activities and the status of the lead-soil berms

5. Specifics of SWMU 72-001, TA-72, berm/backstop material management which assures that no migration of the contaminant will occur. This should include any sampling methodologies for lead and/or total metals at the site to support the proposed deferred corrective action on the lead-soil.

NMED believes that this decision represents a common sense approach which maximizes the taxpayer's dollar in meeting the requirements of the regulations, and is in the best interest of the general public, the regulated entity, and the regulatory agencies.

Should you wish to discuss this issue further, please contact me at (505) 827-4358 or Ms. Barbara Hoditschek at (505) 827-4308.

Sincerely,

Benito J. Garcia
Bureau Chief
Hazardous and Radioactive Materials Bureau

CC: E. Kelley, Ph.D., Director, WNMD
B. Hoditschek, HRMB
S. Dinwiddie, HRMB
R. Kern, HRMB
B. Driscoll, U.S. EPA

C. Fesmire, AAMEP, LAAO
B. Koch, AAMEP, LAAO
J. White, ESH-19
T. Baca, EM, LANL, MS-J591
J. Jansen, EM/ER, LANL, MS-M992
ESH-19, (95-0178), LANL, MS-K490
RPF, LANL, MS-M707
J. Levings, ERPO, AL

TOTAL P.01

0-016

THIS FORM REPLACES PREVIOUS FORM 3510-7 (8-92)
Please See Instructions Before Completing This Form

Form Approved. OMB No. 2040-0086
Approval expires: 8-31-98

NPDES FORM

EPA

United States Environmental Protection Agency
Washington, DC 20460

Notice of Termination (NOT) of Coverage Under a NPDES General Permit for Storm Water Discharges Associated with Industrial Activity

Submission of this Notice of Termination constitutes notice that the party identified in Section II of this form is no longer authorized to discharge storm water associated with industrial activity under the NPDES program. ALL NECESSARY INFORMATION MUST BE PROVIDED ON THIS FORM.

I. Permit Information

NPDES Storm Water General Permit Number: NM R10A277

Check Here if You are No Longer the Operator of the Facility: [ ]

Check Here if the Storm Water Discharge is Being Terminated: [X]

II. Facility Operator Information

Name: University of California

Phone: 505 667 3394

Address: PO BOX1663 MS E525

City: Los Alamos

State: NM

ZIP Code: 87545

III. Facility/Site Location Information

Name: Los Alamos National Laboratory

Address: PO Box 1663 MS E525

City: Los Alamos

State: NM

ZIP Code: 87545

Latitude: 35 54 30

Longitude: 106 18 02

Quarter:

Section:

Township:

Range:

IV. Certification:

I certify under penalty of law that all storm water discharges associated with industrial activity from the identified facility that are authorized by a NPDES general permit have been eliminated or that I am no longer the operator of the facility or construction site. I understand that by submitting this Notice of Termination, I am no longer authorized to discharge storm water associated with industrial activity under this general permit, and that discharging pollutants in storm water associated with industrial activity to waters of the United States is unlawful under the Clean Water Act where the discharge is not authorized by a NPDES permit. I also understand that the submittal of this Notice of Termination does not release an operator from liability for any violations of this permit or the Clean Water Act.

Print Name: Garry Allen

Date: 07 01 97

Signature: GRAllen

Instructions for Completing Notice of Termination (NOT) Form

Who May File a Notice of Termination (NOT) Form

Permittees who are presently covered under the EPA-issued National Pollutant Discharge Elimination System (NPDES) General Permit (including the 1995 Multi-Sector Permit) for Storm Water Discharges Associated with Industrial Activity may submit a Notice of Termination (NOT) form when their facilities no longer have any storm water discharges associated with industrial activity as defined in the storm water regulations at 40 CFR 122.26(b)(14), or when they are no longer the operator of the facilities.

For construction activities, elimination of all storm water discharges associated with industrial activity occurs when disturbed soils at the construction site have been finally stabilized and temporary erosion and sediment control measures have been removed or will be removed at an appropriate time, or that all storm water discharges associated with industrial activity from the construction site that are authorized by a NPDES general permit have otherwise been eliminated. Final stabilization means that all soil-disturbing activities at the site have been completed, and that a uniform perennial vegetative cover with a density of 70% of the cover for unpaved areas and areas not covered by permanent structures has been established, or equivalent permanent stabilization measures (such as the use of riprap, gabions, or geotextiles) have been employed.

When to File NOT Form

Send this form to the the following address:

Storm Water Notice of Termination (4203)
401 M Street, S.W.
Washington, DC 20460

Completing the Form

Type or print, using upper-case letters, in the appropriate areas only. Please place each character between the marks. Abbreviate if necessary to stay within the number of characters allowed for each item. Use only one space for breaks between words, but not for punctuation marks unless they are needed to clarify your response. If you have any questions about this form, telephone or write the Notice of Intent Processing Center at (703) 931-3230.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

OCT 10 1995

Mr. Benito J. Garcia, Chief
Hazardous and Radioactive Materials Bureau
New Mexico Environment Department
P.O. Box 26110
Santa Fe, NM 87502

Dear Mr. Garcia:

On August 10, 1995, you submitted to this office a request for guidance on management of lead-contaminated soil at Los Alamos National Laboratory (LANL) solid waste management unit (SWMU) 0-016 and the active firing range TA-72.

It is our understanding that LANL was conducting soil washing to remove lead from the soil at the Inactive Firing Range (SWMU 0-016) as part of a Voluntary Corrective Action. The soil washing operation was intended to be completed in the fall of 1994. However, additional soil containing lead was found, increasing the total amount of soil requiring processing.

On April 18, 1995, LANL requested that the New Mexico Environment Department (NMED) approve a proposed alternative "solution" to continued soil washing at SWMU 0-016. The proposal recommended moving untreated lead-contaminated soil from SWMU 0-016 to an active firing range (TA-72) to be used as fill material for existing backstops.

LANL has requested confirmation that the lead and the soil containing lead constitute a recyclable material under the Resource Conservation & Recovery Act (RCRA) as provided by 40 CFR § 261.6(a)(3)(iii) - scrap metal. Scrap metal is defined in Volume 50 of the Federal Register of January 4, 1985, as bits or pieces of metal that are discarded after consumer use or that result from metal processing operations. Soil containing lead does not meet the definition of scrap metal and is not, therefore, eligible for the exemptions provided by 40 CFR § 261.6(a)(3).

LANL also contends that the soil from SWMU 0-016 would "function as effectively as clean soil (i.e., commercial product)." Presumably LANL is asserting that the use of the

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contaminated soil as a substitute for "clean" fill material constitutes use or reuse as an effective substitute for a commercial product. This type of activity would exempt the material from being a solid waste, and from RCRA regulation (40 CFR § 261.2(e)(ii)).

However, this type of activity is subject to regulation if the material is used in a manner constituting disposal (40 CFR § 261.2(e)(2)(i)). As defined in 40 CFR § 261.1(c), "used in a manner constituting disposal" generally means placement on or in the land unless it is a commercial chemical product listed in 40 CFR § 263.33 and that is its ordinary manner of use.

The Agency also uses other criteria in evaluating whether or not a waste is being legitimately recycled. One criterion is how closely the substitute material resembles an analogous raw material. According to LANL, soil from the Inactive Firing Range contains lead bullets and is a characteristic hazardous waste due to lead (D008). Normal soil does not exhibit a hazardous characteristic and, therefore, is not similar to the material LANL wishes to use as a substitute.

The Land Disposal Restrictions (LDR) promulgated under the Hazardous and Solid Waste Amendments (HSWA) of RCRA forbid the placement of any hazardous waste in or on the land. Specifically, restricted wastes removed from SWMU's must meet applicable treatment standards before subsequent placement on the land. There are no exemptions which allow placement of hazardous wastes obtained from one SWMU into another "unit" without appropriate treatment. LANL's proposal would violate the requirements of LDR. Therefore, we recommend that your office deny LANL's request.

If LANL continues soil washing operations to remove lead bullets from the soil, the lead bullets could be recycled as scrap metal as provided by the scrap metal exemption. If the hazardous characteristic of D008 is removed from the soil, the soil could then be used as fill or berm material at the active firing range since it would no longer be considered a hazardous waste.

LANL could also pursue the option of designating certain areas at its facility as Corrective Action Management Units (CAMU) as specified in 40 CFR § 264.552 and detailed in Volume 58 of the Federal Register of February 16, 1993. Placement of remediation wastes into or within a CAMU does not constitute land disposal of hazardous wastes. To explore the possibility of using this option, please call Ms. Barbara Driscoll of our RCRA Permits Office at (214) 665-7441.

If you have any questions concerning this matter, or wish to discuss it in greater detail, please have your staff call Dr. Joel Dougherty of my staff at (214) 665-2281.

Sincerely yours,

Mark W. Potts, P.E., Chief
ALONM Section
Hazardous Waste Enforcement Branch
Compliance Assurance &
Enforcement Division

Meeting Agenda
SWMU 0-016: Tour and Discussion with NMED
December 1, 1995

I.	**Introductions** - Joe Vozella, Jorg Jansen	<5 Minutes
II.	**Site History and Background** - Garry Allen (BonnieKoch)	7.5 Minutes
III.	**History of Cleanup Activities** - Garry Allen (Bonnie Koch)	7.5 Minutes
IV.	**Overview of Recent Correspondence** - Dave McInroy/Pat Shanley	10 Minutes
V.	**Recent Analytical Results**	
	Sampling of Soil Piles - Randy Ryti	10 Minutes
	TA-72 Sediment Sampling - Pat Shanley	5 Minutes
VI.	**Questions/ Discussion** - NMED, All	10 Minutes
VII.	**Site Tour** - Carl Newton	1 Hour

ER ID 59975

United States Government

Department of Energy
Albuquerque Operations Office
Los Alamos Area Office
Los Alamos, New Mexico 87544

memorandum

DRAFT

DATE:
REPLY TO ATTN OF: LESH:BK: (OU 1071) 1.4.2.6.1.4.2.2
SUBJECT: SWMU 0-016: Initiation of Shaker Plant VCA

TO: Joseph C. Vozella, Assistant Area Manager, EP

For the subject VCA, you have requested that I identify compliance issues and review the strategy associated with the VCA for meeting compliance requirements via submittal of this memo. The compliance requirements for the remediation fall into three categories: I) HSWA, or corrective action requirements, for validation that the site is clean after the remediation, II) RCRA requirements which cover A) the applicability of recycling and the question of dilution, and B) the hazardous waste determination: validating that the characteristic of lead is removed before releasing the soil after shaking, and III) OSHA, or health and safety requirements. The following discussion is provided in an effort to respond to your request:

I. HSWA
The remedial activity has been proposed as a VCA which means that formal approval of the cleanup will not be sought from NMED HRMB and EPA until after the activity has been completed. The approval will be sought via submittal of a VCA Report and a request for a Class III Permit Modification to remove SWMU 0-016 from Table A of the HSWA Permit. Because the Shaker Plant VCA Plan specifies a cleanup level that is the most protective under RCRA corrective actions, 400 ppm for lead under a residential scenario, and because this will be documented by a conservative confirmatory sampling plan, all HSWA requirements will be met (attachment A).

Even though the action is one that LANL will initiate at risk as a voluntary remedial measure, a VCA Plan for the Shaker Plant approach was submitted to both NMED HRMB and EPA Region 6 on March 8, 1996, in an effort to receive regulatory comment. NMED HRMB provided comments on the plan during a meeting on March 15, 1996 (attachment 1). The comments included a statement from B. Hoditscheck indicating that "it is a very good approach." Although NMED stated that they would prefer that LANL not create another revision to the VCA Plan, the plan will be updated and submitted to NMED HRMB so

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that the changes recommended by Ron Kern during the meeting are incorporated into the VCA Plan. EPA indicated verbally on March 19, 1996 that they would not be reviewing the plan because the action is voluntary (attachment 2). However, because the Shaker Plant dry sieving is in principle similar to the Soil Washing wet sieving, for which the EPA provided a only very simple NOD prior to initiation, there is a limited concern that EPA might find some fundamental inadequacy in the approach (attachment B).

II) RCRA

A) Recycling

As outlined in the Shaker Plant VCA Plan, the method of removing lead to levels below TCLP is a recycling approach. EPA Region 6 sent NMED HRMB a letter, dated October 10, 1995 (attachment 3), stating that LANL could Soil Wash and recycle the lead bullets and that the soil could be reused as fill or berm material if the hazardous characteristic of D008 is removed. The Shaker Plant VCA Plan is also a recycling approach to remove bullets below levels that are characteristic for lead. The only differences between the Shaker Plant recycling and the Soil Washing recycling, as explained to NMED HRMB during the March 15, 1996 meeting, is that the Shaker Plant is a dry form of sieving while Soil Washing is simply a wet form. Because of this difference, the Shaker Plant approach will remove fewer fine particles of lead than the Soil Washing approach. However, since the sampling performed by LANL in October of 1995 indicates that lead is already less than the TCLP limit, this difference should not present a problem for meeting the definition of clean soil after shaking (attachment C).

B) Dilution (40 CFR 268.3)

Mr. Beaver raised the issue of dilution at the site in his letter to Sam Coleman, of EPA Region 6 Hazardous Waste Enforcement Bureau, in his letter of January 18, 1996 (attachment 4). His concerns have raised the general question of whether recycling, or for that matter any form of treatment, is valid. In other words, is the soil locked into the designation of hazardous waste because dilution took place after the USFS sampled the material and found it to be at levels of lead above the TCLP limit. Apparently, EPA OSWER OGC has considered this issue internally and has indicated verbally to NMED HRMB that dilution is not an issue relative to any future recycling operations at the site because: 1) the dilution that occurred at the site did not occur with the intent of avoiding a hazardous waste determination, and 2) when dilution occurs during treatment or recycling and there is a net reduction in volume of waste, there is no violation of the hazardous

waste regulations (attachment 5). Items 1 and 2, together with the EPA letter of October 10, 1995, indicate that recycling is still valid as a means of changing the waste stream to remove the characteristic of lead as documented by the USFS.

NMED HRMB indicated during the meeting on March 15, 1996 (attachment 1), that the sampling strategy outlined in the VCA Plan for documentation that each 25 cubic yards of material is below TCLP limits for lead before releasing the material to the TA-72 firing range, would have to be modified to meet their concerns. Because the guidance for modification was very specific and because NMED HRMB indicated that they would provide actual oversight during the initiation of the operations so that LANL has clear indication that the modifications meet NMED's specifications, there will be no violation of the regulations for determination of whether the material meets the definition of clean soil before release from the SWMU.

Summarizing A and B above, the recycling approach in combination with the sampling strategy that NMED HRMB specified on March 15 ensure that the VCA operations will be conducted according to regulations under 40 CFR 261.6(a)(3), which address requirements for recyclable materials, and 40 CFR 261.24, which addresses identification of hazardous waste.

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III. OSHA

ESH-5 has prepared and approved a Health and Safety Plan for the Shaker Plan VCA activities (attachment 6). Therefore all OSHA requirements will be met during the Shaker Plant VCA operations.

The Shaker Plant VCA activities are scheduled to initiate on or before April 8, 1996. Because the activities have been designed to be conducted in accordance with applicable HSWA, RCRA and OSHA requirements, I am recommending you provide authorization for the field activities to begin. If you have any further questions regarding this discussion, please let me know so that I can meet with you.

Bonnie Koch
ER Geologist

DRAFT

Enclosures:

cc w/enclosures:
H. Haynes, LAAO, , MS A316

cc w/o enclosures:
T. Taylor, LAAO EP, MS A316
G. Allen, UC-LANL, EM/ER, MS M992
B. Koch, LAAO EP, MS A316

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October 1991

NCEL Technical Note

By J.C. Heath, L. Karr, V. Novstrup, and B. Nelson, NCEL and S.K. Ong, P. Aggarwal, J. Means, S. Pomeroy, and S. Clark of Battelle

Sponsored By Naval Facilities Engineering Command

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ENVIRONMENTAL EFFECTS OF SMALL ARMS RANGES

ABSTRACT This study focuses on contaminant releases from outdoor small arms ranges. Ranges for larger weapons such as artillery, cannons, mortars, and howitzers, as well as skeet and trap shooting areas, and indoor ranges are excluded from this study. This report attempts to locate and evaluate information in the following general subject areas: contaminant concentrations normally present at sites, normal background levels of identified contaminants, toxicity information on identified contaminants, regulatory controls and considerations, and identification and classification of small arms ranges that are controlled by the Navy.

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EXECUTIVE SUMMARY

This report is part of a series of reports assessing environmental contamination at outdoor small arms ranges, identifying associated health risks, and evaluating and selecting control alternatives. The final product of this effort will be a technology transfer package specifying technologies to recover, recycle, and treat contaminated soil and control nonpoint source pollution at abandoned, current, and future ranges. Indoor ranges and skeet ranges are not addressed in this report.

This report consists of a literature search of data and studies of environmental contamination at small arms ranges; geochemical equilibria modeling to determine the fate of lead, copper, and zinc in the environment; and a survey to gather information on the Navy's small arms ranges.

Soils in the impact and target berms have been found to have elevated levels of metals including lead, copper, and zinc, causing the soils to be classified as hazardous waste. Of these, lead is the only metal regulated by the Resource Conservation and Recovery Act. Elevated levels of metals have also been found in the soils and vegetation in large areas behind and adjacent to the target and impact berms. Though these levels are below hazardous waste levels, storm-water runoff from these areas can transport the metals to nearby watercourses and be classified as nonpoint sources of pollution.

Geochemical equilibria modeling of lead, copper, and zinc in three different groundwater compositions shows that the solubility of these metals increases with decreasing pH values. The modeling and current data indicate that groundwater contamination should only be a problem at sites where the soil pH is below 7 and groundwater is less than 10 feet deep.

A total of 34 responses were received to a survey requesting information on the size and number of ranges, and current environmental practices at ranges at 65 Naval bases. There are 245 active ranges at 89 bases and a minimum of 56 abandoned ranges. The average annual mass of lead accumulated in a single berm is estimated to be 7,000 pounds. The average berm is 18 feet tall, 42 feet wide, and 132 feet long.

More information and data on the extent of environmental contamination at small arms ranges can be found in the following Naval Civil Engineering Laboratory selected reports:

Memorandum to files, Characterization of Metals in Soil and Vegetation of a Small Arms Impact Berm, NAVAMPHIBASE Little Creek, Leslie Farr, et al., June 1990.

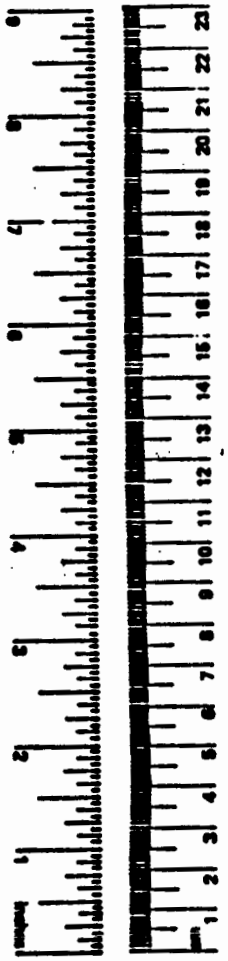
TN-1823, A Biogeochemical Analysis of Metal Contamination at a Small Arms Firing Range, Leslie Karr, et al., Marine Corps Combat Development Command (MCCDC), Quantico, Virginia.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

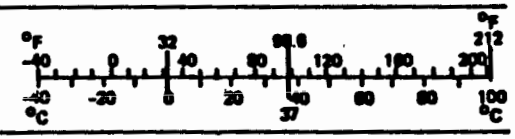
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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13. ABSTRACT (Maximum 200 words)

This study focuses on contaminant releases from outdoor small arms ranges. Ranges for larger weapons such as artillery, cannons, mortars, and howitzers, as well as skeet and trap shooting areas, and indoor ranges are excluded from this study. This report attempts to locate and evaluate information in the following general subject areas: contaminant concentrations normally present at sites, normal background levels of identified contaminants, toxicity information on identified contaminants, regulatory controls and considerations, and identification and classification of small arms ranges that are controlled by the Navy.

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A - Survey Questionnaire A-1
B - Mailing List for Written Small Arms Practice Range Survey B-1

An assessment report for a small arms range at Camp Pendleton is being prepared.

The result of the findings included in this report will be used to aid in the selection of systems to prevent runoff from ranges and technologies to recover, recycle, and treat contaminated soil. The selection process and its results will be discussed in the next report of the series. After that, the selected technologies will be bench-scale tested and a design for field demonstration will be prepared. Results of these studies will be included in demonstration evaluation reports. Successfully demonstrated technologies will be transferred to Navy use in User Data Packages.

For further program information, please contact Mr. Jeff Heath, Code L71, Naval Civil Engineering Laboratory, Port Hueneme, CA, at AUTOVON 551-1657 or commercial 805-982-1657.

INTRODUCTION

The Navy and Marine Corps control approximately 245 active outdoor small arms ranges and an estimated 56 abandoned ranges. Because of the inevitable build-up of bullets in the target and impact berms, these ranges are potential source areas for metals contamination. If left unattended, this source of contamination may be dispersed into the environment along various pathways including surface water runoff, groundwater migration, and airborne dust migration.

Typically, small arms ranges consist of a firing line, target line, target berm (on rifle ranges only), and impact berm. The distance from the firing line to the target line is normally 100 to 300 feet for pistol ranges and up to 2,000 feet for rifle ranges. Impact berms vary in height from 5 feet to as high as 50 feet. Figures 1 and 2 show typical configurations for pistol and rifle ranges.

Lead contamination levels along the face of small arms range berms typically are in the range of approximately 1 percent by weight with concentrations reaching 30 percent for some isolated samples. Ricochet problems often result from the build-up of large bullet fragments. Currently practiced solutions for the ricochet problem are: (1) removing and replacing the berm with clean soil, (2) adding a clean layer of soil to the face of the berm, (3) removing large projectiles by screening and returning the soil to the berm, and (4) abandoning the berm. Initial test results indicate that berms are often surrounded by a halo of lead contamination in surface soils and plants.

SCOPE

This study focuses on outdoor small arms ranges. Small arms are pistols, rifles, and machine guns with calibers of 0.6 inches (15 mm) or less. Ranges for larger weapons such as artillery, cannons, mortars, and howitzers, as well as skeet and trap shooting areas, and indoor ranges are excluded from this study.

This report provides baseline information that will be used to: (1) assist in selecting technologies and developing technologies for routine Navy use, (2) assist in development of design improvements for new ranges, and (3) identify additional information and techniques that will be needed to implement these efforts. Specifically, this report attempts to locate and evaluate information in the following general subject areas:

1. Contaminant concentrations normally present at sites.

2. Normal background levels of identified contaminants.

3. Toxicity information on identified contaminants.

4. Regulatory controls and considerations.

5. Identification and classification of small arms ranges that are controlled by the Navy.

APPROACH

The approach taken in this study includes conducting a literature search of relevant published data and studies; determining the fate of lead, copper, and zinc in groundwater through geochemical equilibria modeling; and conducting a survey of small arms ranges located at Naval bases.

Literature Search

Information on the potential for nonpoint source pollution from Navy small arms ranges was obtained by conducting a computerized literature search and by surveying various organizations and facilities that were familiar with either lead in the environment or the use of small arms.

The data bases that were consulted included National Technical Information Services (NTIS), Chemical Abstracts (CA), Water Resources Abstracts, Pollution Abstracts, and the Defense Technical Information Center (DTIC). The keywords used to access information were:

- Lead
- Shot
- Pistol
- Handgun
- Sidearm
- Rifle
- Shotgun
- Range
- Pollution
- Fate
- Environment
- Transport
- Stabilization
- Fixation
- Recovery
- Contamination
- Groundwater
- Soil

Information on the fate of spent shot in soil was solicited by phone from various organizations including the following:

- Lead Coalition
- Lead Industries Association
- National Rifle Association

- Sport Arms and Ammunition Association in Connecticut
- Bureau of Mines
- Amateur Trap Shooting Association
- International Lead Zinc Research Organization.

Information on the potential for pollution from small arms ranges was requested from the following governmental and military agencies:

- U.S. Environmental Protection Agency (EPA) in Cincinnati, Ohio
- Minnesota Pollution Control Agency
- Army Corps of Engineers
- National Guard facility at Camp Grayling Michigan
- Civil Engineering Environmental Group at Tyndall Air Force Base
- U.S. Army Toxic and Hazardous Waste Management (USATHAMA) group
- Numerous Navy bases

Information on bullet casings was solicited from the Copper Development Association.

Survey

A written survey was sent to 65 of the 89 Naval and Marine bases believed to have outdoor small arms ranges. The survey and was used to evaluate the potential for nonpoint source pollution from Navy small arms ranges. Appendix A contains a copy of the survey. A mailing list (Appendix B) was created using the list of Naval small arms firing ranges found in Karr, et al. (1990) and cross-referencing it to the Naval publication OPNAVPO9B2105(87) which lists addresses for the bases.

The written survey was developed to obtain more detailed responses about the potential for nonpoint source pollution from the ranges. Factors that were considered important in understanding the potential for nonpoint source pollution included the following:

- Amount and type of bullets used
- Amount and type of soil polluted

- Current practices for handling berm soil
- Closeness and quality of ground and surface waters.

Geochemical Equilibria Modeling

The mobility of lead, copper, and zinc in an aqueous environment (surface waters and groundwaters) is dependent on the aqueous solubility of the metal ions. To understand the potential nonpoint source pollution of impact berms, a geochemical model, SOLMINEQ.88 (Kharaka, et al., 1988), was used to study the solubility of lead, copper, and zinc in various groundwaters of typical geological terrains. The computer program can be used to model speciation, saturation, solubility, and dissolution/precipitation of metal ions at subsurface temperatures (0 to 250°C) and pressures (1 to 1,000 bars). A thermodynamic data base of 260 inorganic and 80 organic aqueous species and 220 minerals is included in the program.

BACKGROUND INFORMATION AND DATA

Literature Search and Case Studies

Literature Search and Phone Inquiries. A limited amount of information was generated by the computerized literature search. The Copper Development Association searched its files for information on casings; however, limited information was found. Information was obtained from a computer search on the transformation ot lead pellets in soil and the bioaccumulation of lead in wildlife as the result of soil polluted with metallic lead pellets. Specific information on lead pollution at small arms ranges consists primarily of recent studies conducted by the Navy (Karr, et al., 1990 and Karr, 1990) at two Naval bases, Marine Corps Combat Development Center (MCCDC) Quantico and Naval Amphibious Base Little Creek, and a study made by Battelle (Battelle Ocean Sciences, 1987) on skeet ranges. A study (Jorgensen and Willems, 1987) conducted in Sweden on shotgun pellets provided some insights on the fate of lead in the environment.

Responses to the phone inquiries led to information on two additional case studies. In the first case study, both Patrick Reagan of the Lead Coalition and Shelly Siewert of the Minnesota Pollution Control Board mentioned that elevated lead levels were found in the milk of cows that had grazed on pasture land that was adjacent to the White Bear Run Gun Club in Ramsey County, Minnesota. Results of the milk analyses were unavailable. As a result of this incident, the gun club has disbanded. The second case study was mentioned by Craig Boreiko with the International Lead/Zinc Research Organization. He stated that a firing range in Stockholm, Sweden, had been converted into a park; however, he was not familiar with any written reports about the project. In discussions with Patrick Reagan concerning the fate of spent shot in soil, several pertinent characteristics about lead mobility were mentioned; namely, (1) lead tends to remain in the upper surface layers, (2) lead is bound to the organic content in the soil, and (3) lead is amphoteric, meaning that it is mobile at both low and high pHs.

Wayne Sisk with USATHAMA indicated that the Army has not yet conducted a study on this subject.

Chemical Composition of Small Arms Ammunition. A typical round of ammunition consists of a bullet or ball, a cartridge case that contains the propellant, and a cap consisting of an ignition system. Bullets are either solid or filled and come with or without an outer metal jacket. Jacketed bullets are used for antipersonnel and armour piercing roles, while filled bullets consist mainly of tracer or incendiary materials. The bullet or ball is usually made of a lead alloy consisting of copper and sometimes tin, with up to 15 percent antimony added for hardness (Ross, 1980). Table 1 presents the various grades of lead alloy used in bullets that are acceptable to the U.S. Military (Federoff and Sheffield, 1975). The unjacketed or "bare" ball is used in shotgun shells, .22 caliber rifle ammunition, and in many revolver cartridges.

Metal jacketed bullets are used in high-velocity and automatic weapons such as M16 rifles and M60 machine guns. The outer metal jacket is usually either copper-plated or covered with a thin layer of gilding metal. There are various grades of gilding metals having copper and zinc as the major components (Table 2). Jacketed bullets have been shown to reduce the amount of airborne lead particulates (Juhasz, 1977), but the bullet may shatter upon impact, exposing the lead core. Metals of significant mass fraction in a bullet are lead, copper, zinc, and antimony. Of these, lead is the only metal that is regulated as a Resource Conservation and Recovery Act (RCRA) "characteristic waste," as determined using the Toxicity Characteristic Leaching Procedure (TCLP) test.

Filled bullets (i.e., tracer munitions) are used to provide an effective means of determining the direction of fire for rapid firing of small arms. When used in machine guns, filled bullets are belted in a predetermined sequence. Tracers are generally made up of chemical compounds of strontium and magnesium. Typical chemical compositions of igniters and tracers for small arms are given in Table 3.

In addition to the bullet, the ignition system primer may be a possible source of metals contamination. Commercial primer compounds for small arms ammunition are generally mixtures of lead styphane and barium nitrate (Table 4). Barium is a RCRA metal, similar to lead, but is regulated at much higher levels. A study on lead contamination from various primers (Juhasz, 1977) showed that the use of nonlead primers with jacketed bullets reduced airborne lead particulates from a pistol from levels of about 402 µg/round to about 23 µg/round. Airborne lead particulates from nonjacketed bullets fired from a pistol can be present in concentrations as high as 3,380 µg/round. Consequently, airborne particulates can contribute to pollution in the area adjacent to the firing line.

Toxicity of Lead, Copper, and Zinc.

Lead Occurrence in the Environment. Lead is ubiquitous in nature, being a natural constituent of the earth's crust. Lead is commonly used in ammunition, batteries, solder, radiation shielding, and cable sheaths. Its use in paints and as an octane additive in gasoline has decreased. In addition to occurring naturally in soil, lead concentrations may be increased by atmospheric pollutants from smelters, motor vehicles, and other sources. Land-spreading of sewage sludge may also increase the lead levels in treated areas.

Lead content in soil averages approximately 16 parts per million (ppm) with the normal range being 10 to 37 ppm and a 99.7 percent upper limit of 121 ppm (Davis and Wixson, 1986). Lead levels in surface waters average approximately 3 µg/L with a few streams exceeding 50 µg/L. Groundwater lead levels that occur naturally are usually in the 1 to 10 µg/L range, but may exceed 100 µg/L in some areas. Normal lead levels in various media are given in Table 5.

Accumulation by Plants and Animals and Ecotoxicology. Lead in soil is generally unavailable to plants and is frequently strongly fixed to the organic fraction of the soil. Lead has been found in many plant species (e.g., at levels of 2 to 5 mg/kg in leaves), but it is not an essential element. High lead levels have been reported to be tolerated by many plant species, while other species have shown retarded growth. Accumulation in plants can occur by adsorption through roots and leaves with little translocation within the plant. Compared with soil concentrations, lead concentrations in plants are low (Carrier, 1977). Translocation of lead from the foliage surface into the plant may occur, but the rate is very slow even under conditions of elevated lead solubility, low pH, and long exposure time.

Lead is not an essential element in animals. Ingestion of plant foliage contaminated by atmospheric deposition of lead and inhalation of lead may contribute significantly to the total body burdens, primarily in the bones and kidneys of wildlife and livestock. Lead poisoning in livestock and other grazing animals has been reported. Lead is poorly absorbed through the intestine, but retention time in the body is long. Susceptibility to lead may be affected by the type of lead compound, acidity of the general intestinal tract, animal species, and life stage or age. Young cattle have been reported to be especially susceptible to lead poisoning (Wilkes, 1977). Lead may bioaccumulate from herbivorous to carnivorous trophic levels, and earthworms may accumulate levels that may be toxic to birds.

Lead may be accumulated by fish and other aquatic animals through the body surface or via the food chain. Accumulations occur primarily in the calcareous tissues. Toxicity varies with species and generally increases with decreasing hardness. Chronic exposure to elevated concentrations may result in deformities in fish, with frequency varying with concentrations and hardness. Experiments have shown that acute toxicity of rainbow trout occur at about 1,170 µg/L and 671,000 µg/L in freshwater of 28 and 353 mg/L hardness as $CaCO_3$, respectively (Davies, 1976). Chronic toxicities of rainbow trout were found to be 31.7 µg/L and 7.6 µg/L in freshwater of similar hardness (Davies, 1976).

Effects on Humans. The principal route of exposure to lead for humans is via food and beverages. The normal daily intake of lead for an adult averages about 0.75 mg/day. The lead content of food is quite variable, and there are no absolutely lead-free food items. Municipal water supplies also contain traces of lead; the daily human intake of lead from water is usually about 10 µg/day (Doull, et al., 1986). The primary drinking water standard for lead is 50 µg/L.

Other less common sources of ingested lead are lead-based paint in older dwellings, lead in atmospheric deposition from vehicle exhaust and industrial emissions, hand-to-mouth activities of children in polluted environments, and dust brought home on clothes of industrial workers. Adults absorb 5 to 15 percent of the lead ingested and retain less than 5 percent of

that absorbed (Doull, et al., 1986). Small children may absorb approximately 40 percent of the ingested lead and retain about 30 percent of that absorbed. Another source of lead is inhaled particulates. In the average urban environment, intake of respired lead is about one-half that of ingestion. Lead levels in blood vary with age and sex. Children under 7 years of age have higher levels of lead than older children, and men have higher levels than women. Lead levels in blood in adult men average about 15 to 18 µg/dL, while adult women average about 10 to 12 µg/dL (Doull, et al., 1986). The acceptable level of lead in blood is less than 25 µg/dL.

The most serious effects of lead are those related to the central nervous system (CNS), although other effects such as kidney dysfunction may occur in individuals exposed to high concentrations. Effects on the CNS are manifested as disorders of the brain and nervous system. Low-level lead toxicity is associated with levels in the blood of 30 to 50 µg/dL. These levels may cause hyperactivity, decreased attention span, and impairment of mental function (Doull, et al., 1986).

Ingestion of high levels of lead may result in lack of muscular coordination, stupor, coma, or convulsions. In early stages of acute lead poisoning, kidney dysfunction may be reversible. However, after years of elevated exposure, permanent kidney damage may occur (Doull, et al., 1986). Lead-induced anemia may occur from reduced life span and numbers of red blood cells. Also, alteration of enzyme activity in the blood may occur. Blood lead levels above 40 µg/dL cause anemia in children and above 50 µg/dL can cause anemia in adults. Some effects on blood synthesis have been noted at lead levels of 20 to 25 µg/dL in children and at 25 to 35 µg/dL in adults blood (Doull, et al., 1986).

Severe lead toxicity is known to cause sterility, abortion, and infant mortality and illness. Some studies (Doull, et al., 1986) indicate that a reduced response in the immune system may occur. In experimental animals, high doses of lead have resulted in cancer in the kidneys (Carson, et al., 1986).

Copper Occurrence in the Environment. Copper is ubiquitous in the earth's crust and is present as the metal and as cupric (+1) and cuprous (+2) species. Copper occurs primarily as sulfides and oxides in the ores. Metallic copper is prepared from ores by smelting and refining. These processes are the largest source of atmospheric emissions of copper (Demayo, et al., 1982). About one-half of all copper produced is used as a conductor in electrical equipment; it is also used in alloys, plumbing, and in the manufacture of various goods.

Copper content in soil averages approximately 30 ppm with the normal range being 2 ppm to 250 ppm. Copper levels in surface waters average 3 µg/L with a normal range of 0.05 µg/L to 12 µg/L.

Uptake and Effects in Plants, Animals, and Humans. Copper is an essential element for normal growth of both plants and animals, but can be harmful in excess. Copper compounds are often used in various pesticides for control of insects, algae, and fungi.

Oral ingestion is the major source of copper in humans and wildlife. Inhalation is an insignificant source of copper except for a few instances of occupational exposure. Shellfish, liver, kidney, nuts, and dried legumes are food sources high in copper. The estimated copper

requirement is about 0.03 mg/day per kilogram of weight for an adult and about 0.08 mg/day/kg of weight for a child. This translates to an average daily requirement of about 1 to 3 mg per person (Demayo, et al., 1982). The average daily intake is about 2 to 4 mg per person (Doull, et al., 1986).

Copper is actively absorbed by the stomach and intestines and stored in the brain, liver, kidney, and heart. Approximately 40 to 70 percent of the ingested copper is retained (Demayo, et al., 1982). Acute ingestion of copper causes gastric disorders, jaundice, liver damage, and anemia. Chronic copper toxicity is very rare in humans and few chronic effects have been reported in humans and animals, except for sheep which are particularly sensitive to copper. Dietary intakes above 15 mg/day may produce observable effects in humans.

Acute copper toxicity is considered high for invertebrates and moderate for vertebrates. Concentrations in nonaquatic organisms range from 2 to 4 mg/kg with accumulation occurring primarily in the liver of higher organisms and in the blood of annelids and insects.

Aquatic Toxicity. Copper toxicity to aquatic organisms varies with species of plant or animal and depends on factors such as pH, complexing agents, other metals present, and the species of copper. Toxicity generally increases with decreasing pH, hardness, and organic content; toxicity is also greater for the cupric than for the cuprous species. Copper is reported to bioaccumulate in algae and oysters, but does not accumulate in the edible portion of fish tissue (Demayo, et al., 1982).

Copper toxicity levels in rainbow trout are 22.4 µg/L for a water hardness of 32 mg/L as $CaCO_3$, and 82.2 µg/L for a water hardness of 371 mg/L as $CaCO_3$ (Howarth and Sprague, 1978). Chronic toxicity levels for rainbow trout range from 11.4 to 31.7 µg/L for a hardness of 45.4 mg/L as $CaCO_3$ (McKim, et al., 1978).

In the case of saltwater animals, acute sensitivities range from 5.8 µg/L for the blue mussel to 600 µg/L for the green crab. Oysters can bioaccumulate up to 28,200 times when exposed continuously to 50 µg/L for 140 days as compared to the control, and become bluish-green, apparently without significant mortality. The bay scallop, however, does not survive under long-term exposures of saltwater with 5 µg/L of lead (U.S. EPA, 1984). The water quality criteria for both fresh water and seawater concerning copper are given in Table 5.

Zinc Occurrence in the Environment. Zinc is seldom found as a free metal in nature, but it does occur as the sulfide, oxide, or carbonate. Zinc is the fourth most widely used metal in the world (Cammarota, et al., 1980). The principal uses of zinc are in metallurgy, mainly as a constituent of brass and bronze, or for galvanizing and as a white pigment (zinc oxide) in paint and rubber. Zinc is present in most foodstuffs as well as in water and air. Zinc is divalent and also amphoteric. Complexes of zinc with common ligands in surface water are soluble in neutral and acidic solutions, so that zinc is easily transported in most natural waters and is fairly mobile.

Zinc content in soil averages approximately 90 ppm with the normal range being 1 ppm to 900 ppm. Lead levels in surface waters average approximately 15 µg/L.

Uptake and Effects. Zinc is a nutritionally essential element and is not carcinogenic. Seafoods, meat, whole grains, dairy products, nuts, and legumes are high in zinc content. A deficiency in zinc can result in severe health consequences. The National

Academy of Science recommends that adults should have an intake of 15 mg of zinc per day, and pregnant women should have an intake of 20 mg/day (Sittig, 1980). In humans, zinc ingestion for therapeutic purposes has produced no clinical symptoms at daily intakes of 150 mg/day for as long as 6 months (Greeves and Sillen, 1970). Food poisoning (Sittig, 1980) was observed with ingestion of a meal containing about 1,000 ppm of zinc and among people who ingested fluids containing zinc at a concentration of 2,200 ppm. However, evidence of hematologic and renal toxicity was not observed in individuals ingesting as much as 12 grams of elemental zinc over a 2-day period.

The current zinc standard for drinking water is 5 mg/L based on organoleptic effects (i.e., the bitter taste caused by zinc present at this level). Zinc compounds are not particularly toxic to nonaquatic organisms unless ingested in significant quantities. Earthworms have been demonstrated to accumulate up to 670 ppm of zinc from soil and may be capable of supplying potentially lethal concentrations of zinc to predators such as birds and small mammals (Gish and Christensen, 1973). Toxic levels in predator organisms range from 50 to 500 ppm wet weight.

The toxicity of zinc in an aquatic environment is influenced by chemical parameters such as pH, hardness, and the presence of other ions such as calcium and magnesium, which vary among species. These factors either influence the availability of zinc or inhibit the sorption or binding of available zinc by biological tissues. For example, in one study (Sinley, et al., 1974) the acute toxicities of juvenile rainbow trout were 1,210 µg/L and 430 µg/L in freshwater with a hardness of 330 mg/L and 25 mg/L as $CaCO_3$, respectively. Chronic toxicity of rainbow trout was shown to be 227 µg/L in water with a hardness of 26 mg/L as $CaCO_3$. In marine waters, acute toxicity was found in bivalve larvae at 141 µg/L and for a species of polychaetes chronic toxicity at 220 µg/L (Wilkes, 1977). The proposed EPA water quality criteria for both acute and chronic toxicity are 120 and 110 µg/L, respectively, in freshwater (100 mg/L hardness), and 95 and 86 µg/L for marine environments. Other information on the levels of zinc in various media is presented in Table 5.

Case Studies.

NAB Little Creek. Karr, et al. (1990) studied an impact berm at the Naval Amphibious Base (NAB), Little Creek, Virginia. Soil samples from the A horizon (1- to 2-inch depth) and B horizon (4- to 6-inch depth) and vegetation samples were collected primarily from the face berm and top of the berm and analyzed for total elemental lead, zinc, and copper. Soil obtained from bullet pockets on the berm and in the vicinity of the impact berm was sieved to 80 mesh (0.177 mm) prior to analysis. Leaves from trees near the impact berm were cut from heights ranging from 1 foot to 7 feet aboveground, depending on species. Leaf litter beneath two trees was also analyzed.

The concentrations of lead, copper and zinc from the samples are summarized in Table 6. Lead concentrations are greatly elevated in both the A and B horizon soil samples and the vegetation. Copper concentrations are also elevated in the A and B horizon soil samples, but are still within the range found in naturally occurring soils. Copper was only slightly elevated in the vegetation. Zinc results are inconclusive as it is believed the control sample was contaminated from other sources of lead. Zinc levels are within the range of naturally occurring soils.

MCCDC Quantico. In a similar study at MCCDC Quantico (Karr, 1990), elevated levels of lead, copper, and zinc were found in the impact berm soils, in soils up to 250 feet behind the impact berm, and in soils in the drainage ditch leading from the berm. Vegetation samples at these locations also showed elevated levels of these metals. Lead levels in bullet pockets in the berm were as high as 23,200 ppm. The results of the soil sampling of the impact berm are included in Table 6. Two sampling transects were performed to assess the extent of nonpoint source pollution in storm-water runoff from the impact berm and surrounding area. The first sampling transect started at the top of the impact berm and extended down the back slope and to a distance of 250 feet behind the berm. The other transect extended from the front toe of the impact berm and for a distance of about 250 feet along a drainage ditch leading away from the berm. Lead, copper, and zinc concentrations in the soils of the A and B horizons and in vegetation at the sampling points in the transects were all elevated above background levels. The lead concentrations as reported by Karr, et al. (1990) are summarized in Figures 1 and 2.

The lead concentrations on the downslope of the A and B horizons (Figure 3) were about one to two orders of magnitude higher than the lead concentrations in the background soils. The lack of a uniform decrease in lead concentrations away from the berm and elevated lead concentration (258 ppm) as far as 270 feet away from the berm suggest that contaminated sediments and possibly fine lead particulates from the berm were transported by runoff. Also, lead levels in the vegetation along this sampling transect were significantly higher than the mean background lead concentration in uncontaminated plants. A rapid decrease in the soil lead concentrations for the backslope transect up to about 100 feet away from the berm (Figure 4) probably indicates low sediment transport downstream by runoff and some overshoot. The soils for the backslope and downslope sampling transects are moderately acidic (pHs 5.6 and 4.69, respectively), and are conducive to solubilization of lead. Similar results were found for copper and zinc in the soil and vegetation at the site.

In an environmental assessment study also conducted at MCCDC Quantico in 1988 (Wm. F. Freeman Associates, 1988), a leachable lead content as high as 18.6 mg/L was observed for a soil sample taken from the bullet pockets of an impact berm. This leachate concentration exceeds the TCLP level of 5 mg/L for lead. Soils with this lead level in the TCLP leachate will be classified as hazardous. Leachable lead levels taken from the toe of the berm and sediments from the side slope of the drainage swale were also relatively elevated at 0.75 mg/L and 0.44 mg/L, respectively. The lead concentrations in soils away from the berm suggest that lead is being transported with surface runoff.

Remington Gun Club. The effects of lead pollution on wildlife from a trap and skeet facility, Remington Gun Club in Stratford, Connecticut, were investigated by Battelle (Battelle Ocean Sciences, 1987). In this facility, the lead shot was discharged into the cove area of the Long Island Sound. Approximately 3 million pounds of lead have been fired into the cove since the club's founding.

Lead levels in the blood of black ducks nesting around the facility were higher than normal, suggesting that lead shot in the sediments was ingested by the ducks. Blue mussels around the shooting range had tissue lead levels significantly greater than those in nearby

background areas. Although lead shot pollution from a trap and skeet facility would be more diffused in comparison with a small arms range, similar threats to health and the environment can be assumed.

Aging of Lead in Soils. An article by Jorgensen and Willems (1987) describes the fate of lead shot in soils. Lead pellets collected from the ranges showed slight corrosion and were partially covered by a crust of a white, grey, or brown material. Analyses of the outer crust using x-ray fluorescence, diffractometry, and infrared spectrometry indicate that the crusts were generally hydrocerussite ($Pb_3(CO_3)_2(OH)_2$) with smaller fractions of $PbCO_3$ and $PbSO_4$. Increasing amounts of $PbSO_4$ were found in soils with lower pH values.

Summary of Case Studies. In summary, the various case studies showed instances where soils from target and impact berms were contaminated with high levels of lead and failed the TCLP test, leading to a hazardous waste classification. The fairly high lead, copper, and zinc concentrations in the areas surrounding the berms and in the storm-water runoff channel from the berms indicated that storm-water runoff from small arms ranges may contribute to nonpoint source pollution of receiving waters. Stray bullets and airborne particulates from nonjacketed bullets may also add to this dispersed or "halo" effect of lead, copper, and zinc contamination around the berms. Significant levels of lead and copper in the vegetation around the berm also suggested possible lead and copper accumulation in wildlife present in the vicinity of the small arms ranges.

Regulatory Considerations

How small arms ranges are regulated under various Federal, State, and local laws and regulations is a nebulous subject. This is due to the lack of clear guidance on how to classify this operation and the right of States under several Federal Laws to impose stricter standards.

The following is a summary of the regulations that may apply to small arms ranges. We have attempted to identify the minimum and maximum levels of regulations that may be imposed as of the date of this publication. It is highly recommended that environmental legal counsel be sought for determining how the regulations impact small arms ranges at specific facilities before initiating any permitting, reporting, mitigation, cleanup, or closure activities.

Federal Hazardous Waste Regulations. The Resource Conservation and Recovery Act (RCRA) requires that all wastes destined for land disposal be evaluated for their potential hazard to the environment. Wastes are deemed hazardous if they: (1) appear on an extensive EPA list, or (2) show a hazardous waste characteristic, which is determined by testing.

The first question one must answer in determining if soil contaminated by lead projectiles is a solid or hazardous waste is whether the soil is a waste. At currently operating small arms ranges, bullets containing lead are shot at a target and eventually fall to the ground. There is strong argument that bullets fired during target practice are not discarded material which falls within the regulatory definition of "solid waste," but instead are a recyclable material. Bullets and fragments would be expected to land on the ground. Hence, the "ordinary use" of bullets includes placement on land. Moreover, it is possible that the user

has not abandoned or discarded the bullets, but rather intends to recycle them at some time in the future. Therefore, the bullets may not be considered a solid waste or a hazardous waste in certain cases. The preamble to the EPA's corrective action proposed rules, and several other EPA documents, contain the above discussion of the definition of waste at impact ranges.

In addition, a U.S. District Court decision (Barcello vs. Brown, 478 F. Supp. 646, 688-869 - D. Puerto Rico, 1979) has suggested that materials resulting from uniquely military activities engaged in by no other parties fall outside the definition of solid waste. This argument can be applied to small arms ranges implying that the bullets in the soil are not a solid or hazardous waste.

Contaminated soil from small arms ranges is classified as a waste if it is removed and hauled to a disposal site. Also, in some areas, the State regulatory agencies have adopted a stricter stance and have listed currently operating small arms ranges as a Solid Waste Management Unit (SWMU) as defined by RCRA. As such, the contaminated soil is considered a waste.

The second question that needs to be answered is whether the soil is hazardous. Soils containing lead shot are not included in the EPA hazardous lists, but they may fall into the category of "characteristic wastes." The four types of hazardous waste characteristics are reactivity, ignitability, corrosivity, and toxicity, with toxicity pertaining to lead-contaminated soils. The toxicity characteristic is estimated by the amount of toxic contaminant that is solubilized from the solid being tested into an aqueous leaching medium, using a prescribed leaching methodology. Lead is one of the regulated metals and, as indicated above, is one of the principal contaminants in small arms practice ranges. The Extraction Procedure Toxicity Characteristics (EPTC)) leaching methodology was introduced by the EPA in 1980 to assess the toxicity of the wastes destined for land disposal. A new test method, the Toxicity Characteristic Leaching Procedure (TCLP), was officially presented in the January 1986 Land Disposal Restrictions, which proposed to establish treatment standards before wastes could be disposed of on land. Since then, TCLP has been modified several times and is now the accepted procedure for determining whether a waste is hazardous or nonhazardous, and also for determining whether appropriate treatment standards have been met.

TCLP uses an acetic acid or buffered sodium acetate solution in a 20:1 leachate:waste ratio. The threshold concentration for lead in the TCLP extract is 5 mg/L. Below that level a waste is considered nonhazardous; above that level the waste shows "toxicity characteristic" and is therefore defined as hazardous. Theoretically, a soil with a total lead concentration lower than 100 mg/kg cannot exceed the TCLP threshold because of the 20:1 dilution factor during leaching. As discussed earlier in this report, lead content in soil averages about 16 mg/L.

Lead-contaminated soil from small arms practice ranges may vary widely in total lead content because of the highly heterogeneous distribution of shot in the soil. Total lead concentrations ranging up to several percent or more may not be unusual for the soil directly behind the targets. However, RCRA regulates these soils by the TCLP-soluble level content, not the total lead content.

While it is possible for a soil containing percentages of lead to pass the TCLP, it is also possible that such a material will fail the TCLP. In the chemical environment of this test, lower soil pHs will be associated with higher lead extractabilities, as a first rule of thumb.

The physicochemical form of the lead (e.g., weathered lead salts such as oxyhydroxides or carbonates as opposed to elemental lead) is also an important variable.

Therefore, it is likely that a significant percentage of soils at small arms ranges are hazardous. Hazardous soils are expected at and immediately around the bullet pockets in the impact berms.

At some operating small arms ranges, lead bullets build up in the soil in the impact berm to a point where a ricochet hazard exists. Typically, when this occurs, the soil from the berm is either removed for disposal or sieved to remove the bullets and returned to the berm.

If the soil containing lead bullets is removed for disposal and not recycled, it is probably a harzardous waste and must be handled as such under RCRA. The reason behind this is that the soil is a waste because it is removed from the berm and discarded. As a ricochet hazard exists, it is probable that there are at least several percentages of lead in the soil. Testing using the TCLP procedure would reveal if the lead in the soil exceeds the hazardous limit of 5 mg/L, classifying the soil as a hazardous waste.

Contaminated soils classified as hazardous wastes require pretreatment prior to disposal to meet the Land Disposal Restrictions, possibly even for disposal in a subpart B regulated landfill. Stabilization/solidification is the BDAT (Best Developed and Available Technology) for disposal of metal-contaminated soils. A treatment permit under RCRA may be needed.

If the soil is sieved to remove bullets, the soil and bullets may not be considered hazardous waste. As mentioned earlier in this report, the intent here is not to dispose of the soil or bullets, but to recycle or reuse them. The recovered bullets would need to be recycled and the soil returned (recycled) to the impact berm. Sieving to recover most of the lead bullets and fragments may or may not result in a residual soil that can be classified as nonhazardous, depending upon a number of factors such as the amount or chemical form of the lead remaining in the soil after sieving. If the bullets and fragments are not recycled or the soil not returned to the berm, the contaminated soil could be classified as a hazardous waste and regulated as such under RCRA. Also, if the berm has been listed as a SWMU, a RCRA treatment permit may be required to perform the sieving.

A small arms range that is listed as a SWMU and is being closed down may need to be mitigated under the site closure provisions of RCRA. A closure plan may need to be developed and permits obtained for treatment of the contaminated soil or its on-site disposal.

Finally, there has been little action in this area so there is little specific guidance or precedent. The preceding is a discussion of some possible outcomes under the current RCRA regulations. Legal counsel should be sought to determine appropriate actions at a specific site. Figure 5 is a flow chart to aid in determining RCRA criteria.

State Hazardous Waste Regulations. The State of California regulates hazardous wastes on the basis of the total concentration and the California WET (Waste Extraction Test), which uses a citrate solution, a 10:1 leachate waste ratio, and a 48-hour extraction period as opposed to an 18-hour period in the TCLP. Therefore, the test is usually more severe than the TCLP, sometimes by several orders of magnitude, resulting in a waste classification referred to as "California-only" wastes (i.e., wastes that fail WET but pass TCLP). Such wastes are regulated as hazardous only in the State of California but are not considered EPA or RCRA wastes.

In addition to lead, substances containing copper and zinc are regulated under California's hazardous wastes laws. Consequently, it is likely that a larger proportion of contaminated soils from small arms ranges in California will be regulated as hazardous waste than in other states.

Also, as discussed above under the Federal Hazardous Waste Regulations section, the States may have stricter definitions of what qualifies as a waste and may classify contaminated soil as hazardous waste in more instances.

Federal CERCLA Regulations. The Comprehensive Environmental Compensation and Liability Act (CERCLA) requires the reporting and mitigation of releases of certain contaminants to the environment. Small arms ranges could come under the provisions of CERCLA in several instances.

Unused or previously closed small arms ranges may be identified under the Navy's Installation Restoration Program as abandoned sites. If the site poses a risk to human health or the environment, a Remedial Investigation/Feasibility Study (RI/FS) may be performed to determine the extent of contamination and quantify the risk, if any, posed by the site. Any mitigation or cleanup would be performed under CERCLA provisions. This means that, at some sites, no permits would be needed for on-site treatment. Some State and local agencies may have additional requirements so that RCRA treatment permits and other permits may be required to perform the cleanup. Again, as there have been no small arms ranges cleaned up under the Installation Restoration program, legal counsel should be sought to determine how to proceed.

Current operating sites may also be covered under CERCLA. Contaminated soil transported in storm-water runoff could be considered a spill or release under CERCLA. If a reportable quantity of the contaminant left the site, the release would need to be reported under CERCLA. For both lead and copper, the reportable quantity is one (1) pound per event. Note that in this instance, CERCLA only requires reporting. Cleanup or mitigation of the release, if required, would probably be pursued under RCRA or the Clean Water Act.

Prior to closing an operating small arms range, consideration should be given to cleaning up the soil. This action would most likely be considered recycling or covered under RCRA, as discussed previously in this report. If the range is closed without any cleanup, further action would probably be covered under CERCLA.

Clean Water Act Regulations. The Enactment of Section 319 of the Water Quality Act of 1987 created specific provisions for the control of nonpoint source pollution. With this act, the States now have additional support and direction for comprehensive implementation of nonpoint source pollution controls. This Act gives the States responsibility, as well as flexibility, to design and implement nonpoint source pollution programs as a part of an overall State water quality cleanup strategy. As mandated by the Act, the States are required to submit to the EPA a State Assessment Report and a State Management Program within 18 months of enactment. The State Assessment Report identifies water bodies that cannot attain water quality goals without additional nonpoint source pollution controls, sources of nonpoint source pollution for each watershed, and categories of controls including best management practices for nonpoint source pollution control. The State Management Program summarizes how the State will accomplish its nonpoint source pollution goals.

Storm-water runoff from the berms and surrounding areas may contain elevated levels of lead, copper, zinc, and other heavy metals, and increase nonpoint source pollution of receiving waters. Due to erosion of the berms from bullet impacts, increased levels of sediment and nutrients such as nitrogen may be found in the storm-water runoff from the target and impact berms. As the States implement their nonpoint source pollution programs, controls may need to be added to small arms ranges to control pollutants in storm-water runoff.

Storm-water discharges from small arms ranges may need National Pollutant Discharge Elimination System (NPDES) permits. Amendments to 40 CFR Parts 122, 123, 124, which became effective on December 17, 1990, require that NPDES permit applications be submitted for storm-water discharges associated with industrial activities and storm-water discharges from large and medium separate storm sewer systems. As this regulation is currently being implemented, it is unclear if a small arms range is classified as an industrial activity. For example, NPDES permit applications are required for facilities involved in the recycling of materials. We previously discussed that under RCRA, the impact berms at small arms ranges could be considered recycling activities; a NPDES permit application may be required using this same reasoning. Further, under section 122.26 (a)(v) of the December 17, 1990 amendments, the EPA or a State may also require permit applications for discharges that contribute to a violation of water quality criteria. Using this criteria, the EPA or State may require a NPDES permit application on a case by case basis.

Some small arms ranges in coastal areas may not have capture berms and may allow bullets to fall into the adjacent body of water. As this could be considered a discharge of a solid waste directly into a surface water, a NPDES permit may be required.

Due to the newness of this regulation and the different interpretations each State may use, legal counsel should be sought to determine if a NPDES permit application is needed for a specific small arms range.

Geochemical Modeling of Lead, Copper, and Zinc Mobility

The mobility or solubility of metals in natural waters is determined by the chemical characteristics of the water, mainly the pH, redox potential (Eh), and the concentrations of complex-forming ligands (carbonates, sulfate, organic acids, etc.). Solubilities of lead, copper, and zinc in natural groundwaters of different complex-forming ligands and pH are discussed below with reference to groundwater compositions found in three types of geological formations: basaltic, sand and gravel, and limestone. These rocks types were chosen to represent a variety of geological terrains that may be found at Naval bases around the country.

Typical chemical characteristics for these waters are shown in Table 7. We have categorized chemical constituents in water as "low" for concentrations that are less than 100 mg/L, "moderate" for concentrations between 100 and 250 mg/L, and "high" for concentrations that are above 250 mg/L. Groundwater from basaltic terrain can be categorized as having low sulfate and moderate carbonate content. Groundwater from sand/gravel can be categorized as having moderate levels of sulfates and carbonates. Groundwater from limestone terrain tends to have high carbonates but moderate levels of sulfate. To construct the solubility diagram, the various sulfate and carbonate concentrations presented in Table 7 were

used, but with pH as a variable from 4 to 10. In one of the scenarios, organic matter (i.e., fulvic acid) was assumed to be present to illustrate the impact of dissolved organic matter on metal solubility. In the case of zinc, the impact of silicates on zinc solubility is also discussed.

Lead. Lead can occur in three oxidation states: elemental, divalent, and tetravalent. Divalent lead is the dominant species within the range of Eh-pH conditions of natural waters (Figure 6), while tetravalent lead exists only in extremely oxidizing conditions that are not usually found in the environment. Figure 6 also shows that lead is rather insoluble under most Eh-pH conditions found in natural waters except for low pH. Depending upon the pH and the concentrations of anions (sulfate and carbonate), a lead sulfate, lead carbonate, or lead sulfide phase generally controls the total solubility of dissolved lead in the system.

The solubility of lead in the three selected groundwaters is shown in Figure 7. Lead is very insoluble above a pH of 7, and there is not much difference in the solubility of lead between the different groundwater types. Below pH 7, the presence of sulfate at moderate levels (~100 mg/L) increases the solubility of lead when the concentration of carbonate also is at moderate levels (~100 to 200 mg/L). For moderate concentrations of sulfate, the solubility of lead is lower for higher carbonate concentrations; but at about pH 4, the solubility of lead is comparable with moderate concentrations of carbonate. The solubility of lead at low pH is shown to be higher for groundwater with a low concentration of sulfate and a moderate concentration of carbonate. This result suggests that liming the target berms to increase pH and alkalinity may retard dissolution of lead into surface runoff and groundwater.

The effect of dissolved organic matter, represented by fulvic acid, is to increase the solubility of lead in the pH range of 4 to 6. Figure 7 shows this effect at a fulvic acid concentration of 10 mg/L, typical of shallow groundwaters and soil pore size.

In addition to carbonate and sulfate solid phases, lead phosphates may also control the solubility of lead in some environments. The solubility of lead phosphates, however, is lower than that of carbonates or sulfates. On the contrary, lead oxide is much more soluble than most other lead compounds or native lead. The solubility product (log Ksp) of lead phosphate is -44.3, while that of lead oxide is 12.7 (see Table 8). Consequently, the concentration of lead in leachates will be higher where lead oxide, and not native lead, is being leached. However, in an aquatic environment, the equilibrium concentration of dissolved lead in the soil solution will be controlled by the least soluble lead compound that is stable in that environment. From the solubility product information in Table 8, the sulfate, carbonate, and sulfide forms of lead as well as the mixed carbonate-hydroxide form, hydrocerussite, $Pb_3(CO_3)_2(OH)_2$, could be expected to form as an alteration product of elemental lead in various chemical environments. Therefore, depending on the lead compounds that form on the surface of the bullets, the leaching characteristics of lead in abandoned ranges will be different from the leaching characteristics of "fresh" bullets in active ranges.

Copper. The dominant oxidation states of copper are monovalent (cuprous) and divalent (cupric). Copper in both of these forms occurs in natural waters (Figure 8). Within the stability field of divalent copper, cupric carbonate or cupric oxide, depending upon the pH, exerts control over the solubility of copper. The solubility of copper in the three selected groundwaters is below 0.1 mg/L at pH values greater than 8 (Figure 9). In the pH range of 6

to 7, the solubility of copper is below 6 mg/L, and the variations in sulfate concentrations do not have a significant effect. However, organic matter increases copper solubility in a manner similar to lead. At pH below 6, copper may be relatively soluble (and mobile) in oxidized, shallow groundwaters.

Zinc. Zinc occurs in the natural environment exclusively in the divalent oxidation state. The solubility of zinc in groundwater is likely to be controlled by a zinc-silicate phase ($ZnSiO_3$ or Zn_2SiO_4, willemite) or a Zn-Fe-oxide ($ZnFe_2O_4$, franklinite). The hydroxide and carbonate phases are not likely to exert a solubility control because dissolved silica is present in most natural waters. The solubility of zinc in the three groundwater types is shown in Figure 10. Below pH 5, silica is very soluble, even in the presence of relatively high dissolved zinc (SiO_2 = 49 mg/L). At pH >5, the solubility of zinc decreases rapidly and is lower than 1 mg/L at pH 5 and higher. Because of insufficient data, no calculations are shown for the effect of organic complexing on the solubility of zinc. However, organic complexing of zinc is expected to be similar to that of copper and, therefore, will probably have a minor effect on the solubility of zinc at higher pH values.

Summary of Geochemical Modeling. Because of the low solubility of lead in water and its tendency to be trapped by organic matter in the soil, it is doubtful that lead could pose a significant threat to groundwater at most sites. Sites where groundwater is shallow (less than about 10 feet deep), the soils are sandy, and the soil pH is less than 7, may contain elevated levels of lead in the groundwater.

Similarly, copper and zinc solubilities drop greatly with increasing pH. Also, the drinking water standards for these metals are less restrictive. Copper is not a threat at sites where the soil pH is greater than 7 and zinc is not a threat at sites where the soil pH is greater than 6.

SURVEY RESULTS

The Navy Facilities Assets Data Base (NFADB) maintained by the Facilities Support Office (FACSO) in Port Hueneme, California, lists 89 naval bases having a total of 245 outdoor small arms ranges.

Sixty-five of the 89 naval bases were selected to receive a survey to collect data on: (1) small arms ranges, and (2) the potential for nonpoint source pollution from the ranges. From these 65 surveys, 37 responses have been received to date. The following is a compilation and analysis of some of the information contained in these surveys.

Thirty of the bases that responded to the survey currently have one or more active ranges. Three of the bases that responded have only abandoned ranges and three others have no ranges. Indoor ranges and skeet and shotgun ranges were not included in the analysis of the survey data. These ranges pose a different set of environmental concerns, such as indoor air pollution. Thus, 52 percent of the bases surveyed responded positively to the survey, which represents about 38 percent of the total number of bases listed in Karr, et al. (1990) (Figure 11) and about 32 percent of the total number of naval ranges.

Certain types of generalizations are difficult because much of the data are site-specific. For example, berm soil type varies from 90 percent clay at certain sites to 100 percent sand at other sites; therefore, there is not a typical soil type used in the construction of all berms. Similarly, proximity of surface water and groundwater to the berm varies greatly from site to site.

Two common practices were noted. First, spent casings are almost always collected and removed from the range. Second, lead is the primary chemical constituent in the bullet (and also the most toxic) and, therefore, the metal of greatest interest when evaluating the potential for nonpoint source pollution from responses.

Two naval bases indicated that their small arms ranges do not have impact berms to stop the bullets. Instead, the bullets drop onto a designated area adjacent to the small arms range. At Marine Corps Recruiting Depot (MCRD) Parris Island, South Carolina, bullets collect on a marshy area next to the range. At Camp Smith Training Facility, Ewa Beach, Hawaii, the seafront adjacent to the small arms range collects the spent bullets. Metal pollution from these two bases may be more dispersed than at ranges with impact berms and the level of threat to health and the environment may also be different.

The responses to individual questions are discussed below. A blank copy of the survey is included in Appendix A and Appendix B presents the mailing list. Please note that the surveys were screened for reasonableness of the responses and for potential erroneous responses on the part of the person completing the questionnaire. In many cases, questionable data were clarified over the telephone. When this was not possible, any highly suspect data were eliminated from the evaluations below.

Question 2: Number of Active Sites

Most of the sites surveyed (26 out of 30) have one or two active small arms ranges (Figure 12). The total number of active ranges for the 30 responses was 79. The high was 30 ranges (Figure 12), at Marine Corps Air-Ground Combat Center (MCAGCC) Twenty-Nine Palms, California. This assessment is echoed in the NFADB where the majority of activities have one or two ranges, while a few large Marine Corps training bases have over 20 ranges each.

Question 3: Number of Years in Service

The number of years of service for a small arms range varies from a few years to as long as 73 years. The frequency of responses based on a 10-year interval histogram (Figure 13) shows that the majority of the ranges (21 of the 31 responses) have been in service less than 30 years. The average number of years of service is approximately 27 years.

Question 4: Number of Abandoned Ranges

Of the 34 responses, there were a total of 18 abandoned ranges, including three bases that indicated they have only abandoned ranges and no active ranges. This number of abandoned ranges represents about 23 percent of the total number of active ranges (79) in this

survey. Extrapolating this result to the 245 ranges listed in the NFADB yields approximately 56 abandoned small arms ranges at all of the naval installations.

Question 5: Lifetime of Ranges

Of the 35 activities that responded to this question, seven indicated that their ranges had an "indefinite" lifetime, 14 did not know the life span, and 13 gave a specific time period. Of the 13 that stated specific periods, the average lifetime of a small arms range is about 31 years.

Question 6: Number of Targets per Site

Figure 14 illustrates the number of targets per site. Each grouping in the histogram is in increments of five. There was a cluster of responses having 5 to 20 targets per site with several outliers having 40 or more targets per site. These clusters confirm field observations that there are two typical types of ranges: small pistol ranges with an average of 15 targets per range as shown in Figure 1, and larger rifle ranges with 50 or more targets per range as shown in Figure 2. The average is 17 targets per range.

Question 7: Number of Rounds per Year

The data on the number of rounds shot per year were computed to the average mass of lead accumulating per year in an impact berm. The mass of each type of bullet used is given in Table 9. The average coomposition of bullets was assumed to be 70 percent lead, 20 percent copper, 5 percent antimony, and 5 percent zinc.

The mass of lead generated per year is given in Figure 15a, with group intervals in increments of 1,000 kg/year. Fifteen of the total responses indicated lead masses of less than 2,000 kg/year. Three responses indicated that the mass of lead generated was more than 9,000 kg/year. The mean value is 3,190 kg/year. Sample size for this question is 30. For all 245 ranges reported in the NFADB, the mass of lead discharged into the environment at all naval bases is 780,000 kg/year (860 tons).

The mass of copper generated per year is given in Figure 15b with a histogram interval of 100 kg/year. The mean mass is 354 kg/year. For all 245 ranges, the mass of copper discharged into the environment at all naval bases is 87,000 kg/year (95 tons).

Question 8: Chemical Composition of the Bullet

Of the 34 responses, 27 respondents answered this question. Nineteen of the respondents indicated that lead was the major metallic component in the ammunition used, with a relative lead composition greater than 90 percent (see Figure 16a). Of the 19 respondents, two (from NAS Pensacola, Florida, and NAVSTA Panama Canal) indicated that the ammunition used for their small arms was mainly made of copper in proportions as high as 90 percent. Upon questioning, they indicated that 90 percent of their ammunition used consisted of copper-jacketed bullets. Copper seems to be used more extensively as an outer sheath material than steel (Figures 16b and 16c).

Question 9: Spent Casings

Thirty-two respondents indicated that spent casings from ammunition were collected and disposed of or recycled (Figure 17). Only two respondents indicated that the casings were not collected. Of the 32 positive responses, 22 indicated that the spent casings were sold to a metal recycler, and nine indicated that they were disposed of (see Figure 17, insert). Of the 22 respondents that indicated the spent casings were sold to a metal recycler, 10 indicated that the material was turned over to the Defense Reutilization Marketing Office (DRMO) and recycled. The nine respondents that indicated that the metal casings were disposed of did not state the mode of disposal.

Question 10: Type of Soil

There were 31 responses to this question. The data are plotted in Figure 18. Some respondents placed a check mark by the type of soil rather than indicating a percentage. When a single check mark was indicated, we assumed that the soil consisted of 100 percent of that particular material. If check marks were placed on more than one soil type without giving the percentage, the data were not taken into consideration. Of the 31 respondents, 12 indicated that their berms were constructed of 100 percent sand. Figure 18 indicates that a variety of other materials in addition to clay and sand have been used. Impact berms at naval bases on islands such as NAVSTA Guam tend to be built out of coral, while a few indicated that (undefined) crushed rock was used for the core to provide support.

Question 11: Typical Berm Size

Berms come in many sizes with heights varying from as low as 5 feet to as high as 50 feet and with lengths varying from 15 feet to a mile long, such as at NAVSTA Panama Canal. While some impact berms are built out of dirt from near the range, several respondents indicated that their impact berms were actually the side of a hill, such as at NAVSTA Panama Canal. Based on the responses, there was some confusion over the definition of the width and length of the berm. When the width was longer than the length, we took the liberty to switch the measurements around. Figures 19, 20, and 21 summarize the responses for the height, width, and length of the berms. The mean height, width, and length of a berm are 18, 42, and 340 feet, respectively. These averages include two very long berms. The two clusters of data on the length of the berm confirm field observations of two different sizes of small arms ranges. One class of a small arms range has a berm with an average length of 130 feet. The other class consists larger ranges with berm lengths in excess of 500 feet. Two of these long berms reported in the survey, NAVSTA Panama Canal with a berm length of 5,280 feet and MCRD Parris Island with a berm length of 1,500 feet, were not included in Figure 21.

In terms of the shape of the berm cross section, most berms are trapezoidal rather than rectangular. To quantify the total volume of soil in a berm, the width of the crown (i.e., top) of the berm would be required along with the slopes of the impact side and back side of the berm. We have made some approximations to facilitate this calculation.

The slopes of the front (impact side) and back of the berm vary from 1.0 to 2.0 (based on several engineering drawings on impact berms provided by Marine Corps Base Camp Pendleton, California). To compute the volume of soil, we have assumed a slope of 1.5. If the width of the berm was less than twice the height of the berm divided by the slope, we assumed that the berm was rectangular in shape. If not, the berm was assumed to be trapezoidal. The total volume of the berms from the various responses was plotted with group intervals in increments of 1,000 cubic yards (Figure 22). The mean volume of a berm is 3,100 cubic yards per site excluding the two outliers.

As shown by the Karr, et al. (1990) study, soils are not contaminated uniformly. The area directly behind a target (bullet pockets) is obviously the most contaminated. Contamination decreases as one moves away from the bullet pockets and also as one moves deeper into the berm. Some of the soil may not be contaminated enough to fail a TCLP test, therefore, not all soil on the berm needs to be regarded as hazardous. The contaminated soil that is hazardous is certainly only a fraction of the total volume of the berm. To compute this fraction, we assumed that the full length of the impact side of the berm is contaminated to a depth of 3 feet, which probably is a conservative assumption because bullets are unlikely to penetrate that far into the ground. This calculation yields a mean contaminated soil volume of 820 cubic yards per site (excluding the two outliers). Figure 23 illustrates the distribution of contaminated soils based on the above criteria.

The fraction of lead by volume in the contaminated soil was estimated to be about 1.3 percent based on a specific gravity of 11.4 for lead, an annual accumulation of 3,190 kg of lead over a 30-year period in a volume of 820 cubic yards. Localized pockets can contain up to 30 percent lead by volume or more, as reported by Karr, et al. (1990).

The safety and protective sides of the berms were not included in the volume calculations because many respondents did not provide these data. Note, however, that soil from the side berms may also be contaminated because of possible dispersion of fragmented and stray bullets and aerial dispersion from airborne lead particles.

Question 12: Disposal of Soil

For question 12 (see Figure 24), a total of nine respondents indicated that the contaminated soils are mined when a ricochet problem occurs, while four indicated that the soil was removed and disposed of as hazardous waste. Five respondents indicated that the soil was removed and used on-site as fill. Fourteen indicated that other actions were taken. Of these 14 respondents, three indicated that more soil was added to the berm, one indicated that the soil will be analyzed and disposed of accordingly, while the rest indicated that they do not have a ricochet problem. Four did not respond to this question.

As a followup to this question, we attempted to contact the nine respondents that indicated their soils were mined. We were able to contact four of the nine. At MCRD Parris Island, South Carolina, the berm was mined once about 8 months ago. Officials tentatively plan to mine the berm every 12 to 18 months. Manual labor was used and dirt was screened through a 3- by 4-foot frame with a 1/8-inch mesh rabbit wire. Berms at NAS Kingsville, Texas, are mined yearly or more frequently, depending on the number of rounds expended. Again, the soil is sieved. The Officer in Charge did not know what size mesh is used.

At NAS Pensacola, Florida, the Officer in Charge reported that the berms are mined every month. Dirt is screened through a 1/4-inch mesh screen held by a 2- by 4-foot frame. Material remaining in the screen is placed in 55-gallon drums and sent to DRMO, while the soil is returned to the berm. Similar practices are carried out at SUBASE San Diego except that the berms are mined annually, and protective clothing (including masks) is used during shoveling and screening. All four respondents indicated that employing a subcontractor to mine the berm is expensive, and that they do not know to whom DRMO sells the recoverable metals.

The practice of using the soil from impact berms as fill without treatment could possibly result in the transfer of contamination from one site to another. Mining or recycling is clearly a preferred practice.

Questions 13 and 14: Distance to Nearest Surface Water and Depth of Groundwater

Figure 25 illustrates the responses for question 13. The responses show a great range in distances and depths, depending on the site. With regard to depth to groundwater (Figure 26), 11 responded that the depth was less than 10 feet, while 18 indicated that the depth was less than 20 feet. This was expected because most naval bases are close to the coast.

Question 15: Chemical Analysis of Surface Water and Groundwater

Survey responses for this question are shown in Figure 27. A total of seven responses indicated that surface water or groundwater wells were chemically analyzed. Most did not possess data on the concentration of lead and other metals. The respondents were as follows:

- NAS, Mayport, Florida
- MCLB, Albany, Georgia
- MCRD, Parris Island, South Carolina
- NAS, Patuxent River, Maryland
- NAB, Little Creek, Virginia
- MVSEC, Sabana Seca, Puerto Rico
- NAS, Alameda, California.

Table 10 lists the groundwater data for wells that were near the impact berms. The groundwater taken from Well M-3 at NAB Little Creek, about 100 feet from the impact berm (Figure 28), had a concentration of 83 µg/L of lead, which is higher than the drinking water standard for lead of 50 µg/L. This well is also close to an old disposal pit, which could also be the source of the elevated lead levels. More data need to be collected to resolve this issue.

Table 11 lists chemical analysis data that were provided on surface water and surface runoff. At NAS Mayport, surface runoff water collected close to the impact area after a storm indicated lead levels as high as 2.36 mg/L (or 2,360 µg/L). Water at the drainage ditch, however, showed much lower levels of lead. Also included in Table 11 are data on surface water from an environmental assessment study at Quantico, Virginia. These data revealed that lead levels in the stream more than 1,000 feet away from the berm were normal and were less than the drinking water standard.

Question 16: Analysis of Soil

Three respondents indicated that soil from their impact berms was chemically analyzed. In addition to the soil analysis from NAS Mayport, we have included in Table 12 soil analysis data from the case studies discussed earlier. These data positively show that the soils from impact berms are contaminated with lead, zinc, and copper and that the failure of the TCLP test for lead would classify certain soils as hazardous.

SIGNIFICANT FINDINGS AND CONCLUSIONS

Bullets are made of a lead alloy consisting of copper, tin, and antimony. Jacketed bullets have a coating material consisting of copper plate or a copper zinc mixture. Other metals are used as tracers and ignitors and may be a source of contamination.

Lead is ubiquitious in nature and is found at an average concentration of 16 ppm in the soil. It is not an essential element and can bioaccumulate in human, animal, and plant tissue and cause chronic health effects. It can cause severe central nervous system disorders in humans. Grazing cattle have been poisoned by lead.

Copper is ubiquitious in nature and is found in the soil at an average concentration of 30 ppm. It is an essential element at levels of 1 to 3 mg/day, but can be harmful in excess of 15 mg/kg. Chronic health effects are rare, but acute effects such as digestive problems are more common. Sheep are sensitive to copper and fish can tolerate concentrations only up to 12 µg/L.

Zinc is ubiquitious in nature and is found in the soil at an average concentration of 90 ppm. It is an essential element at 15 mg/day, but can cause food poisoning at over 1,000 ppm. Zinc is not very toxic to aquatic organisms, fish can tolerate up to 110 µg/L. Earthworms can bioaccumulate enough lead to supply a lethal concentration to birds and small animals.

There are no guidelines for elevated levels of lead, copper, and zinc in vegetation.

Elevated levels of lead, copper, and zinc in the soil and vegetation have been found in the berms at small arms ranges, in areas 250 feet behind the impact berms, and in the drainage from the berms. These levels of lead, copper, and zinc indicate that the berms represent a nonpoint source of pollution. Levels of lead exceeding the RCRA hazardous waste criteria have been found in the soil of the berms.

How small arms ranges are regulated under various Federal, State, and local laws is a nebulous subject. Generally, if it is intended to recover and recycle all of the bullets and fragments, the site is not regulated under RCRA. The site may be regulated under CERCLA

if more than 1 pound of lead is transported in storm-water runoff from the site or the site is abandoned. The site may also be regulated under the Clean Water Act as a nonpoint source of pollution. A NPDES permit may be needed for collected storm-water runoff from the site or if the site has no impact berm and bullets are discharged directly into a surface water. It is highly recommended that environmental legal counsel be sought for determining how the regulations impact small arms ranges at specific facilities.

Results of limited groundwater sampling and geochemical modelling indicate that lead may cause groundwater pollution at sites with sandy soil, a soil pH less than 7, and shallow groundwater (less than about 10 feet). Groundwater modelling indicates that copper or zinc can cause groundwater pollution at sites where the soil pH is less than 6 and groundwater is shallow. Field sampling has not been performed to acquire data to support the modelling.

The Navy and Marine Corps have an estimated 89 bases with 245 active ranges. There are an estimated 56 abandoned ranges.

It is estimated that a total of 860 tons of lead and 95 tons of copper are discharged into the environment at all naval ranges.

Most of the 89 bases have one or two small arms ranges. The Marine Corps have several bases with over 20 small arms ranges each.

There are two size classes of small arms ranges. The most common class is a site with 15 targets and a berm 130 feet long. The other class contains much larger ranges with 50 or more targets and berm lengths of over 500 feet.

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Table 1. Chemical Composition of Bullet Cores (from MIL-L-13283B (MR) 19 Aug 1970) (Fedoroff & Sheffield, 1975)

Element	Grade 1	Grade 2	Grade 3
Lead and Antimony % minimum	99.2	90.0	90.0
Antimony	1.0-2.5	9.0-10.5	9.0-9.1
Copper % maximum	0.1	0.1	0.1

Table 2. Typical Chemical Composition of Jacket Materials

Element	ASTM B 130-86 Brass[a]	"95/5 Brass" Gilding Metal[b]	"90/10 Brass" Gilding Metal[b]
Copper	89.0-91.0	94-95	89-91
Lead, max	0.05	0.03	0.03
Iron, max	0.05	0.05	0.05
Zinc	remainder	5-6	9-11

[a]ASTM Standard Specification for Commercial Bronze Strip for Bullet Jackets.
[b]Encyclopedia of Explosives and Related Items (Fedoroff & Sheffield, 1968).

Table 3. Typical Formulas for Igniter and Tracer Compositions (Kaye, 1978)

Compound	Delay Action Igniter I-136	Dim I-194	Daylight Bright) Igniter I-276	Red Tracer R-257	Fumer R-284
Strontium Peroxide	90	--	--	--	--
Magnesium	--	6	15	28	28
I-136 Igniter	--	94	--	--	--
Calcium Resinate	10	--	--	4	--
Barium Peroxide	--	--	83	--	--
Zinc Stearate	--	--	1	--	--
Toluidine Red (Identifier)	--	--	1	--	--
Strontium Nitrate	--	--	--	40	55
Strontium Oxalate	--	--	--	8	--
Potassium Perchlorate	--	--	--	20	--
Polyvinyl Chloride	--	--	--	--	17

Table 4. Military Primer Compositions (from Juhasz, 1977)

Ingredients	Composition (Percent by Weight)						
	FA70	FA90	PA100	PA101	793	NOL60	NOL130
Lead Styphnate (Basic)	--	--	--	53	39	60	40
Lead Styphnate (Normal)	--	--	38	--	--	--	--
Barium Nitrate	--	--	39	22	44	25	20
Lead Azide	--	--	--	--	--	--	20
Tetracene	--	--	2	5	2	5	5
Lead Dioxide	--	--	5	--	--	--	--
Calcium Silicide	--	--	11	--	14	--	--
Aluminum Powder	--	--	--	10	--	--	--
Antinomy Sulfide	17	12	5	10	--	10	15
Lead Sulphocyanate	25	25	--	--	--	--	--
PETN	--	10	--	--	--	--	--
TNT	5	--	--	--	--	--	--
Potassium Chlorate	52	53	--	--	--	--	--

Table 5. Summary of Metals Background Data

Standard	Pb	Cu	Zn
Drinking Water Standards (μg/L)	50	1000	5000
Natural Occurrence:			
Groundwater (μg/L) -			
Range	1-10[a]	--	--
Freshwater (μg/L) -			
Mean	3	3	15
Range	0.06-140[a]	0.2-30	0.2-100
Seawater (μg/L) -			
Mean	0.3	0.25	4.9
Range	0.03-13	0.05-12	0.2-48
Soil (mg/kg) -			
Mean	16[b]	30	90
Range	10-37	2-250	1-900
Sediments (mg/kg dry wt)[c]:			
Median	16	4.0[d]	41
95 Percentile	199	32.0[d]	379
Toxicity Criteria in Aquatic Environment (μg/L):			
Freshwater (hardness = 100 mg/L) -			
Acute	82	18	120
Chronic	3.2	12	110
Seawater -			
Acute	140	2.9	95
Chronic	5.6	2.9	86

[a]Sittig (1980).
[b]Davies and Wixson (1986).
[c]Based on analyses of stream, river, lake, and reservior sediments.
[d]Wet weight basis.

Table 6. Total Metals Concentrations in Impact Berm Soil
NAB Little Creek, VA and MCCDC Quantico, VA

Soils	Little Creek			Quantico		
	Pb (ppm)	Cu (ppm)	Zn[a] (ppm)	Pb (ppm)	Cu (ppm)	Zn (ppm)
Natural Occurence, Soil[b]:						
Mean	16.0	30.0	90.0	16.0	30.0	90.0
Minimum	20.0	2.0	1.0	20.0	2.0	1.0
Maximum	37.0	250.0	900.0	37.0	250.0	900.0
Horizon A:						
Mean						
Samples	2954.3	137.0	22.0	4772.7	559.6	112.7
Control	8.6	3.8	13.8	26.0	6.9	19.2
Minimum						
Samples	15.1	1.9	1.3	161.0	61.7	53.6
Control	4.8	2.9	3.2	12.5	4.1	13.0
Maximum						
Samples	15100.0	957.0	173.0	23200.0	1619.0	294.0
Control	18.2	5.5	40.2	37.0	10.3	26.8
Horizon B:						
Mean						
Samples	1243.0	82.4	11.1	1222.9	397.3	130.2
Control	24.5	40.8	25.6	31.9	4.9	13.0
Minimum						
Samples	7.2	2.0	1.5	87.7	71.6	60.2
Control	5.0	2.2	1.7	11.5	2.7	10.7
Maximum						
Samples	8421.0	416.0	56.3	4221.0	1139.0	294.0
Control	61.2	121.0	91.0	103	6.6	19.2
Vegetation:						
Mean						
Samples	57.9	14.1	38.4	61.9	9.3	62.6
Control	1.2	13.2	151.7	1.1	4.7	41.6
Minimum						
Samples	25.0	6.7	21.2	20.1	6.5	45.2
Control	0.8	7.9	32.3	0.7	3.8	33.3
Maximum						
Samples	265.0	26.1	111.5	125.0	13.0	92.8
Control	2.0	13.2	151.7	1.5	5.4	68.6

[a]The control sample for zinc may have been contaminated from other sources.
[b]Values are from Table 5.

Table 7. Groundwater Compositions (mg/L) (Hem, 1986)

Chemical Characteristics	Geological Terrain		
	Basalt	Sand/Gravel	Limestone
pH	7.8	7.0	7.6
Total Dissolved Solids	225.0	314.0	594.0
Conductivity	358.0	517.0	885.0
Potassium	5.2	2.8	2.1
Sodium	30.0	23.0	13.0
Calcium	32.0	58.0	126.0
Magnesium	12.0	13.0	43.0
Iron	0.01	0.04	2.3
Manganese	--	1.3	--
Aluminum	--	0.1	--
Bicarbonates	220.0	101.0	440.0
Sulfates	11.0	116.0	139.0
Chloride	7.9	39.0	100.0
Fluoride	0.2	0.0	0.7
Nitrates	2.9	0.6	0.2
Orthophosphates	--	0.1	--
Hardness as CO_3	129.0	198.0	490.0
Categories:			
Sulfate	low	moderate	moderate
Carbonate	moderate	moderate	high

Table 8. Solubility Product (Log K_{sp}) of Lead Compounds and Lead Minerals at 25°C (Nriagu, 1978)

Lead Compounds and Minerals	Solubility Product (log K_{sp})
PbO (red)	12.7
$PbCl_2$	-4.77
$PbSO_4$	-7.72
PbS	-28.1
$PbCO_3$	-12.8
$Pb_3(CO_3)_2(OH)_2$	-17.0
$Pb_3(PO_4)_2$	-44.3

Table 9. Approximate Weights for Different Ammunition

	Weight of Bullet	
Rounds	Grains	Grams
5.56 mm	56	3.6
7.62 mm	147	9.5
0.90 mm	115	7.5
0.45 caliber	234	15.2
0.38 caliber	130	8.4
12 GA 00 buckshot	120 (assumed)	7.8

Table 10. Summary of Groundwater Contamination

Site	Description	pH	Depth (ft)	Distance from Berm (ft)	Pb (mg/L)
MCLB Albany, GA	June 1989	5.77-10.69	50	--	0.001-0.019
NAB Little Creek, VA	February 1989	--	11	~100	0.083

Table 11. Summary of Surface Runoff/Surface Waters

Site	Description	pH	Distance from Berm (ft)	Pb (mg/L)
MCCDC Quantico	Sample from creek	7.0	>1000	0.0063
NS Mayport	Samples from impact berm	--	5-10	2.36
NS Mayport	Samples from drainage ditch	--	300	<0.005

Table 12. Summary of Lead Analysis at Small Arms Ranges

Site	Description	pH	Depth (ft)	Total Lead (mg/L)	Soluble Lead (mg/L)
NS Mayport	Impact berm	--	0-6	--	0.66-661.0
MCCDC Quantico	Impact berm Base of berm 0-200 ft behind berm Drainage swale next to berm				
NAB Little Creek	Impact berm				

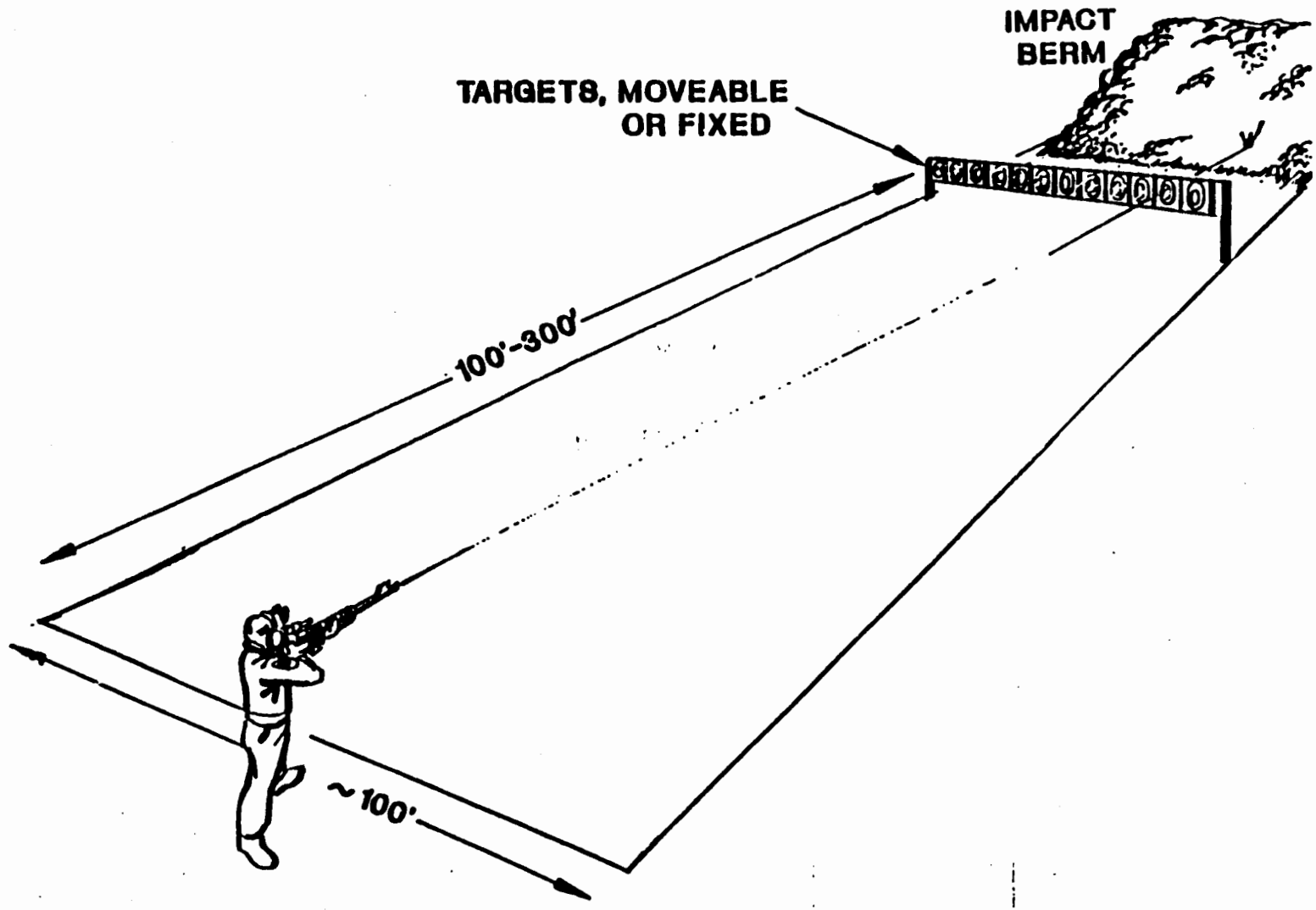


Figure 1. Typical pistol range.

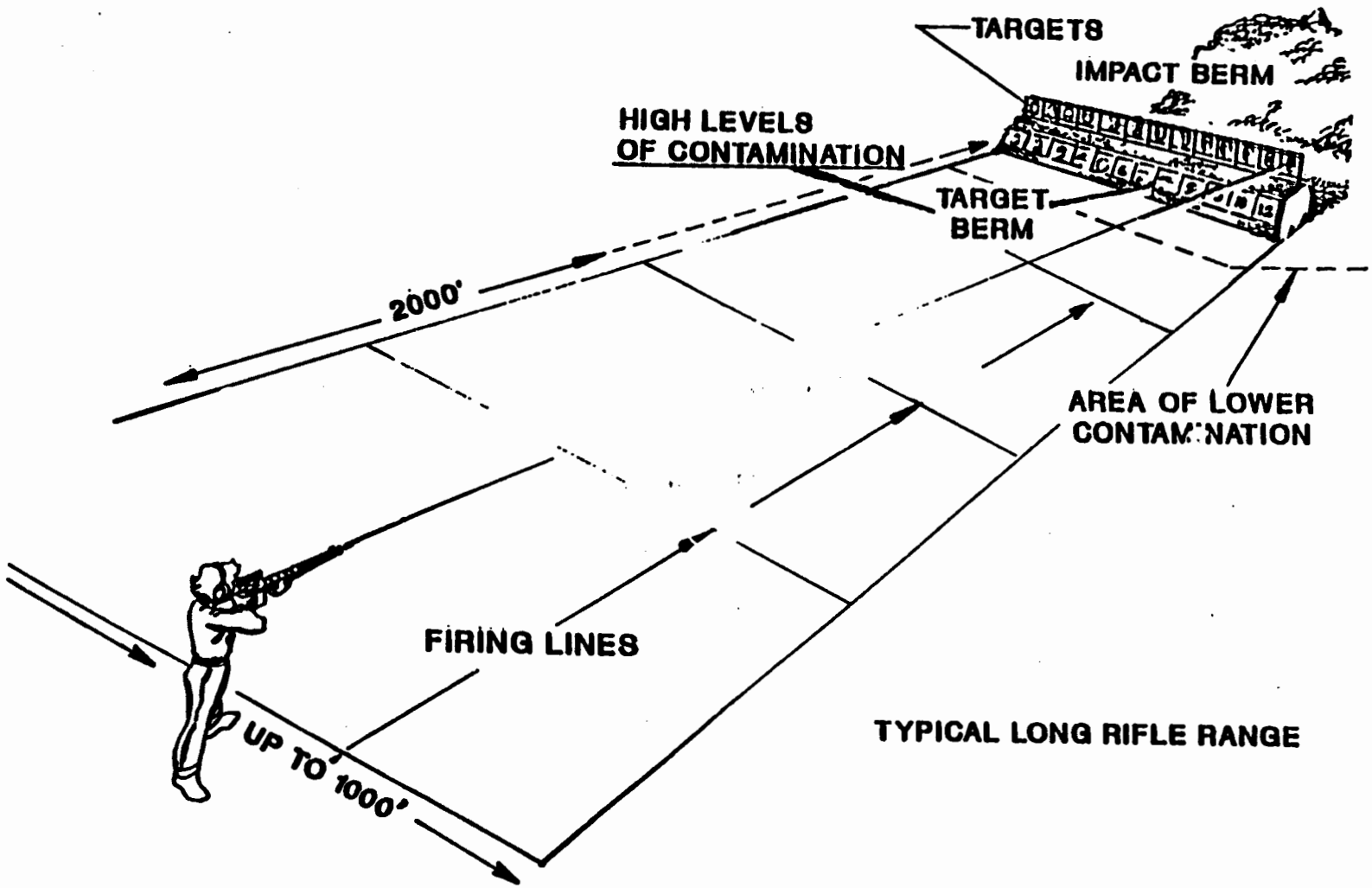


Figure 2. Typical long rifle range.

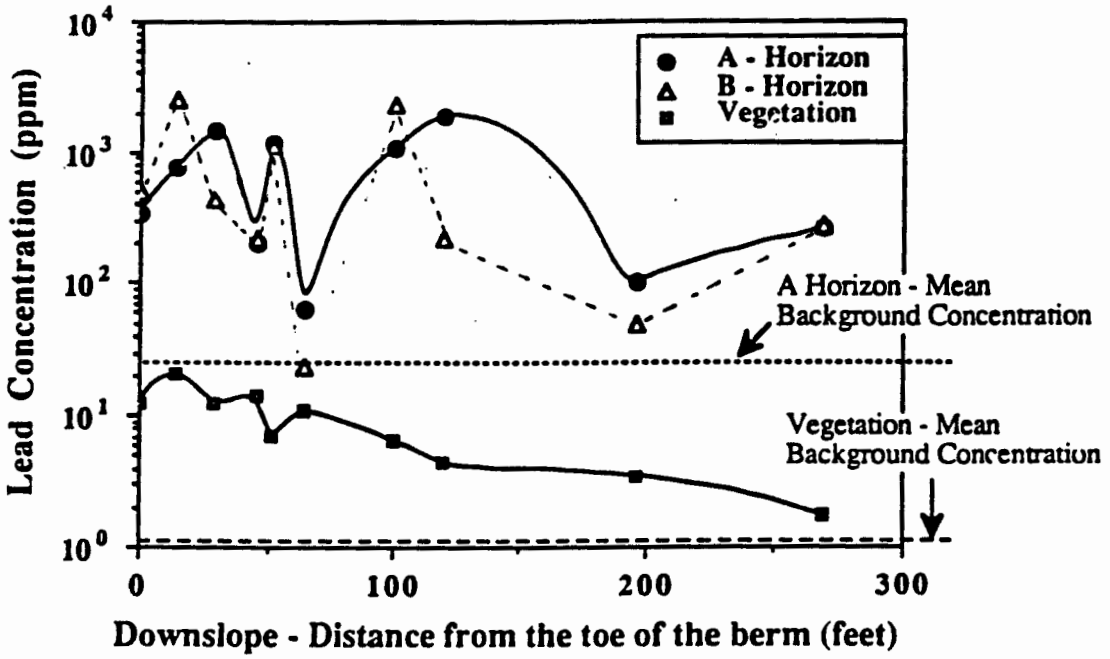


Figure 3. Lead concentration in the downslope transect of an impact berm.

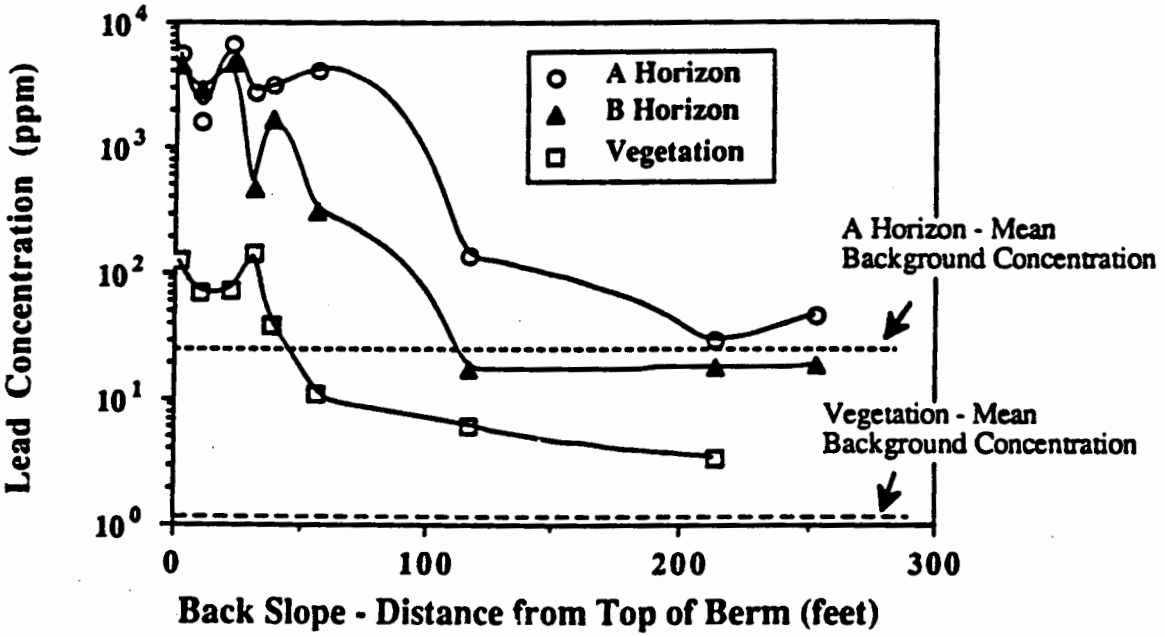
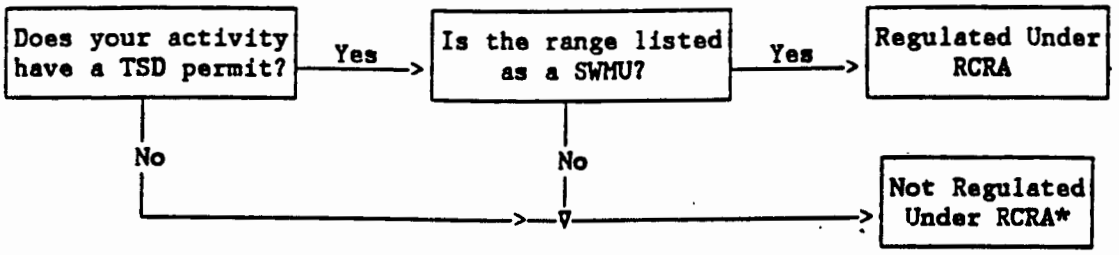


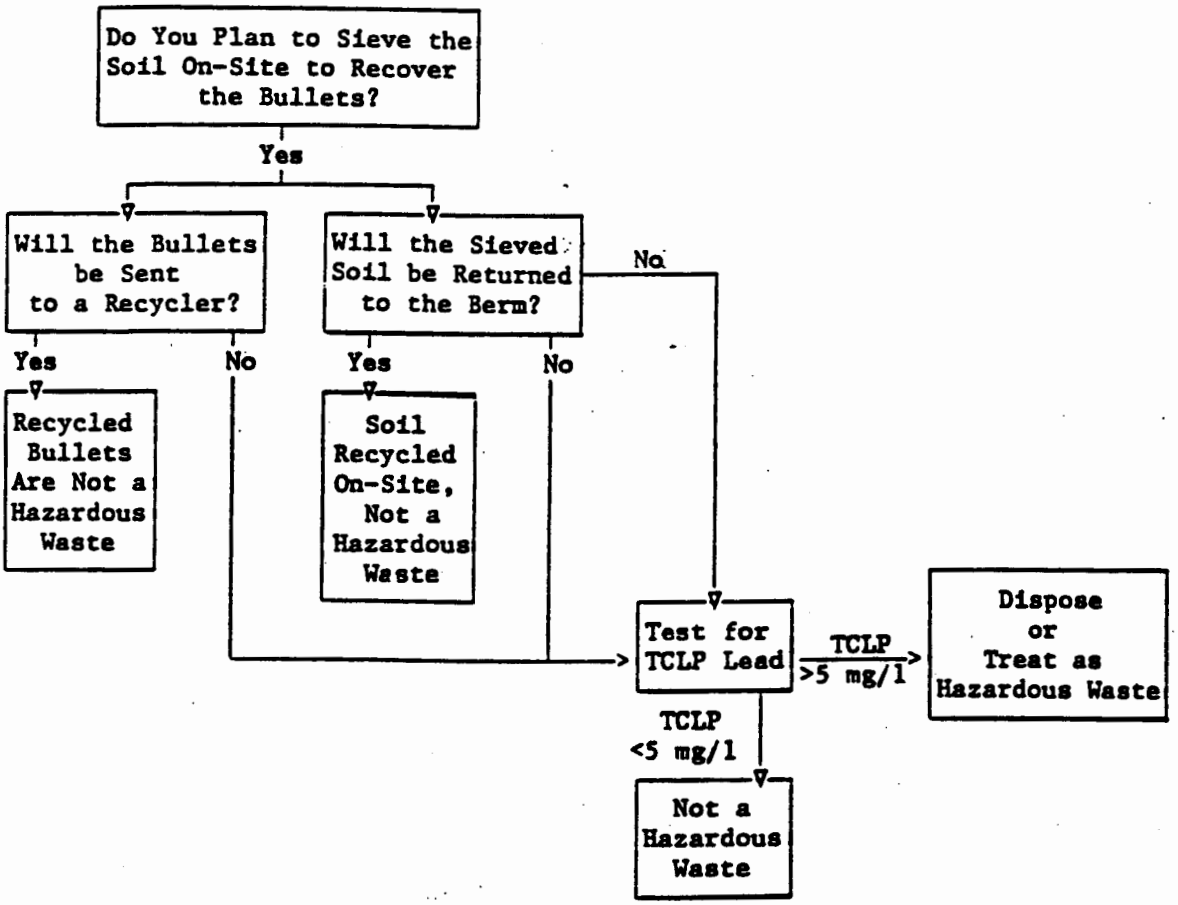
Figure 4. Lead concentration in the backslope transect of an impact berm.

1. Is my currently operating small arms range considered a hazardous or solid waste treatment storage, or disposal (TSD) site?



*This is based on the contention that you eventually plan to recover or recycle the lead from the bullets.

2. I have a ricochet problem with the impact berm at my small arms range. The range is not listed as a SWMU on my activity's RCRA TSD permit. What are the consequences of my actions to reduce the ricochet problem?



If the range is listed as a SWMU, contact regulatory agency and legal council for consequences of actions.

Figure 5. Small arms ranges RCRA minimum criteria.

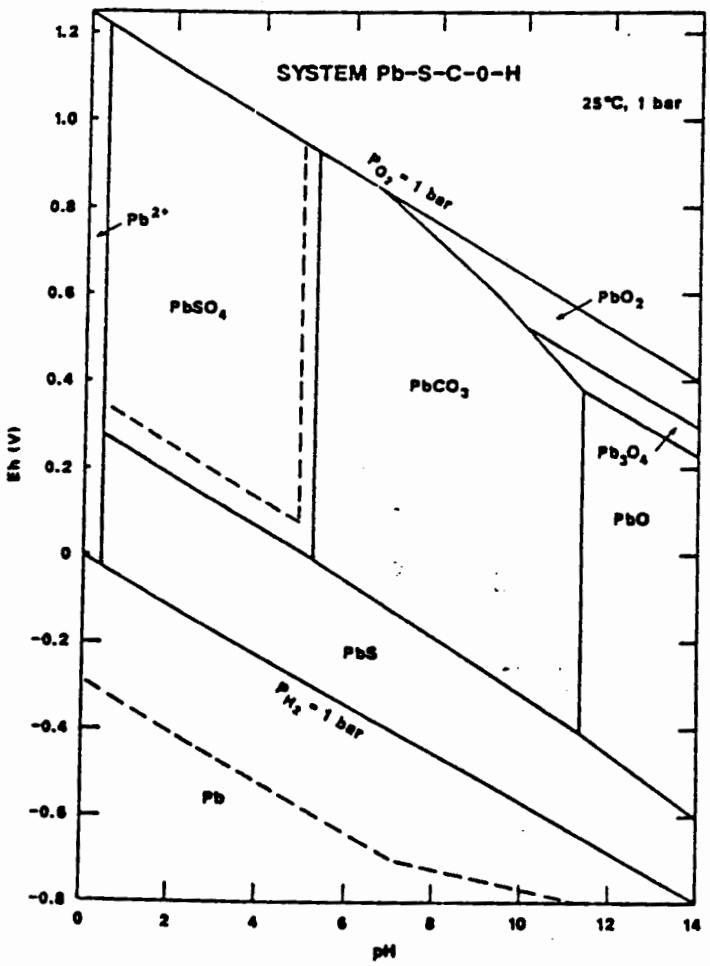


Figure 6. Eh-pH diagram for system Pb-S-C-OH (Pb = 10^{-6}, S = 10^{-3}, C = 10^{-3} M) (from Brookins, 1988).

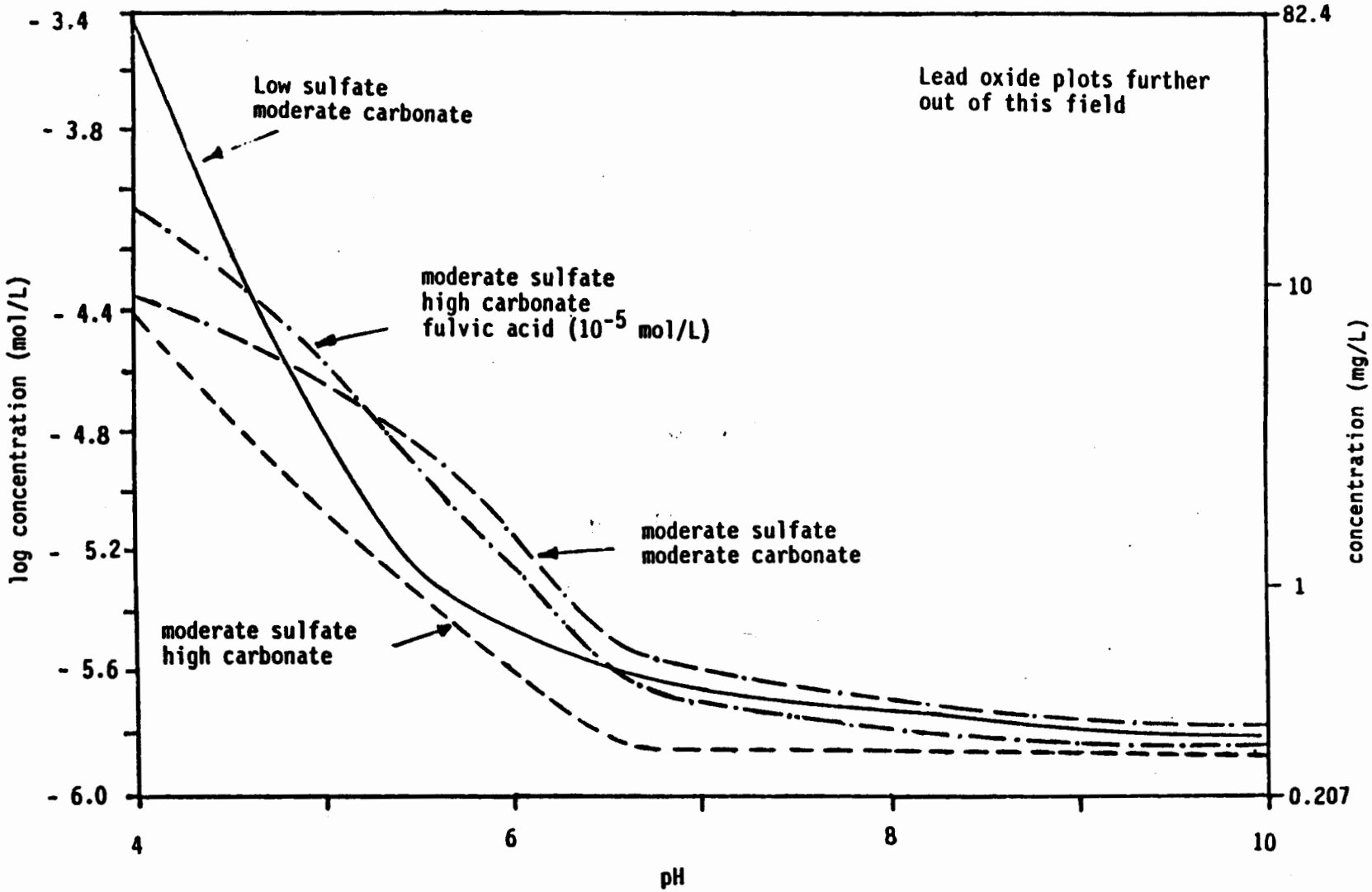


Figure 7. Solubility of lead in three different groundwaters.

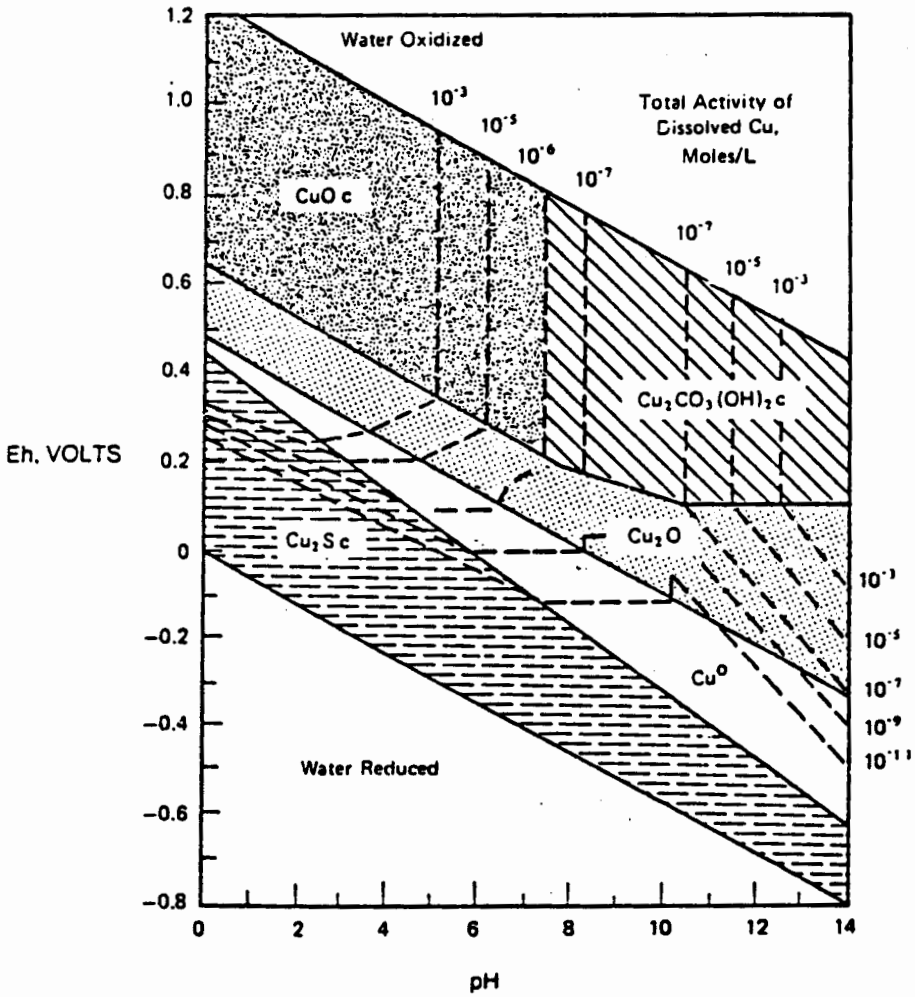


Figure 8. Eh-pH diagram for system Cu-H_2O-C-S (Cu = 10^{-3} M, S = 10^{-4} M) (courtesy J. Anderson).

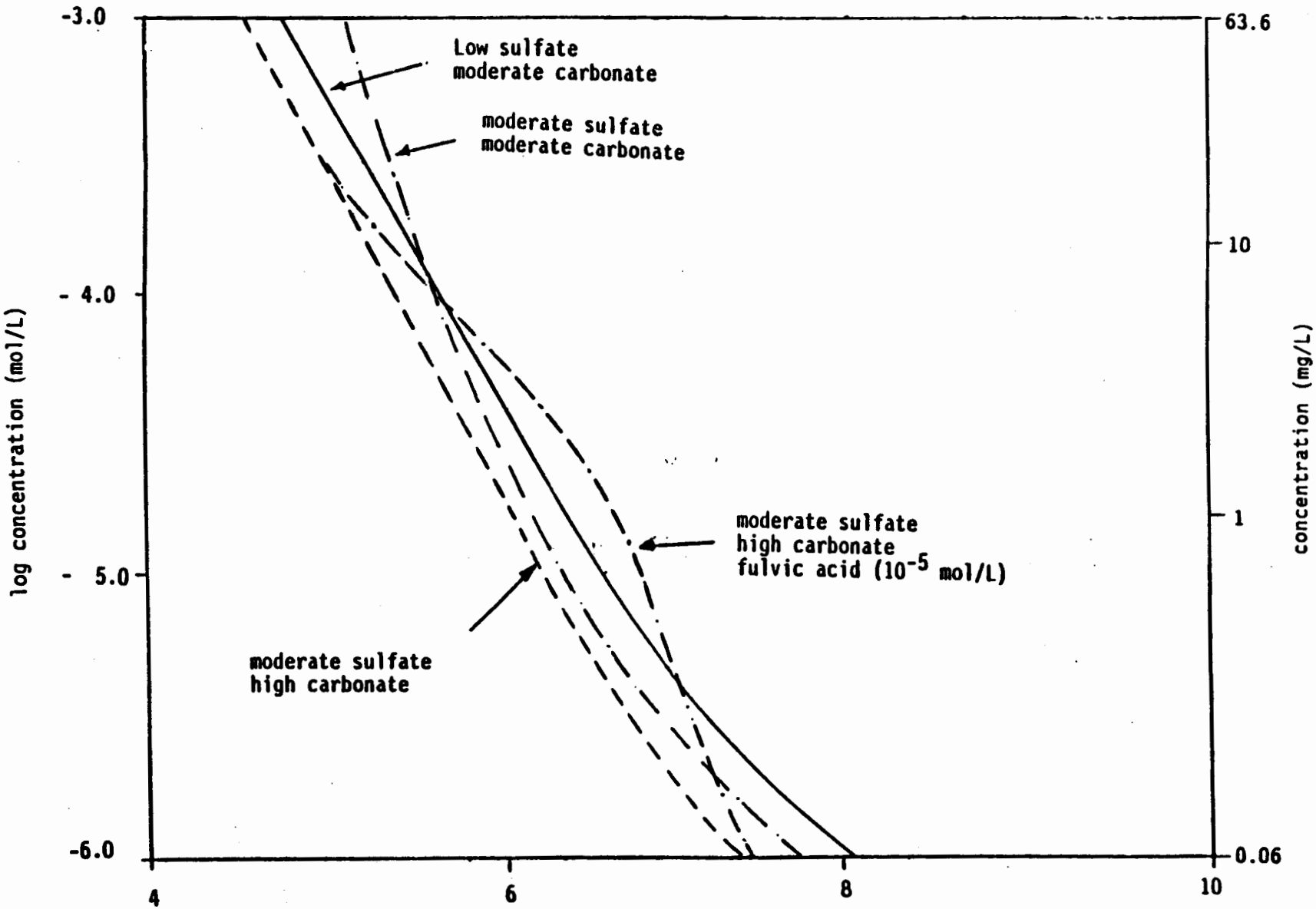


Figure 9. Solubility of copper in three different groundwaters.

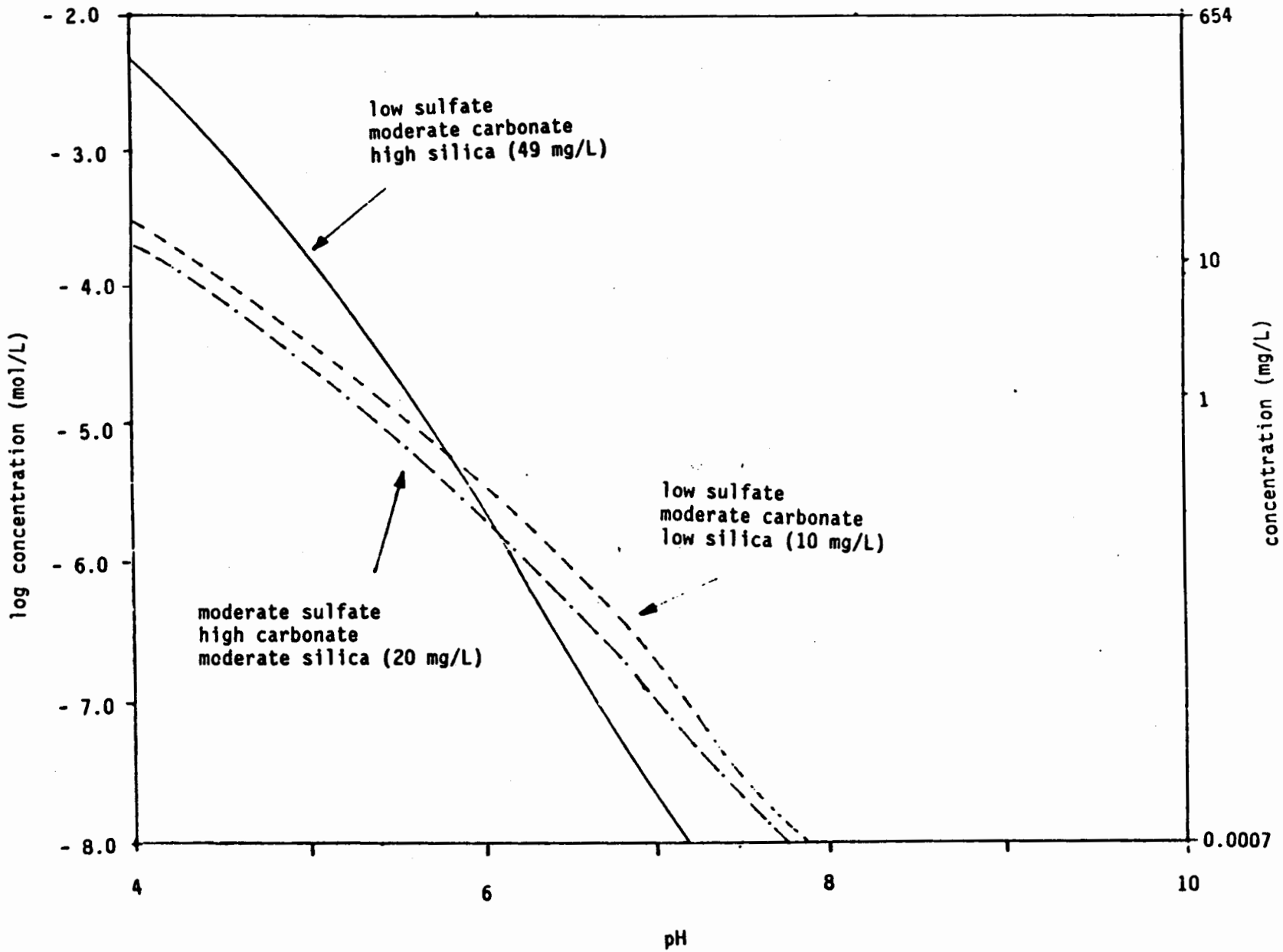


Figure 10. Solubility of zinc in three different groundwaters.

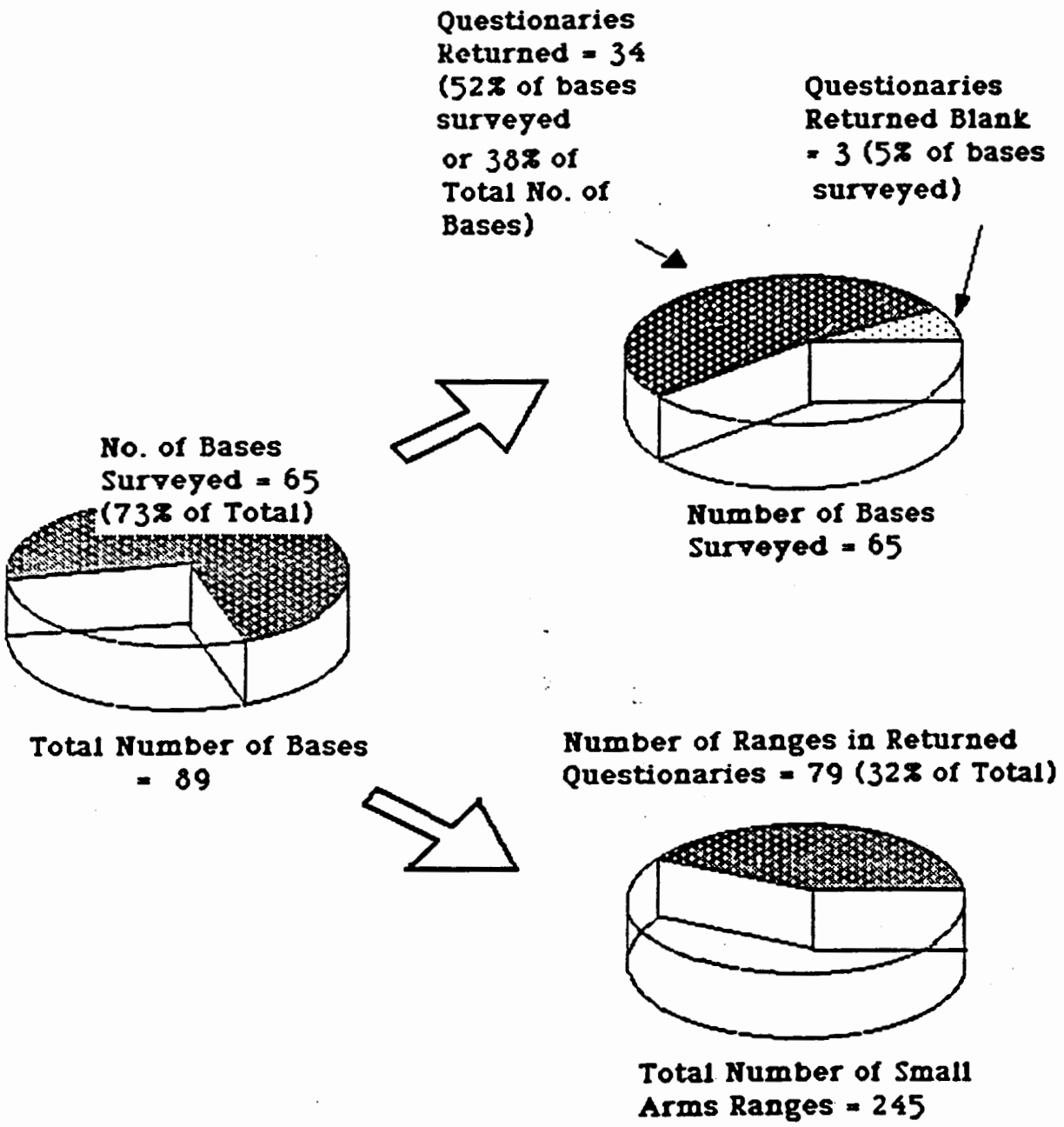


Figure 11. Response from the small arms range survey.

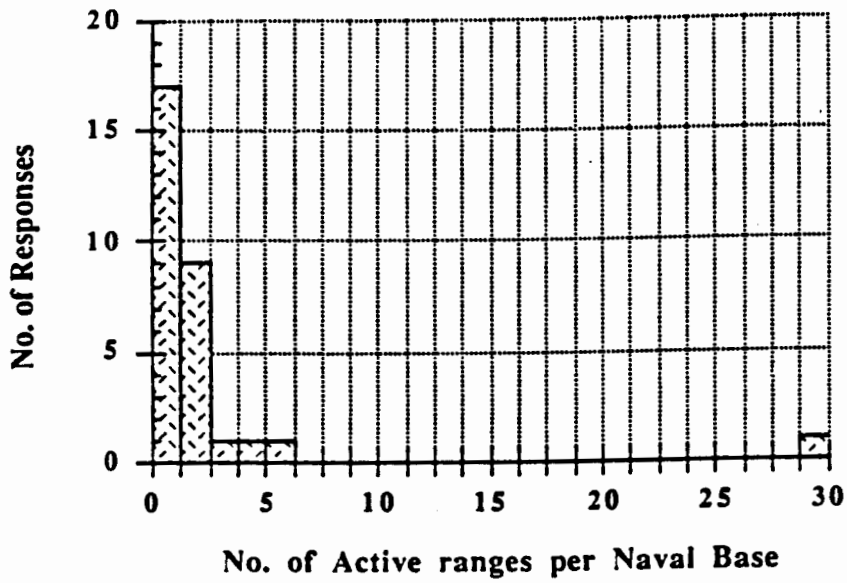


Figure 12. Survey responses to Question 2: Active ranges

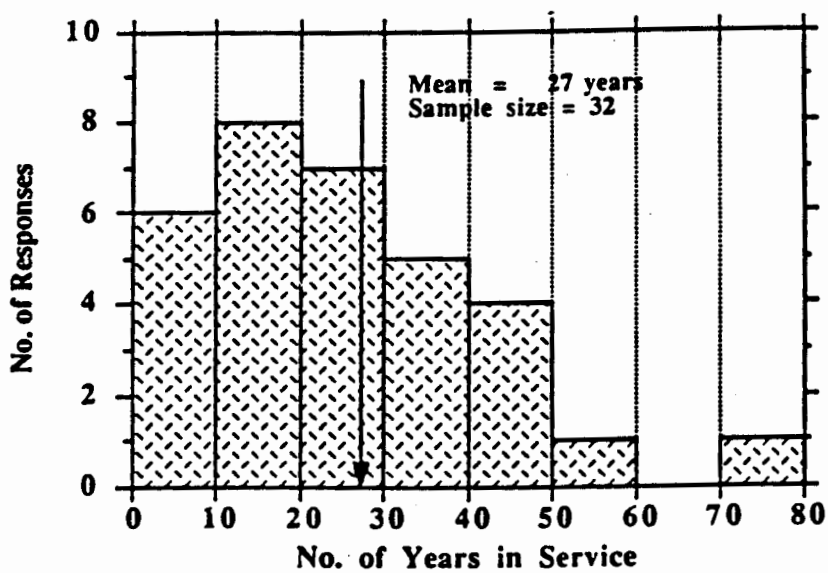


Figure 13. Survey responses to Question 3: Number of years in service for small arms ranges.

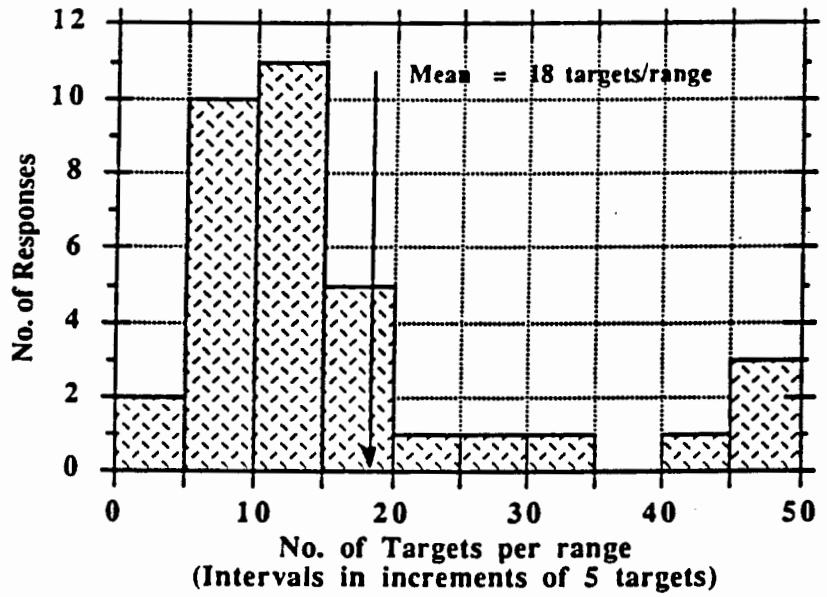
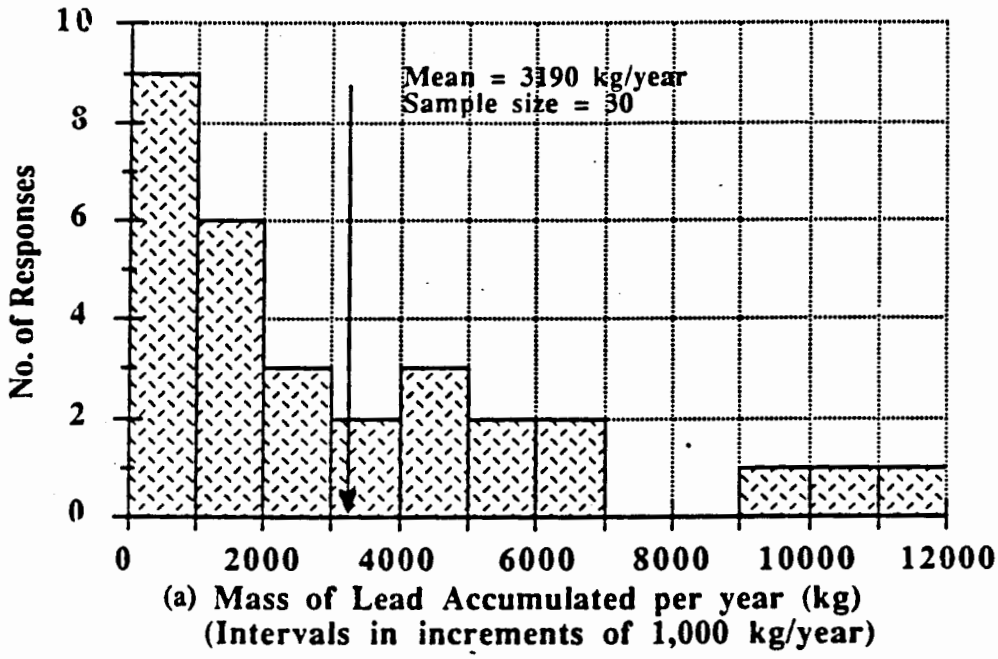


Figure 14. Survey responses to Question 6: Number of targets per site.



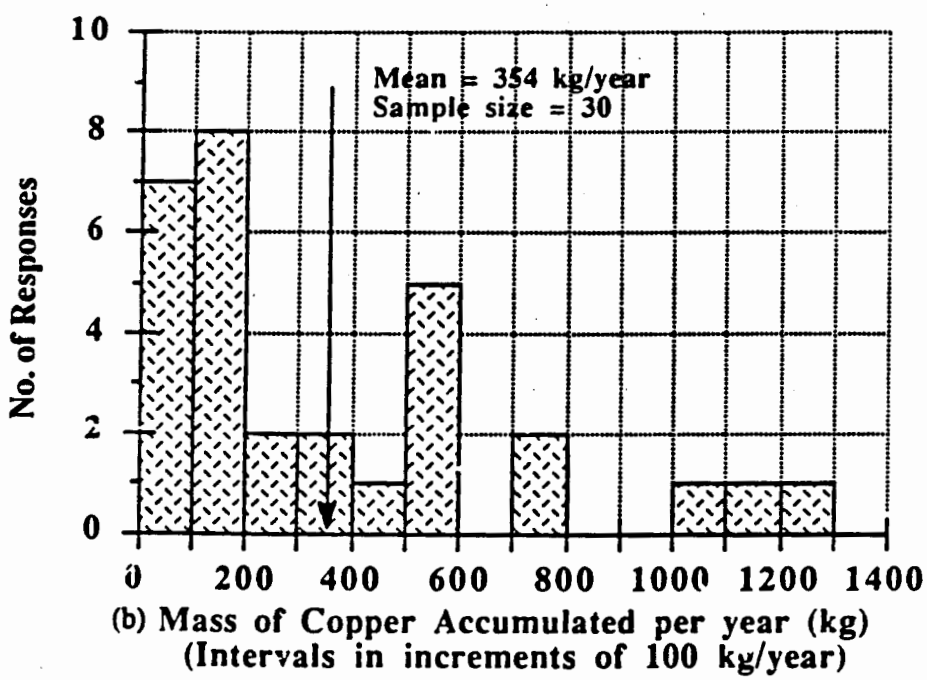


Figure 15. Survey responses to Question 7.

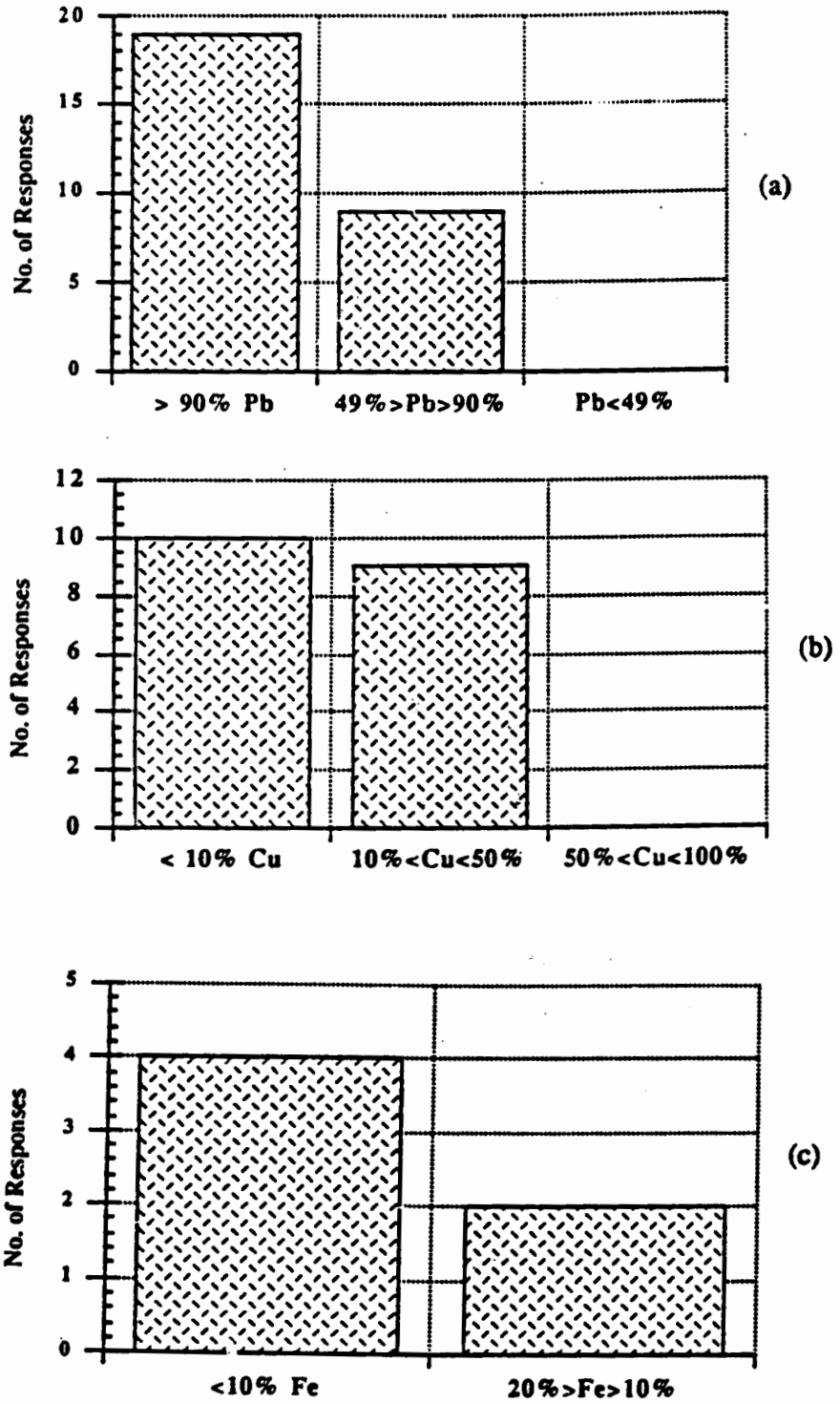


Figure 16. Survey responses to Question 8: Chemical composition of ammunition used.

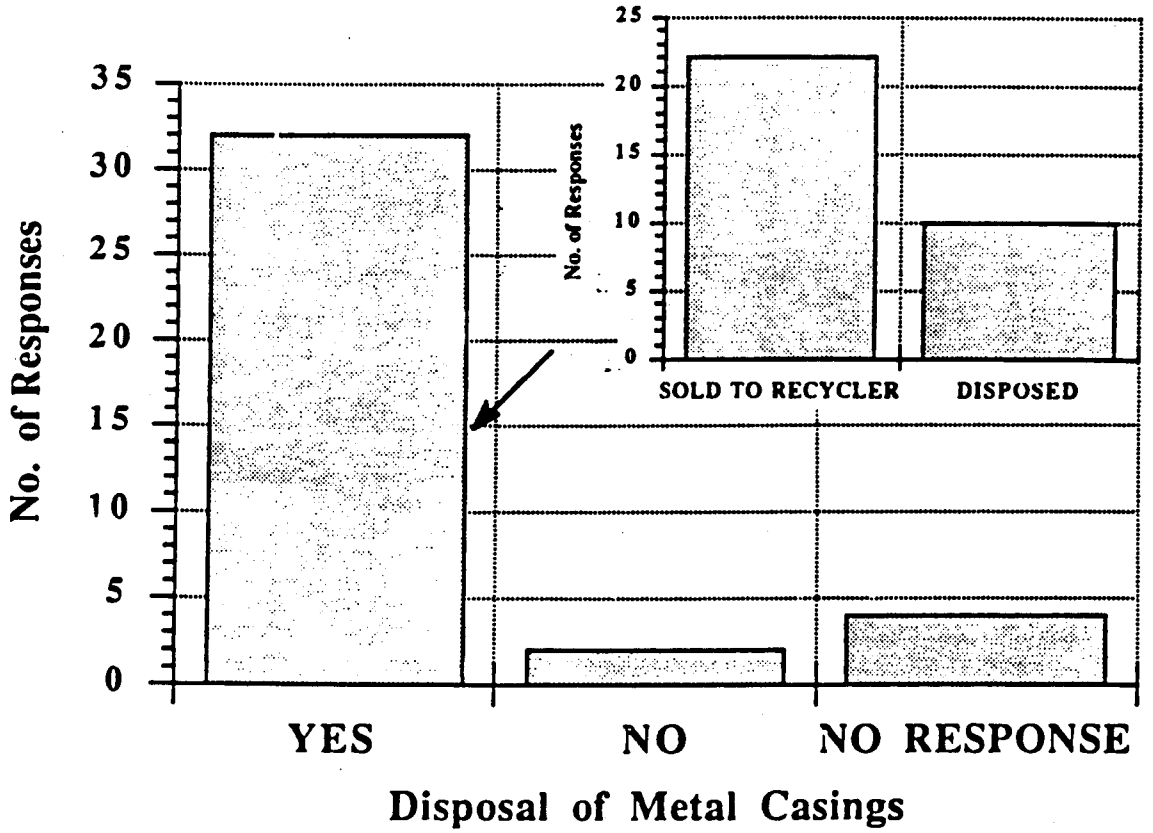


Figure 17. Survey responses to Questions 9 and 10: Disposal of metal casings.

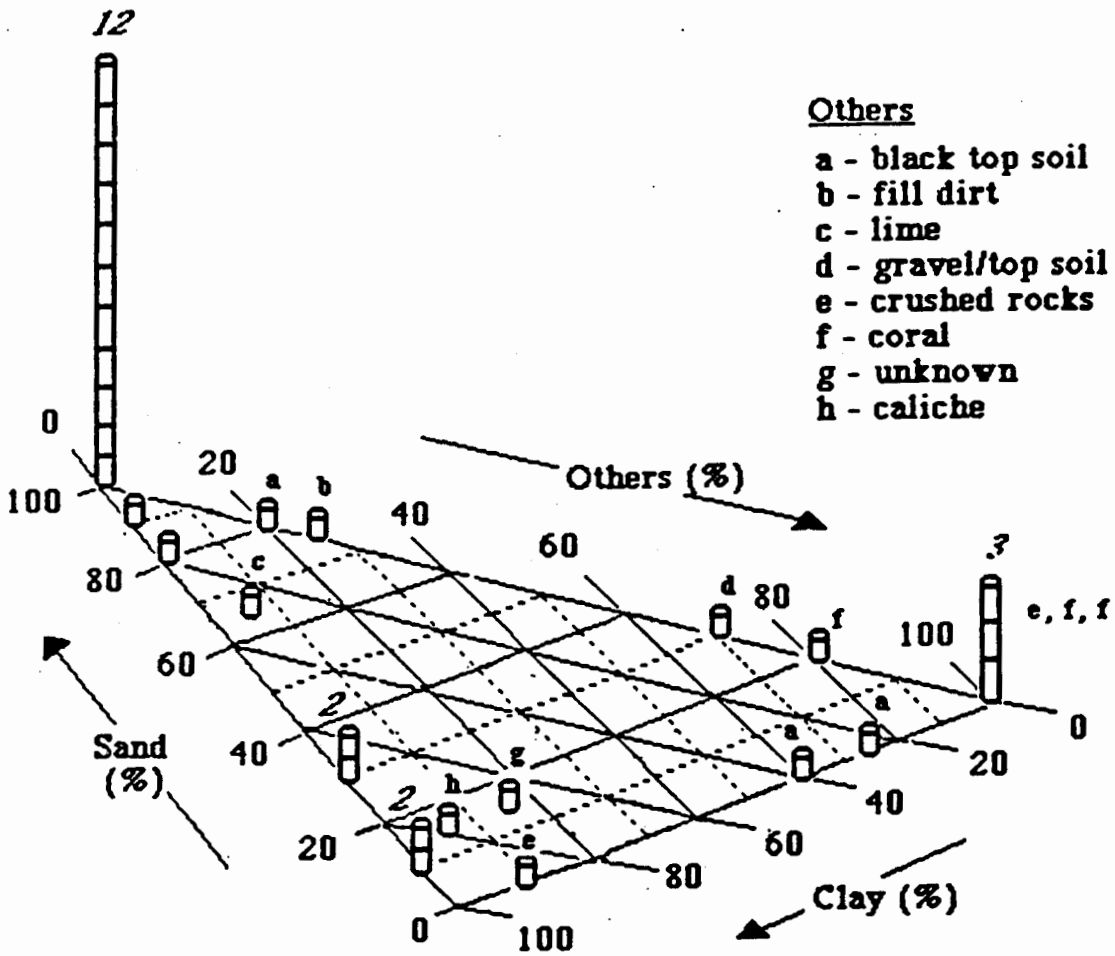


Figure 18. Survey responses to Question 11: Type of material used for impact berms.

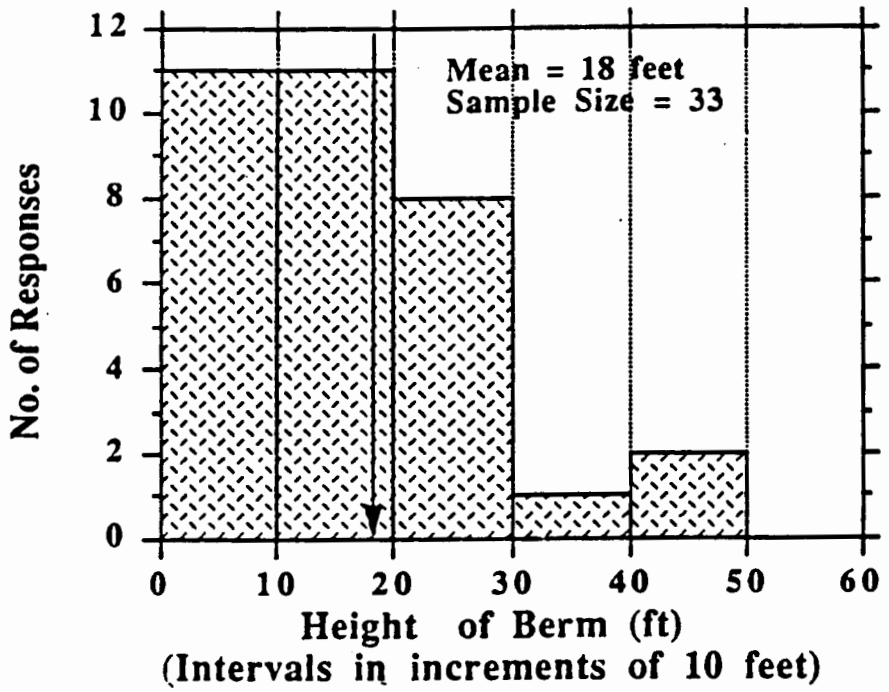


Figure 19. Survey responses to Question 12: Typical berm size - height.

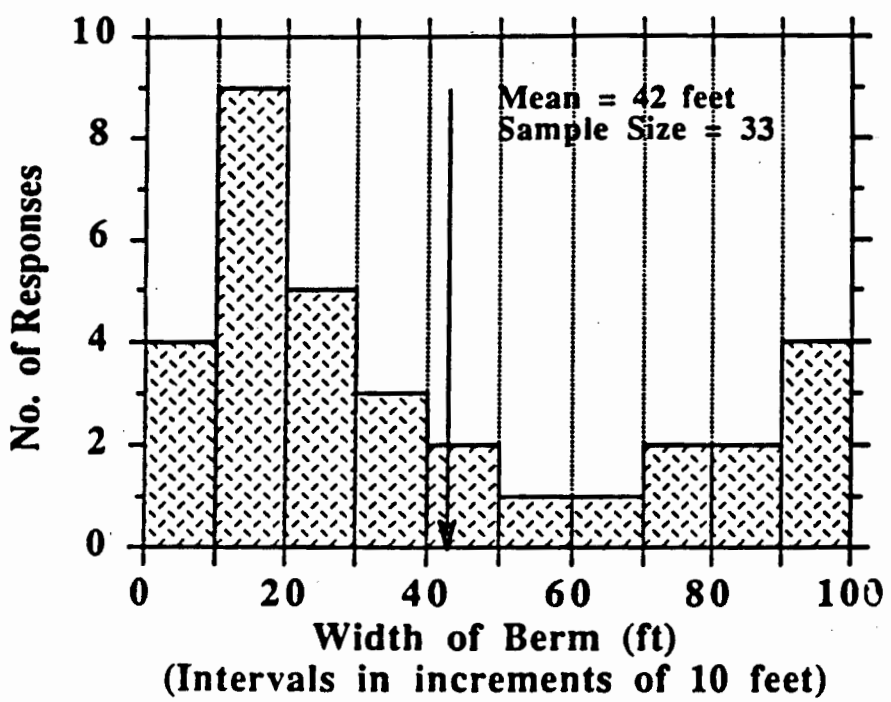


Figure 20. Survey responses to Question 12: Typical berm size - width.

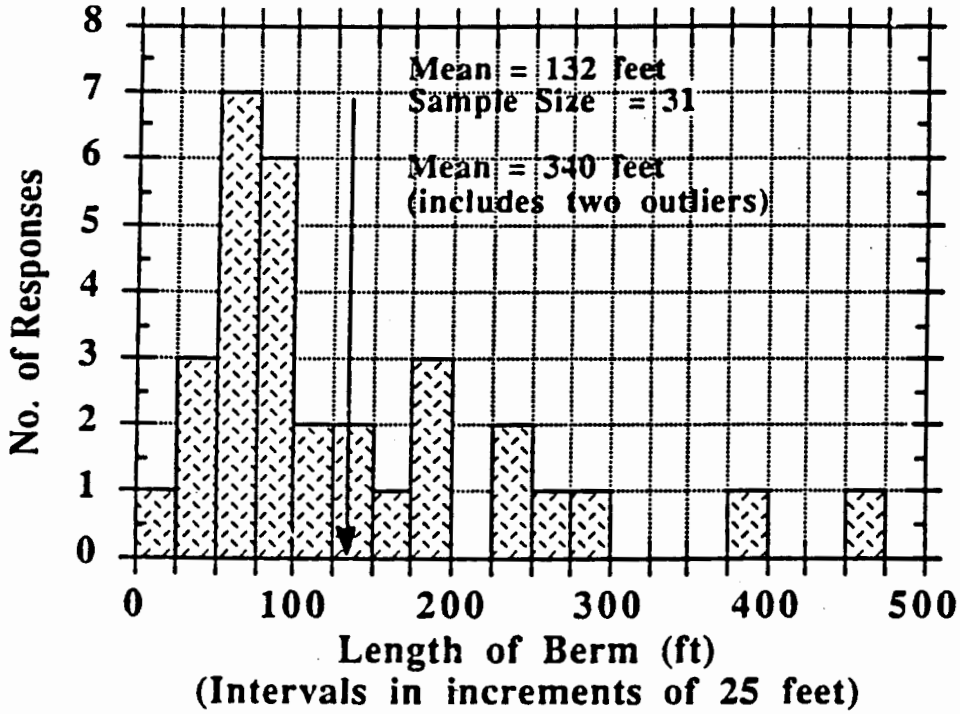


Figure 21. Survey responses to Question 12: Typical berm size - length.
(Outliers are for NAVSTA Panama Canal and MCRD Parris Island)

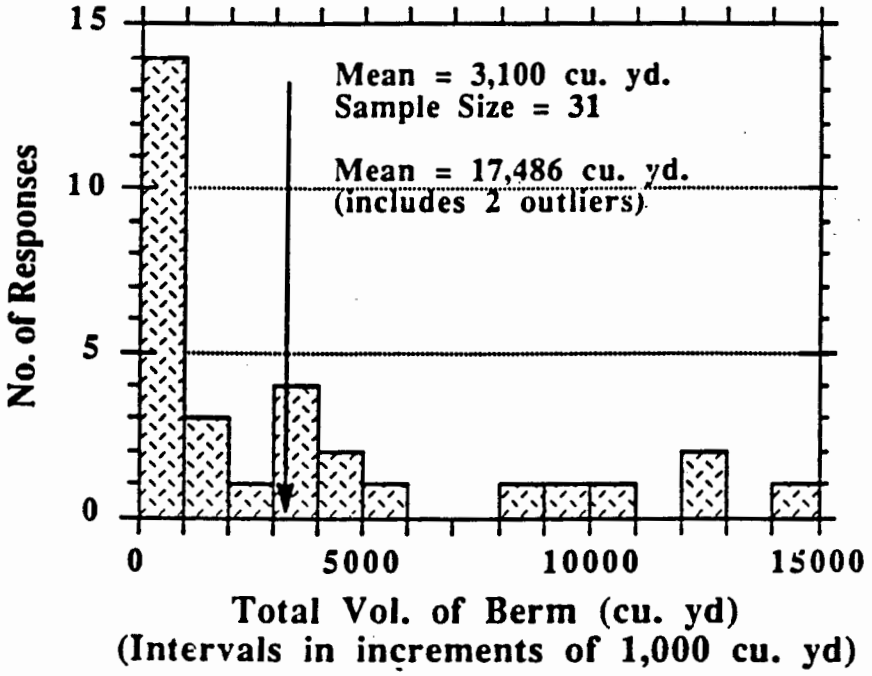


Figure 22. Survey responses to Question 12: Volume of impact berms.

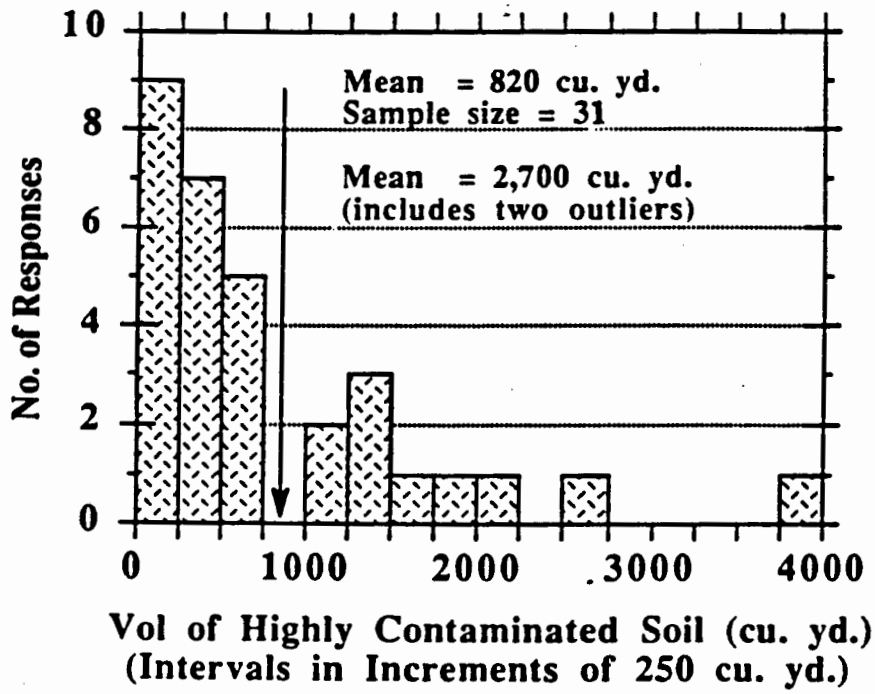


Figure 23. Survey responses to Question 12: Estimated average volume of contaminated soils of impact berms.

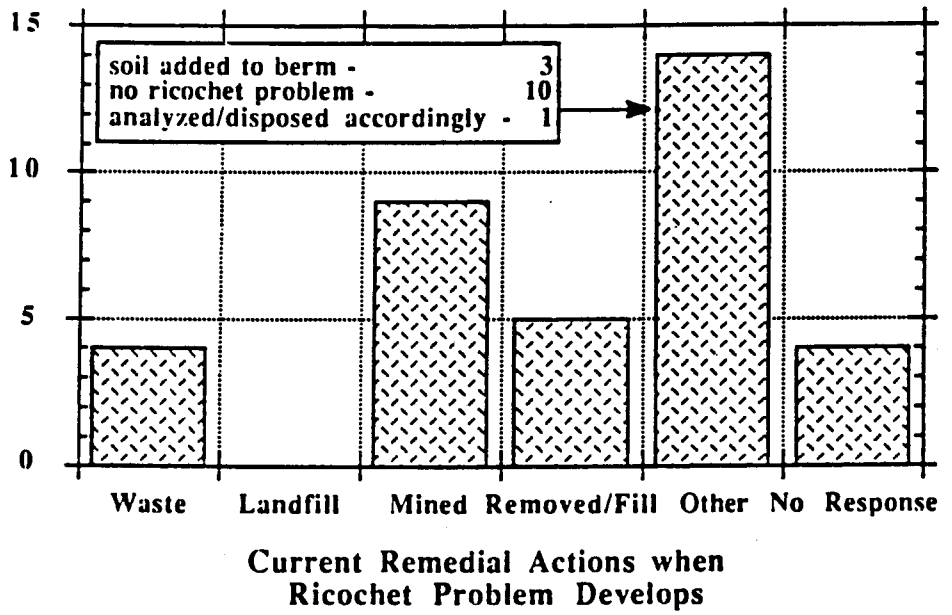


Figure 24. Survey responses to Question 12: Disposal of berm soil.

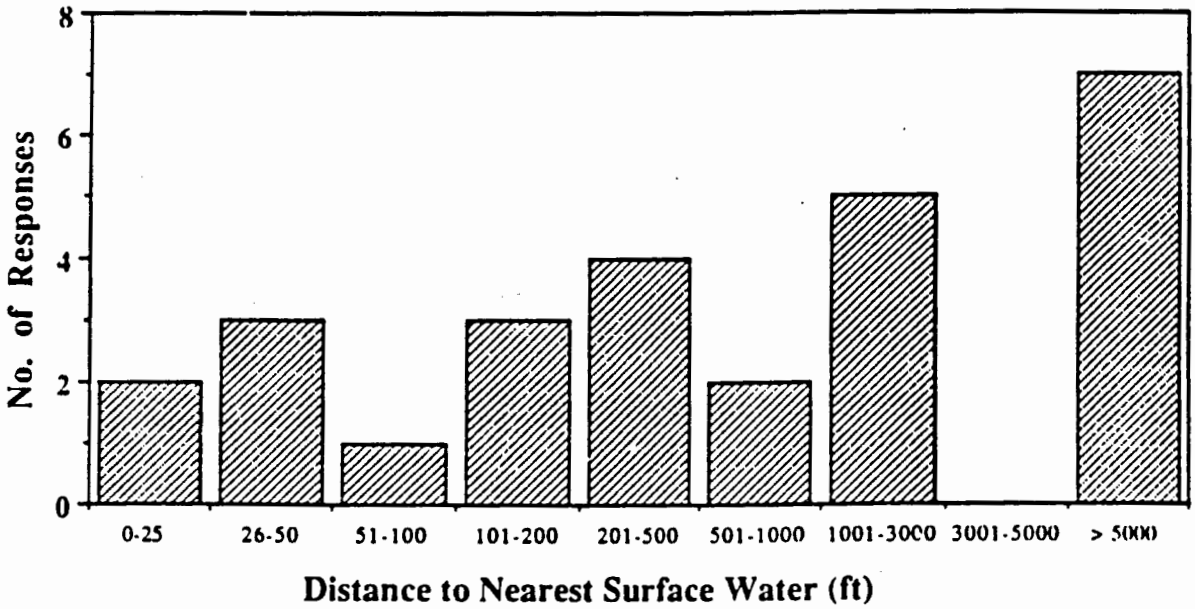


Figure 25. Survey responses to Question 13: Distance to nearest surface water.

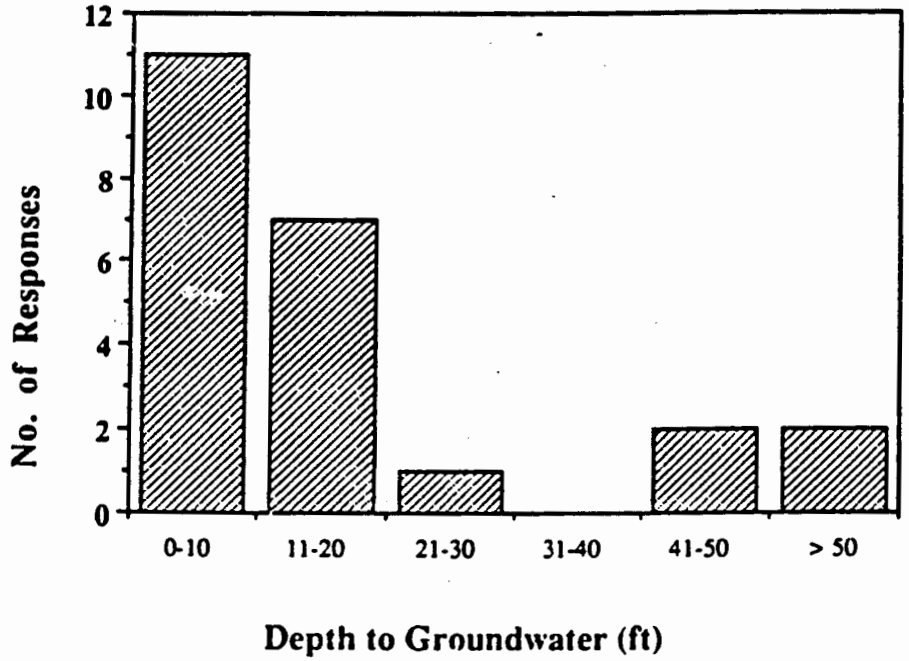


Figure 26. Survey responses to Question 14: Depth to groundwater.

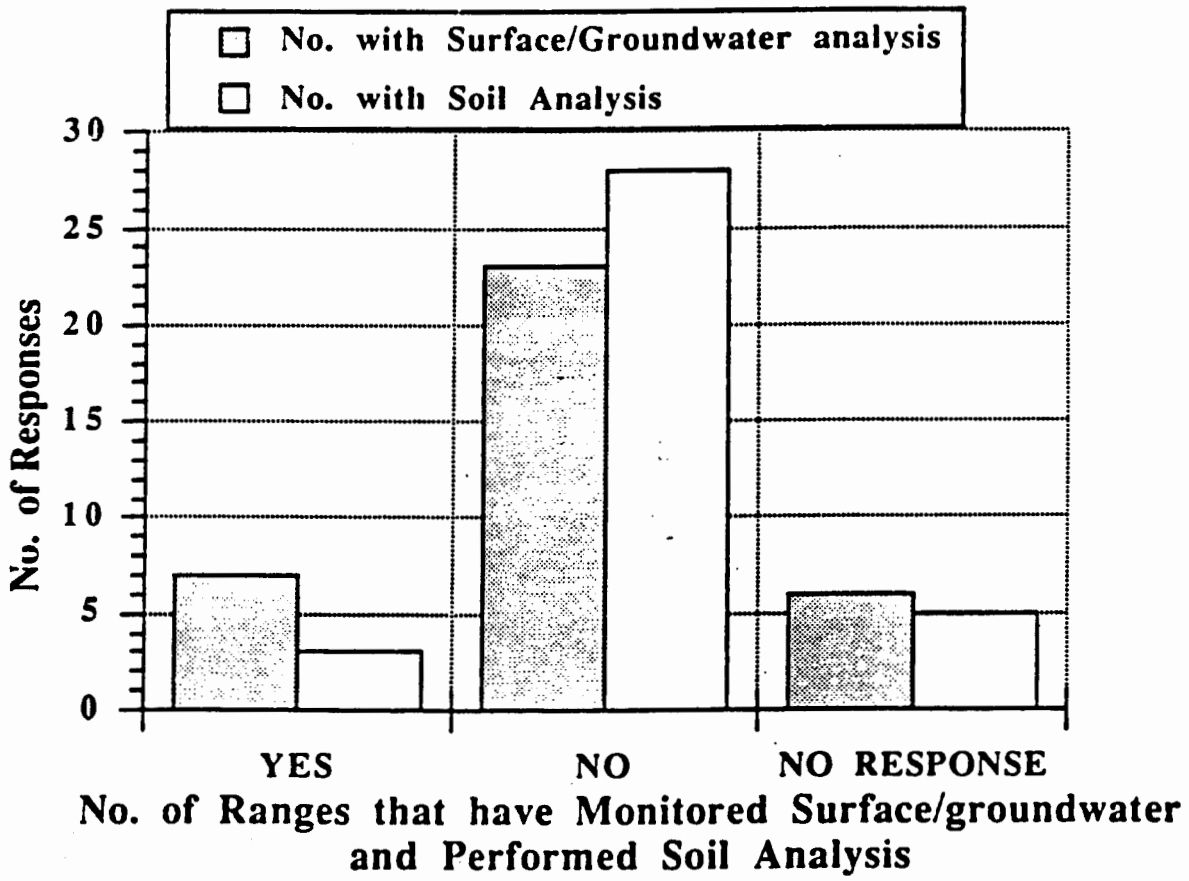


Figure 27. Survey responses to Question 15: Chemical analysis of surface water and groundwater.

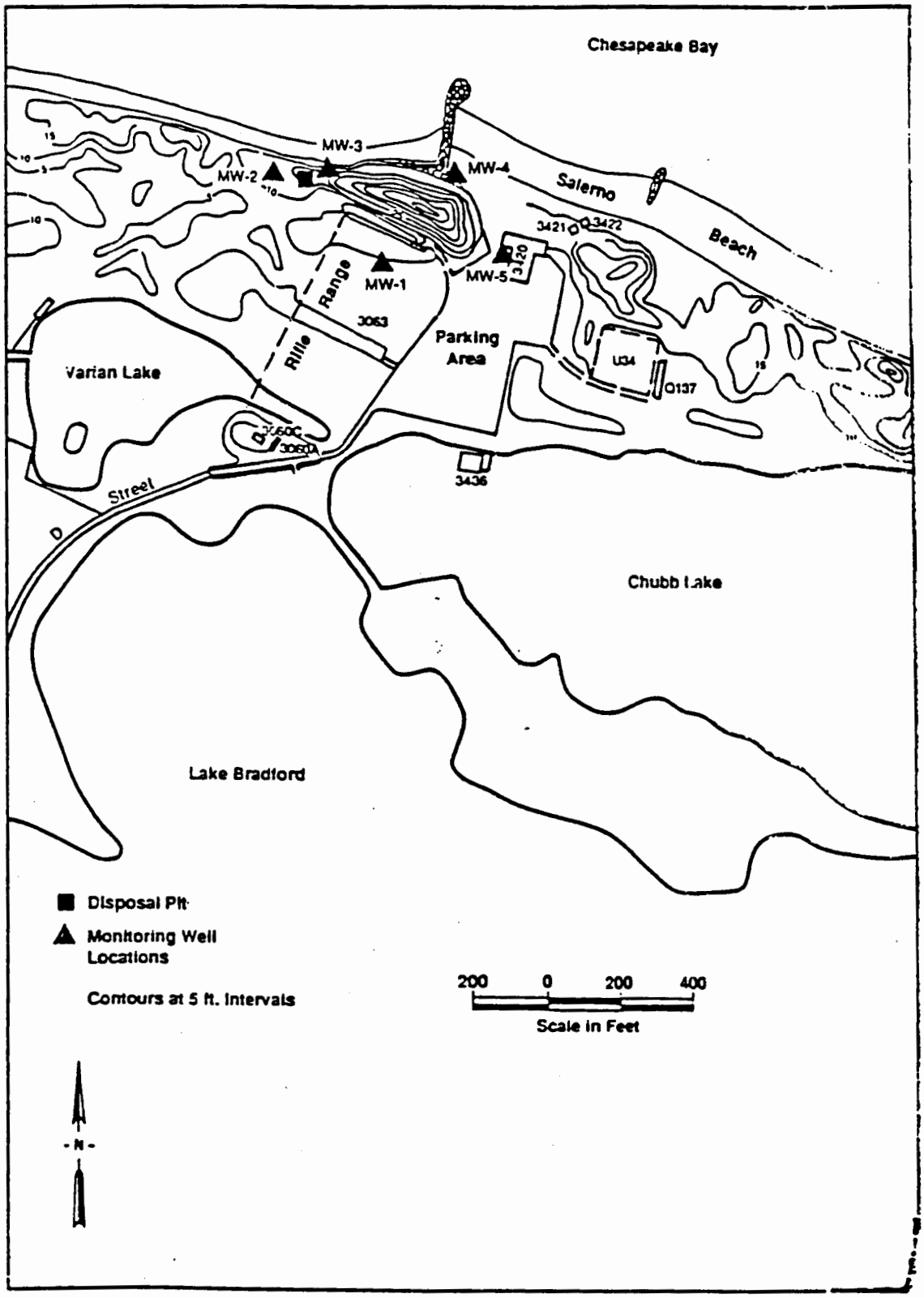


Figure 28. Approximate locations of monitoring wells at the small arms range, NAB, Little Creek, Virginia.

APPENDIX A

SURVEY QUESTIONNAIRE

Please complete and return this survey to:

Jeffrey L. Means, Ph.D.
Battelle
505 King Avenue
Columbus, Ohio 43201-2693

SMALL ARMS PRACTICE RANGE SURVEY

(1) Name, position, and address of person responding to survey:

Name: _____

Position: _____

Telephone Number: _____

Address: _____

_____

_____

(2) Number of active ranges: _____

(3) Number of years that ranges have been used: _____

(4) Number of abandoned ranges: _____

(5) Approximate average lifetime of a range: _____

(6) Approximate number of targets per active range: _____

(7) Approximate average number of rounds shot per year over the last five years. Please indicate by type of ammunition (caliber or other description), if known:

Type of Ammunition	Rounds per Unit Time (per)
_____	_____ / _____
_____	_____ / _____
_____	_____ / _____
_____	_____ / _____

(8) Is most of the shot lead, or are other types also used? _____
Please indicate the relative proportions, if known:

_____ % Lead

_____ % Copper

_____ % Steel

_____ % Other, please specify: _____

(9) Are the spent casings periodically collected and removed from the practice range?

_____ Yes

_____ No

If yes, what is done with the spent casings?

_____ Sold to a metal recycler

_____ Disposed

_____ Other, please specify: _____

(10) What type of soil was used in the construction of the berm? (Approximate proportions in percent, if known):

_____ % Clay

_____ % Sandy

_____ % Lime

_____ % Other, please specify: _____

(11) Typical berm size and dimensions:

_____ Height

_____ Width

_____ Length

Please draw a sketch if your berms are not rectangular:

(12) What is done to the soil from the berm if a ricochet problem occurs?

_____ The soil is removed and disposed of as a hazardous waste.

_____ The soil is disposed in a landfill.

_____ The soil is mined for recoverable metals and returned to the berm.

_____ The soil is removed and used on-site as fill.

_____ Other, please describe below:

(13) At what distance is surface water located in relationship to the ranges? _____

(14) What is the depth of the groundwater from the surface of the soil in the vicinity of the ranges? _____

(15) Have nearby surface waters or groundwater wells ever been chemically analyzed for lead or other metals?

_____ Yes

_____ No

If yes, may we please obtain a copy of the analyses or report?

(16) Has soil from your berms ever been analyzed for lead or other metals?

_____ Yes

_____ No

If yes, may we please obtain a copy of the analyses or report?

(17) Would you be interested in allowing your berm soils to be sampled as part of a berm characterization study?

_____ Yes

_____ No

(18) Would you like to receive a copy of the results of this survey?

_____ Yes

_____ No.

THANK-YOU AGAIN FOR TAKING THE TIME TO FILL OUT AND RETURN THIS SURVEY! YOUR INPUT IS EXTREMELY VALUABLE.

APPENDIX B

MAILING LIST FOR WRITTEN SMALL ARMS PRACTICE RANGE SURVEY

KR ID = 40659.1

United States
Environmental Protection
Agency

Office of
Solid Waste and
Emergency Response

Publication [redacted]
EPA-540/R-94-013
PB94-963502
February 1994

Superfund

EPA

USEPA CONTRACT LABORATORY PROGRAM NATIONAL FUNCTIONAL GUIDELINES FOR INORGANIC DATA REVIEW

9240.1-05-01
PB 94-963502
EPA 540/R-94/013
February 1994

USEPA CONTRACT LABORATORY PROGRAM NATIONAL FUNCTIONAL GUIDELINES FOR INORGANIC DATA REVIEW

Office of Emergency and Remedial Response
U.S. Environmental Protection Agency
Washington, DC 20460

VII. SPIKE SAMPLE ANALYSIS

A. Review Items: Form I-IN, Form V-IN (Part A & B), instrument printouts, raw data.

B. Objective:

The spiked sample analysis is designed to provide information about the effect of each sample matrix on the sample preparation procedures and the measurement methodology. If the spike is added to the sample prior to any distillation steps (cyanide), or before the digestion (e.g., prior to the addition of other reagents), it is then referred to as a spiked sample, a pre-digestion/pre-distillation spike, or a matrix spike. If the spike is added to the sample after the completion of the distillation or digestion procedures, it is then referred to as a post-digestion/post-distillation spike, or an analytical spike.

C. Criteria:

1. Samples identified as field blanks cannot be used for spiked sample analysis.

2. At least one spiked sample (pre-distillation/pre-digestion) must be prepared and analyzed from each group of samples with a similar matrix type (e.g., water, soil) and concentration (e.g., low, medium), or for each SDG.

3. For Flame AA, ICP, and CN analysis, when the pre-distillation/pre-digestion spike recovery falls outside of the control limits and the sample result does not exceed 4x the spike added, a post-digestion/post-distillation spike shall be performed for those elements that do not meet the specified criteria. Spike an aliquot of the remaining unspiked sample at 2x the indigenous level, or 2x the CRDL, whichever is greater.

   Note: Post-digestion spikes are not required for Ag and Hg. Additional spiked sample analyses may be required through Regional EPA or Project Officer request. Alternately, EPA may require that a specific sample be used for the spiked sample analysis.

4. If two analytical methods are used to obtain the reported values for the same element within a SDG (e.g., ICP and GFAA, or a soil and a water method), spiked samples must be run by each method used.

5. The spike percent recovery (%R) must be within the established acceptance limits. However, spike recovery limits do not apply when sample concentration exceeds the spike concentration by a factor of 4 or greater. In such an event, the data shall be reported unflagged even if the percent recovery does not meet the acceptance criteria.

6. If the spiked sample analysis was performed on the same sample that was chosen for the duplicate sample analysis, spike calculations shall be performed using the results of the sample designated as the "original sample". The average of the duplicate results cannot be used for the purpose of determining percent recovery.

Note: The final spike concentrations required for the various target analytes are presented in the actual analytical methodologies.

D. Evaluation:

1. Verify from the COVERPAGE-IN, Form V-IN, and the raw data that the appropriate number of required spiked samples were prepared and analyzed for the SDG.

2. Verify that the field blank was not used for the spiked sample analysis.

3. Evaluate Form V-IN and the raw data to verify that all pre-distillation/pre-digestion spiked sample results, for each analyte and method, fall within the established control limits. If not, verify that a post-digestion/post-distillation spike was prepared and analyzed (see INORG Section VII.C.3. above).

4. Recalculate from the raw data one or more of the spiked sample percent recoveries (%R) using the following equation, and verify that the recalculated value agrees with the laboratory reported values on Form V-IN.

$$\%R = \frac{(SSR-SR)}{SA} \times 100$$

Where:

SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added

Note: When the sample concentration is less than the instrument detection level (IDL), use SR=0 only for the purposes of calculating the %R. The actual spiked sample results, sample results, and %R (positive or negative) still shall be reported on Form V-IN for ICP, AA, and Cyanide analyses.

E. Action:

1. It should be noted for TPO action if a laboratory uses a field blank for the spiked sample analysis. All of the other QC data must then be carefully checked, and professional judgement exercised by the data reviewer when evaluating the data.

Note: This information must be included on the IRDA report form.

2. In the instance where there is more than one spiked sample result per matrix and concentration, per analytical method per SDG, if one spiked sample recovery is not within contract criteria, flag all of the samples of the same matrix, level, and method in the SDG.

3. If the pre-distillation/pre-digestion spike recovery does not meet criteria, a post-distillation/post-digestion spike is required for all analytes (except Ag and Hg), and is required for all methods (except furnace). The data from the post-spikes is <u>not to be used</u> to qualify sample results.

   <u>Note:</u> This information must be included in the IRDA report form.

4. If the spike recovery is > 125% and the reported sample results are < IDL, the data is acceptable for use.

5. If the spike recovery is > 125% or < 75% and the sample results are > IDL, qualify the data for these samples as estimated (J).

6. If the spike recovery falls within the range of 30-74% and the sample results are < IDL, qualify the data for these samples as estimated (UJ).

7. If spike recovery results fall < 30% and the sample results are < IDL, qualify the data for these samples as unusable (R).

8. Whenever possible, the potential effects on the data due to out-of-control spiked sample results should be noted in the data review narrative.

Los Alamos
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

memorandum

TO: J. Aldrich, EES-1, D462

DATE: 7 May 93

FROM: R. Charles, INC-9

MAIL STOP/TELEPHONE: J514,7-4985

SYMBOL: INC-9-341

SUBJECT: Pb

The screening action level for lead in soil is 500 mg/kg. The ultimate source for this data is EPA OSWER Directive 9355.4-02, "Interim Guidance on Establishing Lead Cleanup Levels at Superfund Sites", Office of Solid Waste Emergency Response 1989 (enclosed). In talking with G. Brorby, he said these limits were appropriate for the residential scenario based on ingestion of the soil. D. Katzman stated these were the same levels that the state of New Mexico were using also.

cy: INC-9, file

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

OCT 1 1989

OSWER Directive #9355.4-02

MEMORANDUM

SUBJECT: Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites.

FROM: Henry L. Longest II, Director
Office of Emergency and Remedial Response

Bruce Diamond, Director
Office of Waste Programs Enforcement

TO: Directors, Waste Management Division, Regions I, II, IV, V, VII and VIII
Director, Emergency and Remedial Response Division, Region II
Directors, Hazardous Waste Management Division, Regions III and VI
Director, Toxic Waste Management Division, Region IX
Director, Hazardous Waste Division, Region X

PURPOSE

The purpose of this directive is to set forth an interim soil cleanup level for total lead, at 500 to 1000 ppm, which the Office of Emergency and Remedial Response and the Office of Waste Programs Enforcement consider protective for direct contact at residential settings. This range is to be used at both Fund-lead and Enforcement-lead CERCLA sites. Further guidance will be developed after the Agency has developed a verified Cancer Potency Factor and/or a Reference Dose for lead.

BACKGROUND

Lead is commonly found at hazardous waste sites and is a contaminant of concern at approximately one-third of the sites on the National Priorities List (NPL). Applicable or relevant and appropriate requirements (ARARs) are available to provide cleanup levels for lead in air and water but not in soil. The current

National Ambient Air Quality Standard for lead is 1.5 ug/m^3. While the existing Maximum Contaminant Level (MCL) for lead is 50 ppb, the Agency has proposed lowering the MCL for lead to 10 ppb at the tap and to 5 ppb at the treatment plant(1). A Maximum Contaminant Level Goal (MCLG) for lead of zero was proposed in 1988(2). At the present time, there are no Agency-verified toxicological values (Reference Dose and Cancer Potency Factor, ie., slope factor), that can be used to perform a risk assessment and to develop protective soil cleanup levels for lead.

Efforts are underway by the Agency to develop a Cancer Potency Factor (CPF) and Reference Dose (RfD), (or similar approach), for lead. Recently, the Science Advisory Board strongly suggested that the Human Health Assessment Group (HHAG) of the Office of Research and Development (ORD) develop a CPF for lead, which was designated by the Agency as a B2 carcinogen in 1988. The HHAG is in the process of selecting studies to derive such a level. The level and documentation package will then be sent to the Agency's Carcinogen Risk Assessment Verification Exercise (CRAVE) workgroup for verification. It is expected that the documentation package will be sent to CRAVE by the end of 1989. The Office of Emergency and Remedial Response, the Office of Waste Programs Enforcement and other Agency programs are working with ORD in conjunction with the Office of Air Quality Planning and Standards (OAQPS) to develop an RfD, (or similar approach), for lead. The Office of Research and Development and OAQPS will develop a level to protect the most sensitive populations, namely young children and pregnant women, and submit a documentation package to the Reference Dose workgroup for verification. It is anticipated that the documentation package will be available for review by the fall of 1989.

IMPLEMENTATION

The following guidance is to be implemented for remedial actions until further guidance can be developed based on an Agency verified Cancer Potency Factor and/or Reference Dose for lead.

Guidance

This guidance adopts the recommendation contained in the 1985 Centers for Disease Control (CDC) statement on childhood lead poisoning(3) and is to be followed when the current or predicted land use is residential. The CDC recommendation states that "...lead in soil and dust appears to be responsible for blood levels in children increasing above background levels when the concentration in the soil or dust exceeds 500 to 1000 ppm". Site-specific conditions may warrant the use of soil cleanup levels below the 500 ppm level or somewhat above the 1000 ppm level. The administrative record should include background documents on the toxicology of lead and information related to site-specific conditions.

The range of 500 to 1000 ppm refers to levels for total lead, as measured by protocols developed by the Superfund Contract Laboratory Program. Issues have been raised concerning the role that the bioavailability of lead in various chemical forms and particle sizes should play in assessing the health risks posed by exposure to lead in soil. At this time, the Agency has not developed a position regarding the bioavailability issue and believes that additional information is needed to develop a position. This guidance may be revised as additional information becomes available regarding the bioavailability of lead in soil.

Blood-lead testing should not be used as the sole criterion for evaluating the need for long-term remedial action at sites that do not already have an extensive, long-term blood-lead data base[1].

EFFECTIVE DATE OF THIS GUIDANCE

This interim guidance shall take effect immediately. The guidance does not require that cleanup levels already entered into Records of Decisions, prior to this date, be revised to conform with this guidance.

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[1] In one case, a biokinetic uptake model developed by the Office of Air Quality Planning and Standards was used for a site-specific risk assessment. This approach was reviewed and approved by Headquarters for use at the site, based on the adequacy of data (due to continuing CDC studies conducted over many years). These data included all children's blood-lead levels collected over a period of several years, as well as family socio-economic status, dietary conditions, conditions of homes and extensive environmental lead data, also collected over several years. This amount of data allowed the Agency to use the model without a need for extensive default values. Use of the model thus allowed a more precise calculation of the level of cleanup needed to reduce risk to children based on the amount of contamination from all other sources, and the effect of contamination levels on blood-lead levels of children.

REFERENCES

1. 53 FR 31516, August 18, 1988.
2. 53 FR 31521, August 18, 1988.
3. Preventing Lead Poisoning in Young Children, January U.S. Department of Health and Human Services, Center Disease Control, 99-2230.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUL 19
OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

JUL 14 1994

OSWER Directive # 9355.4-12

MEMORANDUM

SUBJECT: Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities

FROM: Elliott P. Laws
Assistant Administrator

TO: Regional Administrators I-X

PURPOSE

As part of the Superfund Administrative Improvements Initiative, this interim directive establishes a streamlined approach for determining protective levels for lead in soil at CERCLA sites and RCRA facilities that are subject to corrective action under RCRA section 3004(u) or 3008(h) as follows:

- It recommends screening levels for lead in soil for residential land use (400 ppm);[1]
- It describes how to develop site-specific preliminary remediation goals (PRGs) at CERCLA sites and media cleanup standards (MCSs) at RCRA Corrective Action facilities for residential land use; and,
- It describes a plan for soil lead cleanup at CERCLA sites and RCRA Corrective Action facilities that have multiple sources of lead.

This interim directive replaces all previous directives on soil lead cleanup for CERCLA and RCRA programs (see the Background section, 1989-1991).

KEY MESSAGES

Screening levels are not cleanup goals. Rather, these screening levels may be used as a tool to determine which sites

[1]The residential screening level is the same concept as the action level proposed in the RCRA Corrective Action Subpart S rule (July 27, 1990, 55 *Federal Register* 30798).

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or portions of sites do not require further study and to encourage voluntary cleanup. Screening levels are defined as a level of contamination above which there may be enough concern to warrant site-specific study of risks. Levels of contamination above the screening level would NOT automatically require a removal action, nor designate a site as "contaminated."

The residential screening level for lead described in this directive has been calculated with the Agency's new Integrated Exposure Uptake Biokinetic Model (IEUBK) model (Pub. # 9285.7-15-2, PB93-963511), using default parameters. As outlined in the Guidance Manual for the IEUBK Model for Lead in Children (Pub. # 9285.7-15-1, PB93-963510, February 1994), this model was developed to: recognize the multimedia nature of lead exposures; incorporate important absorption and pharmacokinetic information; and allow the risk manager to consider the potential distributions of exposure and risk likely to occur at a site (the model goes beyond providing a single point estimate output). For these reasons, this approach is judged to be superior to the more common method for assessing risks of non-cancer health effects which utilizes the reference dose (RfD) methodology. Both the Guidance Manual and the model are available to Superfund staff through the Superfund Document Center (703-603-8917) and to the public through the National Technical Information Service (703-487-4650).

Residential preliminary remediation goals (PRGs) for CERCLA remediations and media cleanup standards (MCSs) for RCRA corrective actions can be developed using the IEUBK model on a site-specific basis, where site data support modification of model default parameters. At some Superfund sites, using the IEUBK model with site-specific soil and dust characteristics, PRGs of more than twice the screening level have been identified. However, it is important to note that the model alone does not determine the cleanup levels required at a site. After considering other factors such as costs of remedial options, reliability of institutional controls, technical feasibility, and/or community acceptance, still higher cleanup levels may be selected.

The implementation of this guidance is expected to provide for more consistent decisions across the country and improve the use of site-specific information for RCRA and CERCLA sites contaminated with lead. The implementation of this guidance will aid in determining when evaluation with the IEUBK model is appropriate and in assessing the likelihood that environmental lead poses a threat to the public. Use of the IEUBK model in the context of this guidance will allow risk managers to assess the

contribution of different environmental sources of lead to overall blood lead levels (e.g., consideration of the importance of soil lead levels relative to lead from drinking water, paint and household dust). It offers a flexible approach to considering risk reduction options (referred to as the "bubble" concept) that allows for remediation of lead sources that contribute significantly to elevated blood lead. This guidance encourages the risk manager to select, on a site-specific basis, the most appropriate combination of remedial measures needed to address site-specific lead exposure threats. These remedial measures may range widely from intervention to abatement. However, RCRA and CERCLA have very limited authority to address interior exposures from interior paint. For a detailed discussion of the decision logic for addressing lead-contaminated sites, see the Implementation section and Appendix A.

Relationship to lead paint guidance. In addition, this interim directive clarifies the relationship between guidance on Superfund and RCRA Corrective Action cleanups, and EPA's guidance on lead-based paint hazards (discussed further in Appendix C). The paint hazard guidance will be issued to provide information until the Agency issues regulations identifying lead-based paint hazards as directed by Section 403 of the Toxic Substances Control Act (TSCA)[2]. Lead-based paint hazards are those lead levels and conditions of paint, and residential soil and dust that would result in adverse health effects.

The two guidance documents have different purposes and are intended to serve very different audiences. As a result the approaches taken differ to some degree. The lead-based paint hazard guidance is intended for use by any person who may be involved in addressing residential lead exposures (from paint, dust or soil.) It thus relates to a potentially huge number of sites, and serves a very broad potential audience, including private property owners or residents in addition to federal or state regulators. Much residential lead abatement may take place outside any governmental program, and may not involve extensive site-specific study.

This OSWER guidance, on the other hand, deals with a much smaller number of sites, being addressed under close federal regulatory scrutiny, at which extensive site characterization will have been performed before cleanup decisions are made. Thus, the RCRA and CERCLA programs will often have the benefit of much site-specific exposure information. This guidance is intended for use by the relatively small number of agency officials who oversee and direct these cleanups.

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[2]Title IV of TSCA (including section 403) was added by the Residential Lead-Based Paint Hazard Reduction Act of 1992 (Title X of the Housing and Community Development Act of 1992).

Both the TSCA Section 403 and OSWER programs use a flexible, tiered approach. The OSWER guidance sets a residential screening level at 400 ppm. As noted above, this is not intended to be a "cleanup level" for CERCLA and RCRA facilities, but only to serve as an indicator that further study is appropriate. The Section 403 guidance indicates that physical exposure-reduction activities may be appropriate at 400 ppm, depending upon site-specific conditions such as use patterns, populations at risk and other factors. Although worded somewhat differently, the guidances are intended to be similar in effect. For neither guidance is 400 ppm to automatically be considered a "cleanup level"; instead, it indicates a need for considering further action, but not necessarily for taking action. Neither is meant to indicate that cleanup is necessarily appropriate at 400 ppm. The greater emphasis in this OSWER guidance on determining the scope of further study reflects the fact that both CERCLA and RCRA cleanups proceed in stages with detailed site characterization preceding response actions in every case.

Above the 400 ppm level, the Section 403 guidance identifies ranges over which various types of responses are appropriate, commensurate with the level of potential risk reduction, and cost incurred to achieve such risk reduction. For example, in the range of 400 to 5000 ppm, limited interim controls are recommended depending, as noted above, on conditions at the site, while above 5000 ppm, soil abatement is recommended. This OSWER guidance does not include comparable numbers above 400 ppm; instead, as discussed above, it recommends the site-specific use of the IEUBK model to set PRGs and MCSs, when necessary. The remedy selection process specified in the National Contingency Plan (NCP) should then be used to decide what type of action is appropriate to achieve those goals.

In general, because the Section 403 guidance was developed for a different purpose and audience, OSWER does not recommend that it be used as a reference in setting PRGs and MCSs or in determining whether action at a particular site is warranted. (To put it another way, it generally should not be treated as a "to be considered" document or "TBC" under CERCLA.) The section 403 guidance is meant to provide generic levels that can be used at thousands of widely varying sites across the nation. The detailed study that goes on at CERCLA or RCRA sites will allow levels to be developed that are more narrowly tailored to the individual site. Nothing in the section 403 guidance discourages setting more site-specific levels for certain situations; in fact, it specifically identifies factors such as bioavailability that may significantly affect the evaluation of risk at some sites.

The IEUBK model. The Agency is further studying both the IEUBK model and analyses of epidemiologic studies in order to better develop the technical basis for rulemaking under TSCA

Section 403. The Agency intends to promulgate regulations under Section 403 setting health-based standards for lead in soil and dust. OSWER intends to issue a final soil lead directive once the TSCA Section 403 regulations are finalized. For additional information on TSCA Section 403 developments, call (202) 260-1866.

However, the Agency believes that risk managers (risk assessors, on-scene coordinators, remedial project managers, and other decision-makers at Superfund and RCRA sites) are currently in need of the best guidance available today. The Agency believes that the IEUBK model is the best available tool currently available for assessing blood lead levels in children. Furthermore, use of the IEUBK provides allows the risk manager to consider site-specific information that can be very important in evaluating remediation options. Therefore, using the latest developments in the IEUBK model and the collective experience of the Superfund, RCRA Corrective Action, and TSCA Section 403 programs, the Agency is offering this guidance and is recommending a residential screening level for Superfund and RCRA sites of 400 ppm.

BACKGROUND

Early OSWER guidance (1989-1991). Four guidance documents on soil lead cleanup were issued by OSWER during the period of 1989 to 1991:

1. September 1989, OSWER Directive #9355.4-02. This guidance recommended a soil lead cleanup level of 500 - 1000 ppm for protection of human health at residential CERCLA sites.

2. May 9, 1990. RCRA Corrective Action program guidance on soil lead cleanup. This guidance described three alternative methods for setting "cleanup levels" (not action levels) for lead in soil at RCRA facilities. One approach was to use levels derived from preliminary results of IEUBK model runs. The other two approaches were to use the range of 500 to 1000 provided in the 1989 directive on CERCLA sites, or to use "background" levels at the facility in question.

3. June 1990, OSWER Directive #9355.4-02A. Supplement to Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites. This memorandum reiterated that the September 1989 directive was guidance and should not be interpreted as regulation.

4. August 29, 1991. This supplemental guidance discussed EPA's efforts to develop a new directive that would

accomplish two objectives: (1) account for the contribution from multiple media to total lead exposure; and, (2) provide a stronger scientific basis for determining a soil lead cleanup level at a specific site.

Development of the IEUBK Model for OSWER use. During the 1989-91 time period, use of the EPA IEUBK model was identified as the best available approach for accomplishing the objectives outlined in the August 1991 guidance. The model integrates exposure from lead in air, water, soil, dust, diet, and paint with pharmacokinetic modeling to predict blood lead levels in children (i.e., children 6 to 84 months old), a particularly sensitive population.

In the spring of 1991, OSWER organized the Lead Technical Review Workgroup to assist Regional risk assessors and site managers in both using the model and making data collection decisions at CERCLA and RCRA sites. The workgroup was composed of scientists and risk assessors from the Regions and Headquarters, including the Office of Research and Development (ORD), and the Office of Pollution Prevention and Toxic Substances (OPPTS).

In November 1991, the EPA Science Advisory Board (SAB) reviewed the scientific merits of using the IEUBK model for assessing total lead exposure and developing soil lead cleanup levels at CERCLA and RCRA sites. In general, the SAB found the model to be an important advance in assessing potential health risks from environmental contaminants. However, the SAB also recommended additional guidance on the proper use of the model.

In response to SAB concern over the potential for incorrect use of the model and selection of inappropriate input values both for default and site-specific applications, OSWER developed a comprehensive "Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children" (referred to in this interim directive as the "Guidance Manual"). This Guidance Manual assists the user in providing inputs to the model to estimate risks from exposures to lead. It discusses the use of model default values or alternative values, and the application of the model to characterize site risks. Use of the Guidance Manual should facilitate consistent use of the IEUBK model and allow the risk assessor to obtain valid and reliable predictions of lead exposure. The Lead Technical Review Workgroup has been collecting data to further validate the model and to update the Guidance Manual as needed.

Relationship to RCRA Corrective Action "Action" Levels. The approach for calculating a screening level for lead (including exposure assumptions), set forth in this Revised Interim Soil Lead Directive, supersedes the guidance provided for calculating

"action" levels set forth in Appendix D of the proposed Subpart S Corrective Action rule. In the July 27, 1990 RCRA proposal (55 *Federal Register* 30798), EPA introduced the concept of "action levels" as trigger levels for further study and subsequent remediation at RCRA facilities. In this respect, the current directive's "screening levels" are analogous to the proposed rule's "action levels." In the proposal, where data were available, action levels were developed for three pathways of human exposure to contaminants: soil ingestion, water ingestion and inhalation of contaminated air. Exposure assumptions used in the calculations were set out in Appendix D of the proposal. For the soil pathway, action levels were calculated two different ways depending on whether the contaminant in the soil was a carcinogen or a systemic toxicant. Although lead was listed in Appendix A of the preamble to the rule as a class B2 carcinogen, no action level had been calculated because neither a carcinogenic slope factor (SF) nor a reference dose (RfD) had been developed by the Agency. Although the guidance in Appendix D of the proposed Corrective Action rule remains in effect with respect to other hazardous constituents, this directive now allows for the development of the lead screening ("action") level using the IEUBK model.

Recent developments (1992-Present). Following discussions among senior Regional and OSWER management, the OSWER Soil Lead Directive Workgroup (composed of Headquarters, Regional and other Federal agency representatives) recommended in the spring of 1992 that a "two step" decision framework be developed for establishing cleanup levels at sites with lead-contaminated soils. This framework would identify a single level of lead in soils that could be used as either the PRG for CERCLA site cleanups or the action level for RCRA Corrective Action sites, but would also allow site managers to establish site-specific cleanup levels (where appropriate) based on site-specific circumstances. The IEUBK model would be an integral part of this framework. OSWER then developed a draft of this directive which it circulated for review on June 4, 1992. The draft set 500 ppm as a PRG and an action level for RCRA facilities in residential settings.

Following development of this draft, OSWER held a meeting on July 31, 1992 to solicit a broad range of views and expertise. A wide range of interests, including environmental groups, citizens and representatives from the lead industry attended. This meeting encouraged OSWER to think more broadly about how the directive would affect urban areas, how lead paint and dust contribute to overall risk, and how blood lead data could be used to assess risk. In subsequent meetings with the Agency for Toxic Substances and Disease Control (ATSDR) and the Centers for Disease Control (CDC), options were discussed on how to use blood lead data and the need to evaluate the contribution of paint. In addition, during these meetings, a "decision tree" approach was

suggested that proposed different threshold levels (primary and secondary) for screening decisions, action decisions and land use patterns.

Findings from the three cities (Baltimore, Boston, and Cincinnati) of the Urban Soil Lead Abatement Demonstration Project (peer review scheduled for completion in late 1994) indicate that dust and paint are major contributors to elevated blood lead levels in children. Furthermore, preliminary findings suggest that any strategy to reduce overall lead risk at a site needs to consider not only soil, but these other sources and their potential exposure pathways. (For further information on this demonstration project, contact Dr. Rob Elias, USEPA/ORD, Environmental Criteria and Assessment Office (ECAO), RTP, (919) 541-4167.)

Finally, in its efforts to develop this interim directive, the OSWER Soil Lead Workgroup has met with other EPA workgroups including the TSCA Section 403, Large Area Lead Sites, and Urban Lead workgroups, as well as other Federal agencies including the Agency for Toxic Substances and Disease Registry, the Centers for Disease Control, and the Department of Housing and Urban Development.

Derivation of Lead Screening Levels. Development of the residential screening level in this interim directive required two important OSWER decisions. 1) OSWER determined that it would seek to achieve a specific level of protectiveness in site cleanups; generally, OSWER will attempt to limit exposure to soil lead levels such that a typical (or hypothetical) child or group of similarly exposed children would have an estimated risk of no more than 5% of exceeding the a 10 μg lead/dl blood lead level. This 10 μg/dl blood lead level is based upon analyses conducted by the Centers for Disease Control and EPA that associate blood lead levels of 10 μg/dl and higher with health effects in children; however, this blood lead level is below a level that would trigger medical intervention. 2) In developing the residential screening level, OSWER has decided to apply the EPA's IEUBK model on a site-specific basis. This model has been designed specifically to evaluate exposures for children in a residential setting. Current research indicates that young children are particularly sensitive to the effects of lead and require specific attention in the development of a soil screening level for lead. A screening level that is protective for young children is expected to be protective for older population subgroups.

In general, the model generates a probability distribution of blood lead levels for a typical child, or group of children, exposed to a particular soil lead concentration and concurrent lead exposures from other sources. The spread of the distribution reflects the observed variability of blood lead

levels in several communities. This variability arises from several sources including behavioral and cultural factors.

The identification of lead exposures from other sources (due to air, water, diet, paint, etc.) is an essential part of characterizing the appropriate blood lead distribution for a specific neighborhood or site. For the purpose of deriving a residential screening level, the background lead exposure inputs to the IEUBK model were determined using national averages, where suitable, or typical values. Thus, the estimated screening level of 400 ppm is associated with an expected "typical" response to these exposures, and should not be taken to indicate that a certain level of risk (e.g., exactly 5% of children exceeding 10 μg/dl blood) will be observed in a specific community, e.g., in a blood lead survey.

Because a child's exposure to lead involves a complex array of variables, because there is population sampling variability, and because there is variability in environmental lead measurements and background levels of lead in food and drinking water, results from the model may differ from results of blood lead screening of children in a community. Extensive field validation is in progress. The model will be evaluated further once these efforts are completed.

OBJECTIVE

With this interim directive, OSWER recommends using 400 ppm soil lead (based on application of the IEUBK model) as a screening level for lead in soil for residential scenarios at CERCLA sites and at RCRA Corrective Action sites. Residential areas with soil lead below 400 ppm generally require no further action. However, in some special situations, further study is warranted below the screening level. For example, agricultural areas, wetlands, areas with ecological risk, and areas of higher than expected human exposure are all situations that could require further study. For further guidance on ecological risks, Superfund risk managers are encouraged to consult their Regional Biological Technical Assistance Groups (BTAGs; see Appendix D).

Generally, the ground water pathway will not pose a significant risk since many lead compounds are generally not highly mobile. However, there are situations where, because of the form of lead, hydrogeology, or the presence of other contaminants at the site, lead may pose a threat to the ground water. In these situations, additional analysis is warranted, and the Superfund Regional Toxics Integration Coordinators (RTICs; see Appendix B) or RCRA hydrogeologists should be consulted.

While recognizing that urban lead is a significant problem, this interim directive is not designed to be applied in addressing the potential threat of lead in urban areas other than at CERCLA or RCRA Corrective Action sites. Guidance and regulations to be developed under TSCA Section 403 will provide an appropriate tool for addressing urban sites of potential concern.

Generally, where the screening level is exceeded, OSWER recommends using the IEUBK model during the Remedial Investigation or the RCRA Facility Investigation for evaluating potential risks to humans from environmental exposures to lead under residential scenarios. Site-specific data need to be collected to determine PRGs or MCSs. At a minimum, this may involve collecting soil and dust samples in appropriate areas of the site. Further guidance on data collection or modification of the non-residential equation can be obtained by contacting the RTICs or RCRA Regional risk assessors, who in turn may consult the Lead Technical Review Workgroup.

The type of site-specific data that should be collected will obviously depend on a number of factors, including the proximity of residences to the contaminated soil, the presence of site access controls, and other factors that would influence the probability of actual human exposure to the soils. At a minimum, when residences are at or near the site, it is expected that using the model will generally involve taking soil and dust samples from appropriate areas of the site. In many cases, it may not be necessary to gather certain types of data for input into the model. For example, when there are no residences nearby, or where there is otherwise no exposure or very limited exposure to lead contamination, it may not be necessary to collect site-specific data (e.g., dust, water, paint, blood-lead, etc.)

In developing a PRG for CERCLA sites or a MCS for RCRA facilities, EPA recommends that a soil lead concentration be determined so that a typical child or group of children exposed to lead at this level would have an estimated risk of no more than 5% of exceeding a blood lead of 10 μg/dl. In applying the IEUBK model for this purpose, appropriate site specific data on model input parameters, including background exposures to lead, would be identified.

When the PRG or MCS is exceeded, remedial action is generally recommended. Such action does not, however, necessarily involve excavating soil. A range of possible actions may be considered, as discussed in greater detail under the Implementation section of this directive: Issues for Both Programs.

IMPLEMENTATION

Superfund

This interim directive applies to all future CERCLA Remedial Investigation/Feasibility Study (RI/FS) work; this interim directive should generally not be applied at sites for which risk assessments have been completed. For removal sites, this interim directive recommends that decisions regarding removal actions be considered first by the Regional Decision Team (RDT). The RDT will then refer sites to the removal program for early action, as appropriate.

The approach in this interim directive helps meet the goals set by the Superfund Accelerated Cleanup Model (SACM) for streamlining remedial decision-making. (This streamlined approach is described in Appendix A, Suggested Decision Logic for CERCLA and RCRA Corrective Action.) This interim directive also recognizes that other methods (e.g., slope studies and others) for evaluating risks at lead sites may also be appropriate and may be used in lieu of, or in conjunction with, the IEUBK model. If an alternate approach to lead risk assessment is to be applied, an EPA scientific review should be obtained. For example, expert statisticians would need to review slope factor calculations for statistical biases before their use could be supported. Recognizing that all assessment methods involve some uncertainties, the Agency, at this time, believes the IEUBK model is the most appropriate and widely applicable tool for Superfund and RCRA sites. Alternatively, EPA may require setting cleanup levels below the screening level if site-specific circumstances warrant (e.g, ecological risk). For further information on the use of the IEUBK model at CERCLA sites, contact the Regional Toxics Integration Coordinators identified in Appendix B.

RCRA Corrective Action

It is expected that the RCRA corrective action program will generally follow an approach similar to CERCLA's (as described above) in using the IEUBK model. In the case of RCRA facilities at which lead contaminated soils are of concern, collection and evaluation of data for the purpose of using the model will be primarily the responsibility of the owner/operator.

Issues for Both Programs

Cleanup of soils vs. other lead sources: OSWER's approach to assessing and managing risks from lead is intended to address the multi-media/multi-source nature of environmental lead exposures because it is expected that people at or near CERCLA and RCRA Corrective Action sites will experience lead exposures from sources in addition to contaminated soil. In some instances, these other exposures may be large (e.g., where there are

children living in houses with high levels of lead dust from deteriorated paint). The presence of various sources of lead exposure may be very important in both the development of site-specific risk assessments and in the consideration of alternative risk management options.

From an assessment perspective, estimating blood lead levels, that might result from exposures at a site, depends on appropriately integrating exposures from all relevant media. Specifically, it is important to consider direct soil exposures and indoor dust exposures (which can include contributions from both soil and lead-based paint) on a site-specific basis, as well as any contributions from drinking water or other local sources of lead exposure. In using the IEUBK model to estimate blood lead levels, it is important to note that the risk attributable to soil lead exposures is dependent upon the existing level of exposures from other sources. That is, the amount by which the total risk would be lowered if all exposures to lead in soil were removed is not a constant, but varies with the level of existing non-soil exposures. This is because the model derives a "distribution" (rather than a simple point estimate) as an output whose shape and size is quite dependent on the predicted variability of exposures from each lead source. As a result, other factors being equal, the risks attributable to soil will generally be higher in the presence of elevated lead exposures from other sources. Therefore, in applying the IEUBK model, the risk attributable to soil lead can be predicted as the difference between the risk estimated when all sources of lead exposure are assessed, and the risk estimated considering only non-soil related exposures. This concept is especially important when evaluating different options for risk reduction at a given site.

From a risk management perspective, achieving a safe environment for populations at CERCLA and RCRA Corrective Action sites may require attention to multiple sources of lead, not all of which may be related to contamination from the source that was the initial concern at the site. Generally, the goal of the Agency, while acting within the constraints of CERCLA and RCRA legal authorities, is to reduce, to the maximum extent feasible, the risk of having significantly elevated blood lead levels. On a site-specific basis this can include remediation approaches that would lead to reduction of exposure from other sources, such as lead-based paint, in conjunction with appropriate soil remediation. Following from the risk assessment discussion in the previous paragraphs, exposures from lead in soils may have a lesser impact in producing high blood lead levels if existing exposures from lead-based paint are reduced.

Abatement vs. Intervention: Remedial measures can be divided into those that remove the source of contamination (abatement) and those that leave the contamination in place but block the

exposure pathway (intervention). These combinations of measures might include but not be limited to:

Abatement - Soil removal or interior and exterior lead paint abatement.

Intervention - Institutional controls, education/public outreach, gardening restrictions, indoor cleaning and dust removal, or additional cover.

Generally, the most appropriate CERCLA or RCRA response action or combination of actions will be based, in part, on the estimated level of threat posed at a given site. However, as mentioned earlier, key decision criteria also include the overall protectiveness of response options, attainment of Applicable or Relevant and Appropriate Requirements (for CERCLA), a preference for permanent remedies, implementability, cost-effectiveness, and public acceptance. Intervention measures may be more appropriate than abatement (e.g., soil excavation) at many sites, especially in areas where soil lead levels fall at or near the site-specific PRG or MCS.

Addressing exposure from other sources of lead may reduce risk to a greater extent and yet be less expensive than directly remediating soil. In some cases, cleaning up the soil to low levels may, by itself, provide limited risk reduction because other significant lead sources are present (e.g., contaminated drinking water or lead-based paint in residential housing). If it is possible to address the other sources, the most cost-effective approach may be to remediate the other sources as well as, or (if exposures to lead in soil are relatively low) instead of full soil lead abatement.

Lead-based paint can be a significant source of lead exposure and needs to be considered when determining the most appropriate response action. Interior paint can contribute to elevated indoor dust lead levels. In addition, exterior paint can be a significant source of recontamination of soil. Appendix A-3 of this document contains more information on how to evaluate and address the contribution of paint.

Certain legal considerations arise in considering remediation of sources other than soil. In particular, interior exposures from interior paint generally are not within the jurisdiction of RCRA or CERCLA. In addition, where other sources are addressed, issues may arise regarding the recoverability of costs expended by the Agency, or the possibility of claims being asserted against the Fund where other parties are ordered to do the work.

As discussed above, in considering whether to address sources other than soil, it is necessary to consider the risk

that would remain from the lead in the soil. In some cases, after risks from other sources have been addressed, unrestricted exposure to soil could be allowed while still being protective (e.g., where the IEUBK model result was heavily affected by the other sources). In other cases, soil risks may still be high enough to require abatement, containment or institutional controls to prevent high levels of exposure. In such cases, before a conclusion is made that the overall remedy will be protective, institutional controls should be carefully studied to make sure that they will be implementable, effective in both the long-term and short-term, and likely to achieve community acceptance.

A potentially useful approach that can be considered in conjunction with other, more active measures in reducing blood lead levels is to develop and promote public education and awareness programs that focus on the causes and prevention of lead poisoning in children. EPA's Office of Pollution Prevention and Toxics (OPPT) provides information on abatement of lead-based paint by the homeowner as well as inexpensive preventive measures the public can take to reduce their exposure to lead. Additional research to evaluate the effectiveness of educational efforts in reducing lead exposures are needed to allow better evaluation of the usefulness of this option. Further, OPPT is assessing the effectiveness of various lead paint abatement options emphasizing low-cost methods. For additional information, contact the National Lead Information Center at 1-800-424-LEAD.

Mining-related sites: Both risk assessors and site managers should be aware that there are a number of factors that affect the relationship between soil lead concentrations and blood lead levels. These factors include the variability in soil lead contribution to house dust levels, or differences in the bioavailability of lead. See discussion in next section, <u>Use of blood lead data</u>, for assessing differences between measured and predicted blood lead levels.

Thus, for mining-related sites without significant past smelting/milling activity, this interim directive encourages further research for characterizing the potential impact of particle size and speciation on soil bioavailability.

Site managers and risk assessors are cautioned that most areas impacted by mining activities are also associated with present or historical smelting or milling operations. Generalizations regarding distinct differences between mining and smelting or milling sites should be avoided until adequate site history and characterization are complete.

Use of blood lead data: In conducting Remedial Investigations (RIs) for CERCLA or RCRA Facility Investigations (RFIs) for RCRA Corrective Action, the interim directive

recommends evaluating available blood lead data. In some cases, it may be appropriate to collect new or additional blood lead samples. In general, data from well-conducted blood lead studies of children on or near a site can provide useful information to both the risk assessor and site manager. However, the design and conduct of such studies, as well as the interpretation of results, are often difficult because of confounding factors such as a small population sample size. Therefore, any available blood lead data should be carefully evaluated by EPA Regional risk assessors to determine their usefulness. The Guidance Manual discusses how to evaluate observed blood lead survey data and blood lead data predicted by the IEUBK model.

The Guidance Manual recommends that blood lead data not be used alone either to assess risk from lead exposure or to develop soil lead cleanup levels. During its review of the IEUBK model, the SAB supported this position by asserting that site residents may temporarily modify their behavior (e.g., wash their children's hands more frequently) whenever public attention is drawn to a site. In such cases, this behavior could mask the true magnitude of potential risk at a site and lead to only temporary reductions in the blood lead levels of children. Thus, blood lead levels below 10 μg/dl are not necessarily evidence that a potential for significant lead exposure does not exist, or that such potential could not occur in the future.

Non-residential (adult) screening level. EPA also believes there is a strong need to develop a non-residential (adult) screening level. The IEUBK model is, however, not appropriate for calculating this screening level since it is designed specifically for evaluating lead exposures in children. At this time, EPA is considering a few options for developing this screening level. Several adult models have recently become available. Developing a screening level by using any of them is likely to require significant additional work by the Agency. This work might include testing, validation, and selection of one of the existing models or development of its own model, both of which would require a considerable amount of time. Consequently this would probably be a long-term option. A short-term option would be to develop a screening level based on a simple approach that approximates the more complicated biokinetics in humans. This can serve in the interim while more sophisticated adult lead exposure assessment tools can be identified or developed.

NOTICE: Users of this directive should bear in mind that the recommendations in this document are intended solely as guidance, and that EPA risk managers may act at variance with any of these recommendations where site-specific conditions warrant, as has been noted above. These recommendations are not intended, and cannot be relied upon, to create any rights, substantive or procedural, enforceable by any party in litigation with the United States, and may change at any time without public notice.

Because this document and the related Guidance Manual are not legally binding either upon EPA or other parties, Agency personnel should keep in mind if they are questioned or challenged in comments on a proposed remedial plan, such comments must be considered and a substantive explanation must be provided for whatever approach is ultimately selected. For example, while the IEUBK model is recommended here, its use is not a regulatory requirement and comments on the model or its use should be fully considered.

APPENDICES

A Suggested Decision Logic for CERCLA and RCRA Corrective Action

A-1 Suggested Decision Logic for Residential Scenarios for CERCLA and RCRA Corrective Action

A-2 Suggested Decision Logic for Lead-based Paint for CERCLA and RCRA Corrective Action

B Regional Toxics Integration Coordinators (RTICS)

C Relationship between the OSWER Soil Lead Directive and TSCA Section 403 Guidance

D Biological Technical Assistance Group Coordinators (BTAGS)

Appendix A-1

Suggested Decision Logic for Residential Scenarios for CERCLA and RCRA Corrective Action

Step 1: Determine soil lead concentration at the site.

If soil lead is less than 400 ppm:
STOP, no further action is required, UNLESS special circumstances (such as the presence of wetlands, other areas of ecological risk, agricultural areas, shallow aquifers, or other areas of potentially high exposure) warrant further study.

If soil lead is greater than 400 ppm:
PROCEED to Step 2, UNLESS 400 ppm is selected as a cleanup goal based on consideration of all relevant risk management factors.

Step 2: Evaluate probable land use and develop exposure scenarios.

Step 3: Collect appropriate site-specific data based on selected scenarios.

For example, sampling data may include:

- Soil and dust (at a minimum), paint, water, and air
- For unique site situations, data on speciation and particle size, and behavioral activities may be required.

Available blood lead data:

- If blood lead data are available, consult the Guidance Manual and Regional Risk Assessor.
- If blood lead data are not available, Regional Risk Assessors and site managers should consider the appropriateness of conducting a blood lead study to supplement available data.

Step 4: Run the IEUBK model with site-specific data to estimate risk and evaluate key exposure pathways at the site.

- If blood lead data are available, compare the data to the model results

Step 5: Where risks are significant, evaluate remedial options.

If lead-based exterior or interior paint is the only major contributor to exposure, no Superfund action or RCRA corrective action is warranted.

If soil is the only major contributor to elevated blood lead, a response to soil contamination is warranted, but paint abatement is not.

If both exterior lead-based paint and soil are major contributors to exposure, consider remediating both sources, using alternative options as described in Appendix A-2.

If indoor dust levels are greater than soil levels, consider evaluating the contribution of interior lead-based paint to the dust levels. If interior lead-based paint is a major contributor, consider remediating indoor paint to achieve a greater overall risk reduction at lower cost. (See Appendix A-2.)

NOTE: Available authority to remediate lead-based paint under CERCLA and RCRA is extremely limited.)

Step 6: If the IEUBK model predicts elevated blood leads, rerun the model using the site-specific parameters selected to reflect remedial options in Step 5 to determine site-specific PRGs or MCSs for soil.

Appendix A-2

Suggested Decision Logic for Lead-based Paint for CERCLA and RCRA Corrective Action

(If soil lead levels are below screening levels, lead-based paint could be addressed by authorities other than RCRA or CERCLA.)

If soil lead levels are above screening levels:

Step 1. Examine condition of exterior paint and determine its lead content, if any.

- If paint is deteriorated, assess contribution or potential contribution of paint to elevated soil lead levels through speciation studies, structural equation modelling, or other statistical methods.

Step 2. Evaluate potential for recontamination of soil by exterior paint.

Step 3. Remediate exterior paint only in conjunction with soil.

- Determine appropriate remediation based on risk management factors (e.g., applying the nine criteria), remediating the major contributor first.

Step 4. Examine condition of indoor paint and determine its lead content, if any.

- If indoor dust lead concentration is greater than outdoor soil lead concentration (because of contamination from both interior paint and outdoor soil), remediate indoor dust (e.g., through a removal action, or making HEPA-VACS available to community).

Step 5. Once the risk from indoor paint has been assessed, examine options to abate indoor paint (e.g., PRP, State, local, HUD) and consult TSCA Section 403 program for additional information and/or guidance.

Step 6. While RCRA and CERCLA have very limited authority regarding the cleanup of interior paint, the remedy may take into account the reduction of

total risk that may occur if interior paint is addressed by other means. Thus, for example, a Record of Decision (ROD) or Statement of Basis (SB) may recognize that interior lead-based paint is being addressed by other means, and narrow the response accordingly (possibly making this contingent on completion of the interior lead-based paint abatement effort.

Appendix B

Superfund Regional Toxics Integration Coordinators (RTICs)

	Telephone	FAX
Ann-Marie Burke EPA Region 1 HSS-CAN-7 John F. Kennedy Federal Bldg. Boston, MA 02203	617/223-5528	617/573-9662
Peter Grevatt EPA Region 2 26 Federal Plaza New York, NY 10278	212/264-6323	212/264-6119
Reggie Harris EPA Region 3 (3HW15) 841 Chestnut Street Philadelphia, PA 19107	215/597-6626	215/597-3150
Dr. Elmer Akin EPA Region 4 345 Courtland St, NE EPA 9452 Atlanta, GA 30365	404/347-1586	404/347-0076
Erin Moran EPA Region 5 HSRLT-5J 77 West Jackson Street Chicago, Il 60604	312/353-1420	312/886-0753
Jon Rauscher EPA Region 6 6H-SR 1st Interst. Bank Tower 1445 Ross Ave. Dallas, TX 75202	214/655-8513	214/655-6460
David Crawford (Acting) EPA Region 7 Superfund 726 Minnesota Ave. Kansas City, KS 66101	913/551-7702	913/551-7063
Chris Weis EPA Region 8 8HWM-SR 999 18th St, Suite 500 Denver, CO 80202	303/294-7655	303/293-1230
Dan Stralka EPA Region 9 ORA 75 Hawthorne Street San Francisco, CA 94105	415/744-2310	415/744-1916
Carol Sweeney EPA Region 10 ES-098 1200 6th Avenue Seattle, WA 98101	206/553-6699	206/553-0119

Appendix C

Relationship between the OSWER Soil Lead Directive and TSCA Section 403 Guidance

Since lead exposures occur through all media, a variety of Agency programs address lead under a number of statutes. Lead in soil is addressed under TSCA Section 403, the RCRA Corrective Action program, and CERCLA, each of which differs somewhat in the types of sites that apply and the types of standards that are used. These differences are primarily due to differences in the purposes of the programs and the authority granted by the statutes under which they are developed. Section 403 soil standards will apply only to residential soil and the current TSCA guidance is generic in nature, with the same standards applying on a nationwide basis. Given the wide applicability of Section 403, generic standards are used in the current guidance in order to reduce resource requirements, as compared to site-specific decisions which can involve expensive and time-consuming analyses. Required RCRA and CERCLA activities are determined on a site-specific basis. The agency's recommendations for evaluating RCRA Corrective Action and CERCLA sites are contained in the OSWER Interim Soil Lead Directive.

In all three of these programs, the Agency's approach is to consider soil lead in the context of other lead sources that may be present and contribute to the total risk. For example, TSCA Section 403 specifically requires the Agency to consider the hazards posed by lead-based paint and lead-contaminated interior dust, as well as lead-contaminated soil. Likewise, the OSWER Soil Directive includes evaluation of other lead sources at a site as part of site assessment/investigation procedures. In addition, the primary focus of the three programs is primary prevention -- the prevention of future exposures from the source(s) being remediated.

The fundamental difference between the relatively new TSCA Section 403 program and the RCRA Corrective Action and CERCLA cleanup programs is that, under current guidance the Section 403 program seeks to establish national standards to prioritize responses to lead hazards whereas the other two programs usually develop site-specific cleanup requirements. This is because TSCA Section 403 deals with a potentially huge number of sites, and resources for the investigation needed to accurately identify their risks are typically very limited. Therefore most decisions under Section 403 will be made with little or no regulatory oversight and clear generic guidelines will be more effective. The more established RCRA and CERCLA programs, on the other hand, deal with a much smaller number of sites, at which extensive site characterization will have been performed before cleanup decisions are made. In addition, these programs have well-established funding mechanisms.

Appendix D

Superfund Biological Technical Assistance Group Coordinators (BTAGs)

	Telephone	Fax
David Charters Mark Sprenger ERT USEPA (MS-101) 2890 Woodbridge Ave., Bldg. 18 Edison, NJ 08837-3679	908/906-6826	908/321-6724
Jeffrey Langholz TIB USEPA (5204G) 401 M Street SW Washington, DC 20460	703/603-8783	703/603-9103
Susan Svirsky Waste Management Division USEPA Region 1 (HSS-CAN7) JFK Federal Building Boston, MA 02203	617/573-9649	617/573-9662
Shari Stevens Surveillance Monitoring Branch USEPA Region 2 (MS-220) Woodbridge Avenue Raritan Depot Building 209 Edison, NJ 08837	908/906-6994	908/321-6616
Robert Davis Technical Support Section USEPA Region 3 (3HW15) 841 Chestnut Street Philadelphia, PA 19107	215/597-3155	215/597-9890
Lynn Wellman WSMD/HERAS USEPA Region 4 345 Courtland Street, NE Atlanta, GA 30365	404/347-1586	404/347-0076
Eileen Helmer USEPA Region 5 (HSRLT-5J) 77 West Jackson Boulevard Chicago, IL 60604-1602	312/886-4828	312/886-7160

Superfund Biological Technical Assistance Group Coordinators (BTAGs)

Jon Rauscher Susan Swenson Roddy USEPA Region 6 (6H-SR) First Interstate Tower 1445 Ross Avenue Dallas, TX 75202-2733	214/655-8513	214/655-6762
Bob Koke SPFD-REML USEPA Region 7 726 Minnesota Avenue Kansas City, KS 66101	913/551-7468	913/551-7063
Gerry Henningsen USEPA Region 8 Denver Place, Suite 500 999 18th Street Denver, CO 80202-2405	303/294-7656	303/293-1230
Doug Steele USEPA Region 9 75 Hawthorne Street San Francisco, CA 94105	415/744-2309	415/744-1916
Bruce Duncan USEPA Region 10 (ES-098) 1200 6th Avenue Seattle, WA 98101	206/553-8086	206/553-0119

APPENDIX H COMPARISON OF ANTICIPATED AND ACTUAL COSTS

Table H-1 summarizes the estimated costs versus the actual cost for the Voluntary Corrective Action at PRS 0-016. The costs were affected by an increase in volume from 3 000 yd^3 (1994 VCA plan) to 13700 yd^3 when the project was completed. The estimated cost was based on the original volume of soil 3 000 yd^3 and the actual cost reflects the increased soil volume.

TABLE H-1
BEFORE AND AFTER COST COMPARISON
FOR PRS 0-016 VCA

ACTIVITIES	ESTIMATED COST	ACTUAL COST
Pre-field activities	$ 39,000.00	$ 54,000.00
Field activities	$ 177,300.00	$ 1,164,200.00
Analytical costs	$ 23,600.00	$ 51,400.00
Waste Management	$ 23,800.00	$ 162,000.00
Post-field activities	$ 36,300.00	$ 41,000.00
TOTAL	**$300,000.00**	**$1,472,600.00**

APPENDIX I COPIES OF VCA PLANS FOR PRS 0-016

VOLUNTARY CORRECTIVE ACTION PLAN

SWMU 0-016, INACTIVE FIRING RANGE

1.0 Introduction

Solid Waste Management Unit (SWMU) 0-016 is a former small arms range located west of Guaje Pines Cemetery in Los Alamos, New Mexico. The site, which occupies about two acres, consisted of several small buildings and two earthen berms. At present, only concrete steps, pads, and the earthen berms remain. The target berms contain lead bullets, lead fragments, and particulate lead.

The site was used by Los Alamos National Laboratory (LANL) from the late 1940s to the 1960s for small arms target practice. The earthen berms are estimated to contain about 1800 cubic yards of soil. The soil cover is relatively thin at the site outside of the berms, and much of the SWMU 0-016 ground surface is formed by the Bandelier Tuff. This relatively thin soil cover will reduce the additional volume of soil for soil washing. The objective of this voluntary corrective action (VCA) plan is to reduce the level of lead in the earthen berms and associated soil to levels that would allow the site to be released for public use.

The United States Forest Service (USFS) and the County of Los Alamos have requested the cleanup of the range so that the land may be transferred from the USFS to a local developer, as part of a larger public-private land exchange. This VCA plan is being proposed, instead of following the RFI/CMS process as stated in the Operable Unit (OU) 1071 RFI Work Plan (LANL 1992), because of the time constraints placed on the Environmental Restoration (ER) Program by the pending land exchange.

This VCA plan proposes that the lead be removed from the berms using a soil washing process that has been successfully used at similar small arms firing range sites. This process has been shown to reduce the lead concentration in soils to well below the 500 ppm screening action level (e.g., Saracino and Parent, attached). Soil samples will be taken throughout the soil washing process to gauge its effectiveness and to ensure that no hazardous materials escape to the environment.

1.1 Previous Studies

The USFS conducted a study of the area in 1991. At that time 11 of 21 samples taken from the SWMU failed the TCLP test for heavy metals. This was believed to be due to the presence of lead bullets and fragments within the earthen berms. The USFS stated that the TCLP test did not reproduce the essentially pH-neutral soil conditions at the site and that the lead-contaminated soil did not constitute a release of a hazardous substance under the Comprehensive Environmental Response, Liability, and Compensation Act. In addition, they stated that the lead in the earthen berms does not constitute a threat to the ground water in the area due to the great depth to water (approximately 1300 feet below ground surface). The results of this study were reported by the USFS to the U.S. Coast Guard National Response Center in a letter dated 13 April 1993 (attached).

Studies conducted by the Naval Engineering Laboratory indicate that metallic (elemental) lead is the prime contaminant in small arms firing ranges (Heath *et al.*, attached). Other forms of lead, such as oxidized lead, are not commonly found in small arms ranges and would not be expected to be common in the arid environment found in Los Alamos.

All samples will be analyzed for lead. Ten percent of the samples collected will also be analyzed for compounds commonly found in small arms ranges. This list will include lead, copper, and zinc, the three most common contaminants found in small arms ranges (Heath *et al.*, attached). These additional analyses will serve to provide further evidence that any soil contamination from the small arms range has been remediated during the soil washing process.

1.2 Cleanup Levels

The LANL screening action level (SAL) for lead in soils is 500 ppm. This SAL is derived from a generic facility risk assessment based on the assumption that sites will be designated for residential use. This is also the lower cleanup level established by the U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response Directive 9355.4-02 and the New Mexico Environment Department's approved level for lead in soils. The level of 500 ppm will be used as an upper boundary for lead in soils for this VCA.

It is expected, based upon previous experience with this soil washing process, that cleanup levels well below the 500 ppm level for lead in soil will be achieved at SWMU 0-016.

2.0 Soil Washing Process

Lead will be removed from the earthen berms at SWMU 0-016 by a soil washing process that uses a modified sand and gravel plant to separate metallic lead from the soil. Soil will be transferred from the berms to the soil washing plant using front-end loaders. The soil will be sprayed with water if significant amounts of dust are created during this transfer.

All of the earthen berms at the site and up to one foot of soil from the floor of the firing range will be processed to remove lead. While lead is expected to be concentrated in the berms located at the rear of the small arms range (the backstop berms), this additional soil processing will help to ensure that no lead-contaminated soil will remain at the site.

This soil washing process operates on the principle that most soil particles have average densities of 3 to 4 grams per cubic centimeter (g/cc), while particulate lead has an average density of 11.4 g/cc. This difference in average densities is used to physically separate, concentrate, and remove the fine particulate lead from the soil. Larger lead fragments and bullets will be separated from the coarse fraction of the soil by automated sieves.

The soil washing plant consists of a hopper feeder above a jigging box that is used to sort out coarser material from the soil and to retain larger lead fragments and bullets. After the larger lead fragments and bullets are removed, the remaining soil is fed into two sand screws which, in turn, feed the soil into a series of stacked power hydro-screens with 3/4", 1/4", and 1/8" openings. High-pressure water sprays are used to force the soil through these screens. The finer material that passes through these screens is then sent through a 3-foot diameter centrifugal separator. The centrifugal separator uses water and the greater density of lead to separate out the fine particulate lead.

The washed soil and associated water then flows along a drag tank where most of the soil is removed. Next, the water flows into two large recirculating ponds (200 ft. by 50 ft. each) that are used to separate out the fine soil suspended in the water and to act as reservoirs to recirculate the water used during the soil washing process. The recirculating ponds will be excavated during site preparation. The two recirculating ponds will be lined to prevent the release of any water used in the soil washing process to the environment.

The lead removed from the screens and the centrifugal separator will be placed into 55-gallon drums. The lead will then be sent by Johnson Controls, Inc., to a recycling center.

3.0 Sampling and Analysis

Sampling and analysis will consist of a comprehensive series of field and laboratory analytical techniques. The soil will be sampled as it is processed throughout the course of the project to ensure that the soil washing procedure is effective and that no contaminants are released to the environment during or after the soil washing process. The soil analyses are summarized in Table 1.

Field analyses for lead will be conducted using a Spectrace 9000 field portable X-ray fluorescence (XRF) instrument configured to detect lead in soils at low levels (below 100 ppm). The XRF and associated equipment will be housed in a portable field trailer set up at the site. A 120-volt power line will be run to the field laboratory to ensure a consistent and reliable source of electricity for the instrumentation.

Soil samples gathered for analyses in an approved environmental laboratory will be sent to the LANL ER Program Sample Coordination Facility for shipment and analysis, as established in the approved procedures published by the ER Program.

All samples will be analyzed for lead. A minority of the samples collected (approximately 10%) will also be analyzed for compounds commonly found in small arms ranges. This list will include copper and zinc.

3.1 Background Sampling

Soil samples will be gathered from areas outside the SWMU boundary from soils similar in composition to those found in the earthen berms. Approximately 20 background soil samples will be collected. These background samples will be analyzed in the field and approximately five will be analyzed by an approved environmental laboratory. The background samples will provide information on natural levels of lead in the area of SWMU 0-016.

3.2 Sampling during Soil Washing

Soil samples will be gathered from the soil washing apparatus on a regular basis. Depending on the rate at which soil is processed by the apparatus, samples will be taken at regular intervals ranging from 30 to 90 minutes. These soil samples will be used to represent a given batch of washed soil and will be analyzed by XRF in the field. If any of these soil samples are not below the cleanup level of 500 ppm, that batch of soil will be reprocessed until the lead levels are within satisfactory limits. Based upon initial contractor estimates of soil processing rates, it is expected that approximately 150 to 200 soil samples will be analyzed in the field during the soil washing process.

Soil from the recirculating ponds will be gathered and analyzed on a daily basis to ensure that lead levels are below the cleanup levels. Previous experience with this plant has shown that little, if any, lead is released into the recirculating ponds.

3.3 Airborne Lead Sampling

Airborne lead will be monitored at the site for health and safety reasons and to gauge and prevent any release of airborne lead to the environment. High-volume air samplers will be positioned both upwind and downwind of the site. Samples from the high-volume air samplers will be gathered and analyzed by XRF on a twice-daily basis. If detectable amounts of lead are found to be released during the soil washing process, engineering controls will be undertaken to prevent further airborne release of lead. Since the soil is wetted during the washing process and dry soil will be sprayed with water before handling, it is unlikely that significant amounts of lead will be released to the air. It is expected that approximately 60 to 90

samples will be gathered from the high-volume air samplers and analyzed in the field during the soil washing process.

3.4 Confirmation Sampling

Samples from the washed soil will be gathered after the soil washing process. These samples will be sent to an approved laboratory and used to confirm field analyses. One composite sample will be taken for about every 100 cubic yards of soil processed. Since the expected volume of soil is somewhat less than 2000 cubic yards, approximately 20 confirmation samples will be gathered and analyzed.

4.0 Material Disposition

Upon conclusion of the VCA, the site will contain approximately 2000 cubic yards of washed soil and the water contained in the two recirculating ponds. If the confirmation sampling shows the soil contains lead below the cleanup level, it will be left on-site for use by the new owner. The new owner will use the soil to raise the grade of the access road into the site and will then cover the road with asphalt.

The water in the two recirculating ponds will be allowed to evaporate to prevent discharge of liquid water to the environment. Recirculating pumps and sprays may be used to accelerate the evaporation.

REFERENCE CITED:

Los Alamos National Laboratory (LANL) 1992. "RFI Work Plan for Operable Unit 1071 - Environmental Restoration Program," Los Alamos National Laboratory Report LA-UR-92-810, Los Alamos, New Mexico. (LANL 1992)

LANL ER PROGRAM

OPERABLE UNIT 1071

VOLUNTARY CORRECTIVE ACTION PLAN

SWMU 0-016, INACTIVE FIRING RANGE

September 1993

Revision 1

VOLUNTARY CORRECTIVE ACTION PLAN
SWMU 0-016, INACTIVE FIRING RANGE

1.0 INTRODUCTION

Solid Waste Management Unit (SWMU) 0-016 is a former small-arms range located west of Guaje Pines Cemetery in Los Alamos, New Mexico. The site, which occupies about two acres, consisted of several small buildings and two earthen berms. At present, only concrete steps, pads, and the earthen berms remain. The target berms contain lead bullets, lead fragments, and particulate lead.

The site was used by Los Alamos National Laboratory (LANL) from the late 1940s to the 1960s for small-arms target practice. The earthen berms are estimated to contain about 1800 cubic yards of soil. The soil cover is relatively thin at the site outside of the berms, and much of the SWMU 0-016 ground surface is formed by the Bandelier Tuff. This relatively thin soil cover will reduce the additional volume of soil for soil washing. The objective of this voluntary corrective action (VCA) plan is to reduce the level of lead in the earthen berms and associated soil to levels that would allow the site to be released for public use. A report documenting all VCA activities will be submitted to the U.S. Environmental Protection Agency (EPA).

The United States Forest Service (USFS) and the County of Los Alamos have requested the cleanup of the range so that the land may be transferred from the USFS to a local developer, as part of a larger public-private land exchange. This VCA plan is being proposed, instead of following the RFI/CMS process as stated in the Operable Unit (OU) 1071 RFI Work Plan (LANL 1992), because of the time constraints placed on the Environmental Restoration (ER) Program by the pending land exchange.

This VCA plan proposes that the lead be removed from the berms using a soil washing process that has been successfully used at similar small-arms firing range sites. This process has been shown to reduce the lead concentration in soils to well below the 500 ppm screening action level (e.g., Saracino and Parent, attached). Soil samples will be taken throughout the soil washing process to gauge its effectiveness and to ensure that no hazardous materials escape to the environment.

1.1 Previous Studies

The USFS conducted a study of the area in 1991. At that time 11 of 21 samples taken from the SWMU failed the TCLP test for lead. This was believed to be due to the presence of lead bullets and fragments within the earthen berms. The USFS stated that the TCLP test did not reproduce the essentially pH-neutral soil conditions at the site and that the lead-contaminated soil did not constitute a release of a hazardous substance under the Comprehensive Environmental Response, Liability, and Compensation Act. In addition, they stated that the lead in the earthen berms does not constitute a threat to the ground water in the area due to the great depth to water (approximately 1300 feet below ground surface). The results of this study were reported by the USFS to the U.S. Coast Guard National Response Center in a letter dated 13 April 1993 (attached).

Studies conducted by the Naval Engineering Laboratory indicate that metallic (elemental) lead is the prime contaminant in small-arms firing ranges (Heath *et al.*, attached). Other forms of lead, such as oxidized lead, are not commonly found in small-arms ranges and would not be expected to be common in the semi-arid environment found in Los Alamos.

All samples will be analyzed for total lead. Ten percent of the samples collected will also be analyzed for compounds commonly found in small-arms ranges. This list will include copper and zinc, common contaminants found in small-arms ranges (Heath *et al.*, attached). These additional analyses will serve to provide further evidence that any soil contamination from the small-arms range has been remediated during the soil washing process.

1.2 Cleanup Levels

The soil will be cleaned to 500 ppm. This is the lower cleanup level established by the EPA Office of Solid Waste and Emergency Response Directive 9355.4-02 and the New Mexico Environment Department's approved level for lead in soils. The level of 500 ppm will be used as an upper boundary for lead in soils for this VCA.

It is expected, based upon previous experience with this soil washing process, that cleanup levels well below the 500 ppm level for lead in soil will be achieved at SWMU 0-016.

2.0 SOIL WASHING PROCESS

Lead will be removed from the earthen berms at SWMU 0-016 by a soil washing process that uses a modified sand and gravel plant to separate metallic lead from the soil. Soil will be transferred from the berms to the soil washing plant using front-end loaders. The soil will be sprayed with water if significant amounts of dust are created during this transfer.

All of the earthen berms at the site and up to one foot of soil from the floor of the firing range will be processed to remove lead. While lead is expected to be concentrated in the berms located at the rear of the small-arms range (the backstop berms), this additional soil processing will help to ensure that no lead-contaminated soil will remain at the site.

This soil washing process operates on the principle that most soil particles have average densities of 3 to 4 grams per cubic centimeter (g/cc), while particulate lead has an average density of 11.4 g/cc. This difference in average densities is used to physically separate, concentrate, and remove the fine particulate lead from the soil. Larger lead fragments and bullets will be separated from the coarse fraction of the soil by automated sieves.

The soil washing plant consists of a hopper feeder above a jigging box that is used to sort out coarser material from the soil and to retain larger lead fragments and bullets. After the larger lead fragments and bullets are removed, the remaining soil is fed into two sand screws which, in turn, feed the soil into a series of stacked power hydro-screens with 3/4", 1/4", and 1/8" openings. High-pressure water sprays are used to force the soil through these screens. The finer material that passes through these screens is then sent through a 3-foot diameter centrifugal separator. The centrifugal separator uses water and the greater density of lead to separate out the fine particulate lead.

The washed soil and associated water then flows along a drag tank where most of the soil is removed. Next, the water flows into two large recirculating ponds (200 ft. by 50 ft. each) that are used to separate out the fine soil suspended in the water and to act as reservoirs to recirculate the water used during the soil washing process. The recirculating ponds will be excavated during site preparation. The two recirculating ponds will be lined to prevent the release of any water used in the soil washing process to the environment.

The lead removed from the screens and the centrifugal separator will be placed into 55-gallon drums. The lead will then be sent by Johnson Controls, Inc., to a recycling center.

3.0 SAMPLING AND ANALYSIS

Sampling and analysis will consist of a comprehensive series of field and laboratory analytical techniques. The soil will be sampled as it is processed throughout the course of the project to ensure that the soil washing procedure is effective and that no contaminants are released to the environment during or after the soil washing process. The soil analyses are summarized in Table 1.

Field analyses for lead will be conducted using a Sprectrace 9000 field portable X-ray fluorescence (XRF) instrument configured to detect lead in soils at low levels (below 100 ppm). The XRF and associated equipment will be housed in a portable field trailer set up at the site. A 120-volt power line will be run to the field laboratory to ensure a consistent and reliable source of electricity for the instrumentation.

Soil samples gathered for analyses in an approved environmental laboratory will be sent to the LANL ER Program Sample Coordination Facility for shipment and analysis, as established in the approved procedures published by the ER Program.

All samples will be analyzed for lead. A minority of the samples collected (approximately 10%) will also be analyzed for compounds commonly found in small-arms ranges. This list will include copper and zinc.

3.1 Background Sampling

Soil samples will be gathered from areas outside the SWMU boundary from soils similar in composition to those found in the earthen berms. Approximately 5 background soil samples will be collected. These background samples will be analyzed for lead content in the field and for lead, copper, and zinc by an approved environmental laboratory. The background samples will provide information on natural levels of lead in the area of SWMU 0-016.

3.2 Sampling during Soil Washing

Soil samples will be gathered from the soil washing apparatus on a regular basis. Depending on the rate at which soil is processed by the apparatus, samples will be taken at regular intervals ranging from 30 to 90 minutes. These soil samples will be used to represent a given batch of washed soil and will be analyzed for lead by XRF in the field. If any of these soil samples are not below the cleanup level of 500 ppm, that batch of soil will be reprocessed until the lead levels are within satisfactory limits. Based upon initial contractor estimates of soil processing rates, it is expected that approximately 150 to 200 soil samples will be analyzed in the field during the soil washing process.

Soil from the recirculating ponds will be gathered and analyzed on a daily basis to ensure that lead levels are below the cleanup levels. Previous experience with this plant has shown that little, if any, lead is released into the recirculating ponds.

3.3 Airborne Lead Sampling

Airborne lead will be monitored at the site for health and safety reasons and to gauge and prevent any release of airborne lead to the environment. High-volume air samplers will be positioned both upwind and downwind of the site. Samples from the high-volume air samplers will be gathered and analyzed for lead by XRF on a twice-daily basis. If detectable amounts of lead are found to be released during the soil washing process, engineering controls will be undertaken to prevent further airborne release of lead. Since the soil is wetted during the washing process and dry soil will be sprayed with water before handling, it is unlikely that significant amounts of lead will be released to the air. It is expected that approximately 60 to 90 samples will be gathered from the high-volume air samplers and analyzed in the field during the soil washing process.

3.4 Confirmation Sampling

While the numerous discrete samples that will be analyzed during the soil washing process will, on their own, provide more than adequate data to confirm that the processed soil meets the cleanup level, composite samples will also be taken to increase the certainty that the cleaned soil meets the cleanup level. One composite sample will be taken for about every 100 cubic yards of soil processed. Since the expected volume of soil is somewhat less than 2000 cubic yards, approximately 20 composite confirmation samples will be gathered and analyzed. These samples will be analyzed by an approved laboratory.

Additionally, 20 judgmentally selected soil samples will be taken from randomly selected locations around the range floor and areas covered by the berms. These samples will be analyzed by XRF and 25% (5) of them also analyzed in the laboratory (see Table 1).

4.0 MATERIAL DISPOSITION

Upon conclusion of the VCA, the site will contain approximately 2000 cubic yards of washed soil and the water contained in the two recirculating ponds. If the confirmation sampling shows the soil contains lead below the cleanup level, it will be left on-site for use by the new owner. The new owner will use the soil to raise the grade of the access road into the site and will then cover the road with asphalt.

The water in the two recirculating ponds will be allowed to evaporate to prevent discharge of liquid water to the environment. Recirculating pumps and sprays may be used to accelerate the evaporation.

REFERENCE CITED:

Los Alamos National Laboratory (LANL) 1992. "RFI Work Plan for Operable Unit 1071 - Environmental Restoration Program," Los Alamos National Laboratory Report LA-UR-92-810, Los Alamos, New Mexico. (LANL 1992)

TABLE 1

Summary Table

Soil Analyses for SWMU 0-016 VCA

Sample Type	Analytical Method	Quantity	Analytes
Background	XRF (field)	5	Pb
Background	Lab	5	Pb, Cu, Zn
Washed Soil	XRF (field)	150-200	Pb
Airborne Lead	XRF (field)	60-90	Pb
Confirmation	XRF (field)	20	Pb
Confirmation	Lab	25	Pb, Cu, Zn

Notes:

All sample quantities are approximate and may vary slightly due to unforeseen field conditions.

A Sprectrace 9000 field portable X-ray fluorescence (XRF) instrument will be used to analyze for lead in soils.

"Lab" denotes samples to be analyzed by an approved environmental laboratory.

VOLUNTARY CORRECTIVE ACTION PLAN
SWMU 0-016, INACTIVE FIRING RANGE

1.0 INTRODUCTION

Solid Waste Management Unit (SWMU) 0-016 is a former small-arms range located west of Guaje Pines Cemetery in Los Alamos, New Mexico. The site, which occupies about two acres, consisted of several small buildings and two earthen berms. At present, only concrete steps, pads, and the earthen berms remain. The target berms contain lead bullets, lead fragments, and particulate lead.

The site was used by Los Alamos National Laboratory (LANL) from the late 1940s to the 1960s for small-arms target practice. The earthen berms are estimated to contain about 1800 cubic yards of soil. The soil cover is relatively thin at the site outside of the berms, and much of the SWMU 0-016 ground surface is formed by the Bandelier Tuff. This relatively thin soil cover will reduce the additional volume of soil for soil washing. The objective of this voluntary corrective action (VCA) plan is to reduce the level of lead in the earthen berms and associated soil to levels that would allow the site to be released for public use. A report documenting all VCA activities will be submitted to the U.S. Environmental Protection Agency (EPA).

The United States Forest Service (USFS) and the County of Los Alamos have requested the cleanup of the range so that the land may be transferred from the USFS to a local developer, as part of a larger public-private land exchange. This VCA plan is being proposed, instead of following the RFI/CMS process as stated in the Operable Unit (OU) 1071 RFI Work Plan (LANL 1992), because of the time constraints placed on the Environmental Restoration (ER) Program by the pending land exchange.

This VCA plan proposes that the lead be removed from the berms using a soil washing process that has been successfully used at similar small-arms firing range sites. This process has been shown to reduce the lead concentration in soils to well below the 500 ppm screening action level (e.g., Saracino and Parent, attached). Soil samples will be taken throughout the soil washing process to gauge its effectiveness and to ensure that no hazardous materials escape to the environment.

1.1 Previous Studies

The USFS conducted a study of the area in 1991. At that time 11 of 21 samples taken from the SWMU failed the TCLP test for lead. This was believed to be

due to the presence of lead bullets and fragments within the earthen berms. The USFS stated that the TCLP test did not reproduce the essentially pH-neutral soil conditions at the site and that the lead-contaminated soil did not constitute a release of a hazardous substance under the Comprehensive Environmental Response, Liability, and Compensation Act. In addition, they stated that the lead in the earthen berms does not constitute a threat to the ground water in the area due to the great depth to water (approximately 1300 feet below ground surface). The results of this study were reported by the USFS to the U.S. Coast Guard National Response Center in a letter dated 13 April 1993 (attached).

Studies conducted by the Naval Engineering Laboratory indicate that metallic (elemental) lead is the prime contaminant in small-arms firing ranges and copper and lead are possible secondary contaminants (Heath *et al.*, attached). Other forms of lead, such as oxidized lead, are not commonly found in small-arms ranges and would not be expected to be common in the semi-arid environment found in Los Alamos.

1.2 Cleanup Levels

The soil will be cleaned to 500 ppm. This is the lower cleanup level established by the EPA Office of Solid Waste and Emergency Response Directive 9355.4-02 and the New Mexico Environment Department's approved level for lead in soils. The level of 500 ppm will be used as an upper boundary for lead in soils for this VCA.

It is expected, based upon previous experience with this soil washing process, that cleanup levels well below the 500 ppm level for lead in soil will be achieved at SWMU 0-016. Once the VCA is complete, verification samples will be taken to confirm the efficiency of the process (see Section 3.4).

2.0 SOIL WASHING PROCESS

Lead will be removed from the earthen berms at SWMU 0-016 by a soil washing process that uses a modified sand and gravel plant to separate metallic lead from the soil. Soil will be transferred from the berms to the soil washing plant using front-end loaders. The soil will be sprayed with water if significant amounts of dust are created during this transfer.

All of the earthen berms at the site and up to one foot of soil from the floor of the firing range will be processed to remove lead. While lead is expected to be concentrated in the berms located at the rear of the small-arms range (the backstop berms), processing of the soil from the range floor will help to ensure that no lead-contaminated soil will remain at the site.

This soil washing process operates on the principle that most soil particles have average densities of 3 to 4 grams per cubic centimeter (g/cc), while particulate lead has an average density of 11.4 g/cc. This difference in average densities is used to physically separate, concentrate, and remove the fine particulate lead from the soil. Larger lead fragments and bullets will be separated from the coarse fraction of the soil by automated sieves.

The soil washing plant consists of a hopper feeder above a jigging box that is used to sort out coarser material from the soil and to retain larger lead fragments and bullets. After the larger lead fragments and bullets are removed, the remaining soil is fed into two sand screws which, in turn, feed the soil into a series of stacked power hydro-screens with 3/4", 1/4", and 1/8" openings. High-pressure water sprays are used to force the soil through these screens. The finer material that passes through these screens is then sent through a 3-foot diameter centrifugal separator. The centrifugal separator uses water and the greater density of lead to separate out the fine particulate lead.

The washed soil and associated water then flows along a drag tank where most of the soil is removed. Next, the water flows into two large recirculating ponds (200 ft. by 50 ft. each) that are used to separate out the fine soil suspended in the water and to act as reservoirs to recirculate the water used during the soil washing process. The recirculating ponds will be excavated during site preparation. The two recirculating ponds will be lined to prevent the release to the environment of any water used in the soil washing process.

The lead removed from the screens and the centrifugal separator will be placed into 55-gallon drums. The lead will then be sent by Johnson Controls, Inc., to a recycling center.

3.0 SAMPLING AND ANALYSIS

Sampling and analysis will consist of a comprehensive series of field and laboratory analytical techniques. The soil will be sampled as it is processed throughout the course of the project to ensure that the soil washing procedure is effective and that no contaminants are released to the environment during or after the soil washing process. The soil analyses are summarized in Table 1.

Field analyses for lead will be conducted using a Sprectrace 9000 field portable X-ray fluorescence (XRF) instrument configured to detect lead in soils at low levels (below 100 ppm). The XRF and associated equipment will be housed in a portable field trailer set up at the site. A 120-volt power line will be run to the field laboratory to ensure a consistent and reliable source of electricity for the instrumentation.

Soil samples gathered for analyses in an approved off-site analytical laboratory will be sent to the LANL ER Program Sample Coordination Facility for shipment and analysis, as established in the approved procedures published by the ER Program.

All samples will be analyzed for total lead. Ten percent of the samples collected will also be analyzed for copper and zinc found in small-arms ranges. These additional analyses will serve to provide further evidence that any soil contamination from the small-arms range has been remediated during the soil washing process.

3.1 Background Sampling

Samples will be gathered from soils outside the SWMU boundary that are similar in composition to those found in the earthen berms. A minimum of 5 background soil samples will be collected. These background samples will be analyzed in the field for lead content and by an approved off-site analytical laboratory for lead, copper, and zinc. The background samples will provide information on natural levels of lead in the area of SWMU 0-016.

3.2 Sampling during Soil Washing

Samples will be gathered from the soils processed by the washing apparatus on a regular basis. Depending on the rate at which soil is processed by the apparatus, samples will be taken at regular intervals ranging from 30 to 90 minutes. These soil samples will be used to represent a given batch of washed soil and will be analyzed for lead by XRF in the field. If any of these soil samples are not below the cleanup level of 500 ppm, that batch of soil will be reprocessed until the lead levels are within satisfactory limits. Based upon initial contractor estimates of soil processing rates, it is expected that approximately 150 to 200 soil samples will be analyzed in the field during the soil washing process.

Soil from the recirculating ponds will be gathered and analyzed on a daily basis to ensure that lead levels are below the cleanup levels. Previous experience with this plant has shown that little, if any, lead is released into the recirculating ponds.

3.3 Airborne Lead Sampling

Airborne lead will be monitored at the site for health and safety reasons and to gauge and prevent any release of airborne lead to the environment. High-volume air samplers will be positioned both upwind and downwind of the site. Samples from the high-volume air samplers will be gathered and analyzed for lead by XRF on a twice-daily basis. If detectable amounts of lead are found to be released during the soil washing process, engineering controls

will be undertaken to prevent further airborne release of lead. Since soil will be sprayed with water before handling and the soil in the soil processing system is wetted during the washing process, it is unlikely that significant amounts of lead will be released to the air. It is expected that approximately 60 to 90 samples will be gathered from the high-volume air samplers and analyzed in the field during the soil washing process.

3.4 Confirmation Sampling

While the numerous discrete samples that will be analyzed during the soil washing process will, on their own, provide more than adequate data to confirm that the processed soil meets the cleanup level, samples will also be taken to increase the certainty that the cleaned soil meets the cleanup level. One sample will be taken from each pile of about 100 cubic yards of processed soil by running a sampling scoop from the bottom to the top of the pile. Since the expected volume of soil is somewhat less than 2000 cubic yards, approximately 20 confirmation samples will be gathered and analyzed. These samples will be analyzed by an approved off-site analytical laboratory.

Additionally, 20 judgmentally selected soil samples will be taken from randomly selected locations around the range floor, areas covered by the berms, and 3 of these samples from first-order drainages that capture the bulk of the surface water from the site. These samples will be analyzed by XRF in the field and 25% (5) of them will also be analyzed in an approved off-site analytical laboratory (see Table 1).

4.0 MATERIAL DISPOSITION

Upon conclusion of the VCA, the site will contain approximately 2000 cubic yards of washed soil and the water contained in the two recirculating ponds. If the confirmation sampling shows the soil contains lead below the cleanup level, it will be left on-site for use by the new owner. The new owner will use the soil to raise the grade of the access road into the site and will then cover the road with asphalt.

The water in the two recirculating ponds will be allowed to evaporate to prevent discharge of liquid water to the environment. Recirculating pumps and sprays may be used to accelerate the evaporation.

REFERENCE CITED:

Los Alamos National Laboratory (LANL) 1992. "RFI Work Plan for Operable Unit 1071 - Environmental Restoration Program," Los Alamos National Laboratory Report LA-UR-92-810, Los Alamos, New Mexico. (LANL 1992)

TABLE 1

Summary Table

Soil Analyses for SWMU 0-016 VCA

Sample Type	Analytical Method	Quantity	Analytes
Background	XRF (field)	5	Pb
Background	Lab	5	Pb, Cu, Zn
Washed Soil	XRF (field)	150-200	Pb
Soil from Ponds	XRF (field)	~20	Pb
Airborne Lead	XRF (field)	60-90	Pb
Confirmation (range floor)	XRF (field)	20	Pb
Confirmation (range floor and soil piles)	Lab	25	Pb, Cu, Zn

Notes:

All sample quantities are approximate and may vary slightly due to unforeseen field conditions.

A Sprectrace 9000 field portable X-ray fluorescence (XRF) instrument will be used to analyze for lead in soils.

"Lab" denotes samples to be analyzed by an approved off-site analytical laboratory.

EK ID 56802.

LOS ALAMOS NATIONAL LABORATORY
ENVIRONMENTAL RESTORATION PROGRAM
OPERABLE UNIT 1071

VOLUNTARY CORRECTIVE ACTION PLAN
SWMU 0-016, FORMER SMALL-ARMS RANGE

Revision 3
7 February 1994

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1. INTRODUCTION

The United States Forest Service (USFS) and the County of Los Alamos have requested the cleanup of Solid Waste Management Unit (SWMU) 0-016, the former small arms range immediately west of Guaje Pines Cemetery, so that the land can be transferred from the USFS to a local developer as part of a larger public-private land exchange. This Voluntary Corrective Action (VCA) plan is being proposed, instead of following the Resource Conservation and Recovery Act Facility Investigation (RFI) / Corrective Measures Study (CMS) process as presented in the Operable Unit (OU) 1071 RFI Work Plan (LANL, May 1992), because of the time constraints placed on the Environmental Restoration (ER) Program by the pending land exchange. This plan will provide the basis for the implementation of the VCA in a manner that is consistent with the process outlined in the Installation Work Plan for Environmental Restoration (LANL, Nov 1993).

2. SITE BACKGROUND AND ENVIRONMENTAL SETTING

2.1. Detailed Description of SWMU 0-016

SWMU 0-016 is a former small-arms range located in the Santa Fe National Forest west of Guaje Pines Cemetery in Los Alamos, New Mexico (Figure 1). The site, which occupies nearly three acres, consisted of several small buildings and several earthen berms. At present, only concrete steps, pads, and the earthen berms remain.

2.1.1. Operational History

The small-arms range was constructed for use by security forces for the Atomic Energy Commission (AEC). Construction was done after January, 1947, when control of all Manhattan Project sites was transferred to the Atomic Energy Commission (AEC). The range was used by security forces for small-arms target practice until the present firing range in Sandia Canyon was built in the early 1960s. The site has been used unofficially by the general public in the intervening years. The Department of Energy (DOE) released the range and adjacent area to the USFS in 1976.

2.1.2. Physical Setting

The former range is located on a ridge lying between two small valleys which converge about one-quarter mile to the east (Figure 1). The ephemeral streams in these valleys feed into the upper end of Rendija Canyon. The terrain at the site varies from relatively flat on the ridge top to steep grades at the edges of the site which are associated with the valley walls.

With the exception of the areas with soil berms, the site is covered by a thin veneer of soil overlying the Bandelier Tuff. In places, weathered Bandelier Tuff crops out. Soil thickness increases in the colluvial soils on the adjacent valley slopes and is thickest in the alluvial deposits in the valley bottoms.

Ephemeral surface-water conditions occur in the adjacent drainages and are associated with snow melt runoff in the spring and localized thunderstorms during the period of July through September. The main aquifer beneath the site is approximately 1300 feet below the land surface and occurs within the Puye Formation and Santa Fe Group sediments.

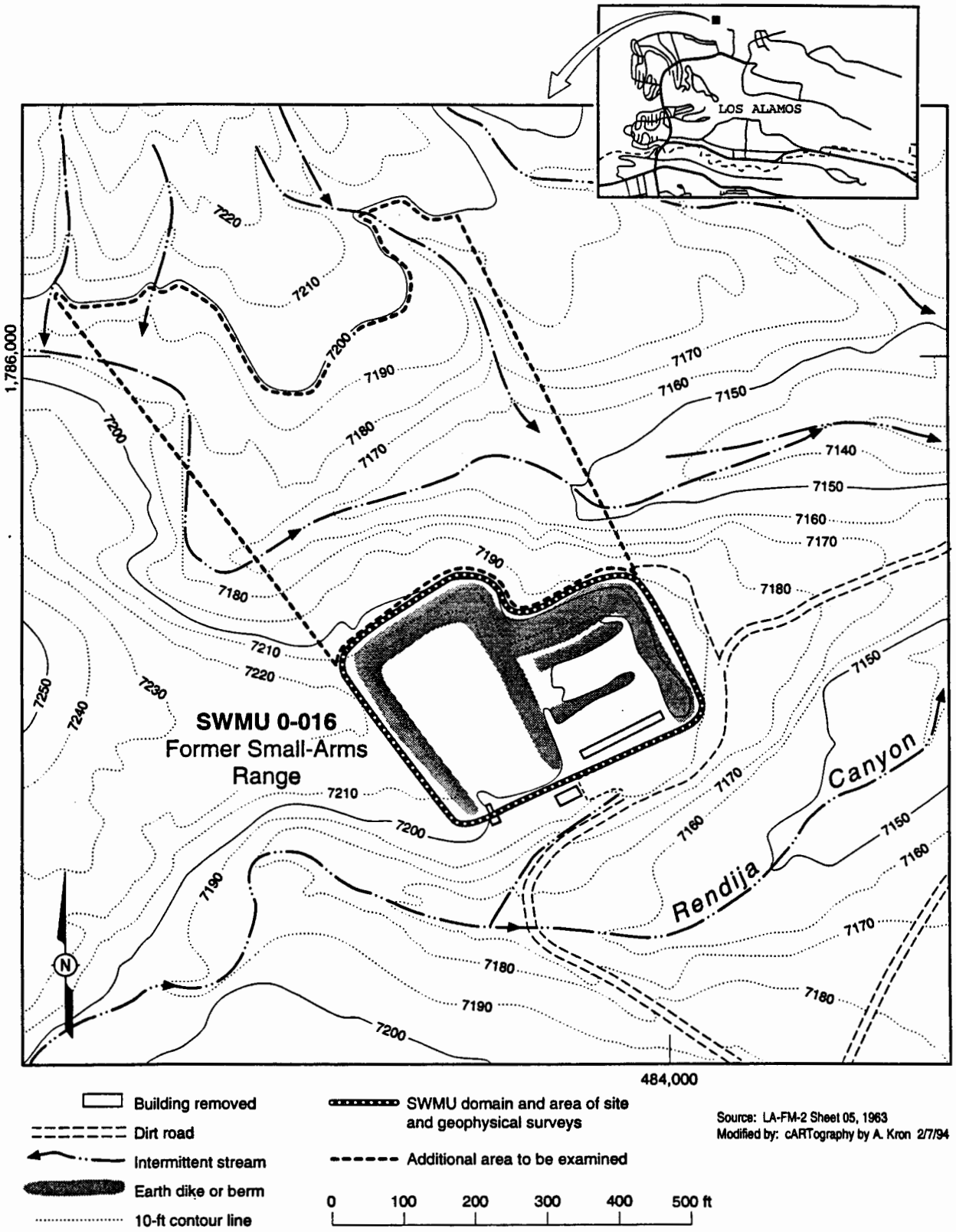

Figure 1. Location and site map of SWMU 0-016 (Former Small-Arms Range).

2.1.3. Regulatory Status of Unit

The site is a Hazardous and Solid Waste Amendments (HSWA) SWMU. This SWMU was not included in Table A of the original HSWA permit and was subsequently added to the permit as a HSWA SWMU when it was identified as a potential release site.

2.2. Summary of Previous Investigations

The USFS conducted a study of the area in 1991 in which 11 of 21 samples taken from the SWMU failed the TCLP test for heavy metals. (The data are not available, but a summary is given in Memorandum 7400, USFS, 1992, attached). This was attributed to the presence of lead bullets and fragments within the earthen berms. USFS Memorandum 7400 concludes that, because the TCLP test did not reproduce the essentially pH-neutral soil conditions at the site, the lead-contaminated soil does not constitute a release of a hazardous substance under the Comprehensive Environmental Response, Liability, and Compensation Act. The Forest Service further maintains in the memorandum that the lead in the earthen berms does not constitute a threat to the ground water in the area due to the great depth to water (approximately 1300 feet below ground surface).

Studies conducted by the Naval Engineering Laboratory indicate that metallic (elemental) lead (Pb) is the prime contaminant in small-arms firing ranges, but copper (Cu) and zinc (Zn) may also be found (Heath, *et. al.*, 1991). Other forms of lead, such as oxidized lead, are not commonly found in small-arms ranges and would not be expected to be present in the arid environment found in Los Alamos.

2.3. Types and Volumes of Waste Present

Given the purpose of the range, it is reasonable to assume that common military small-arms of the period were fired there. A variety of bullets, both bare lead and lead covered with metal jackets, in several rifle and pistol calibers have been found. Some of the bullets have shattered on impact, so that the material found varies from intact bullets to grain-sized fragments.

The SWMU domain is coincident with the boundaries of the former small-arms range and encloses nearly 3 acres (Figure 1). The target berms and part of the floor of the range covered by soil contain lead bullets, lead fragments, and particulate lead. The berms are estimated to contain about 3000 cubic yards of soil. The heaviest concentrations of bullets and lead fragments are in the target berms, but they are also present in reduced concentration in the side berms. The quantity of lead is unknown, but is expected to be no more than the volume of ten drums.

2.4. Potential Pathways of Contamination Migration

Contaminants associated with spent bullets, primarily lead, may have been released to the environment through infiltration, water entrainment and/or leaching/dispersion from the former small-arms range. As a result, contaminants that may be present in the soil can leach/ disperse through the vadose zone or be entrained by surface water and transported downstream by run-off. Unexploded cartridges may also be present at the site and may eventually be exposed by erosion.

Figure 2 presents the conceptual model for potential releases of contaminants from the former small-arms range and subsequent exposure of humans and terrestrial animals.

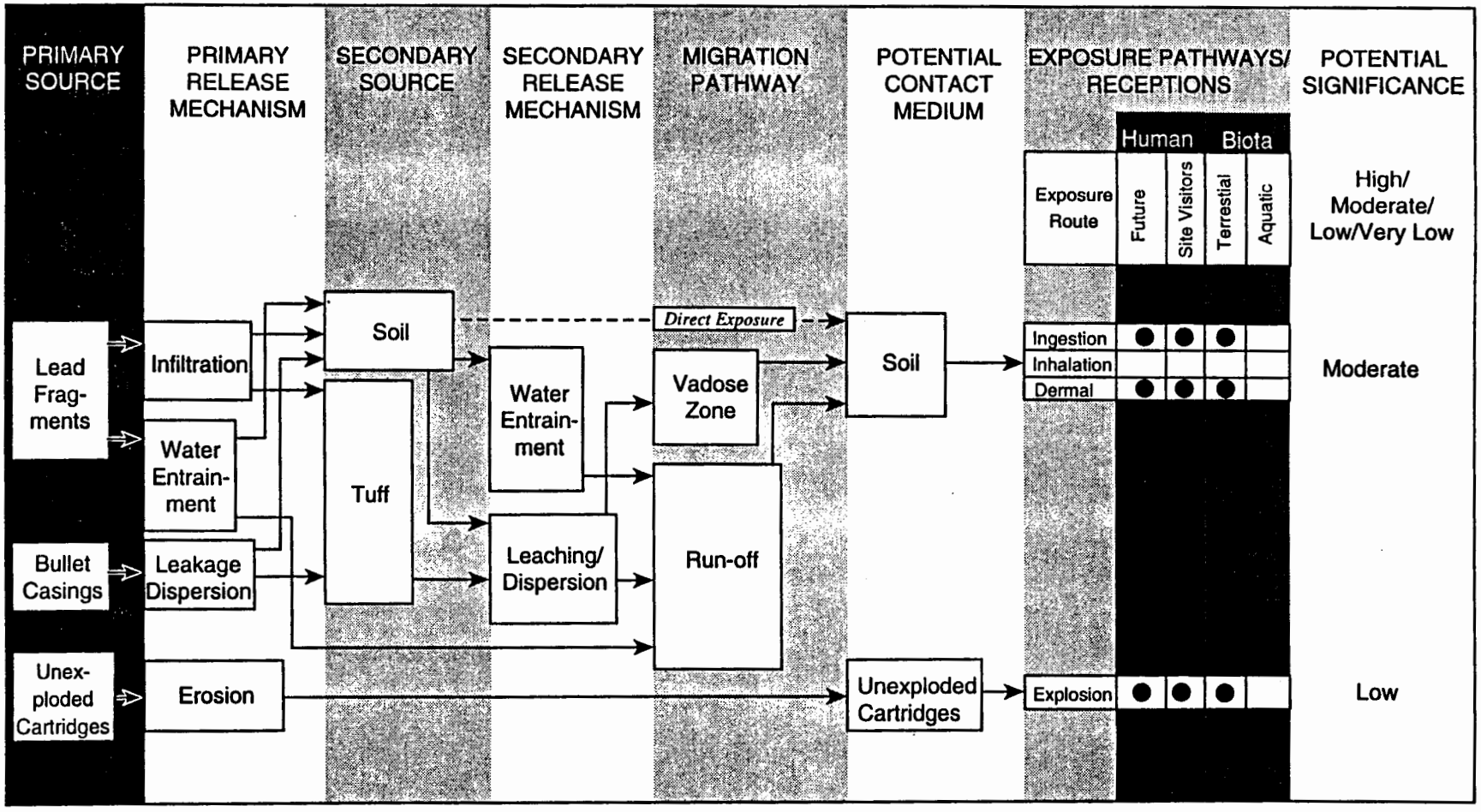

Figure 2. Conceptual model of SWMU 0-016.

In Figure 2, "future residents" refers to people who may live on the site some time in the future, and "site visitors" refers to people who walk through the site under current conditions. Terrestrial animals in the vicinity of the firing range may also be impacted.

2.5. Potential Impacts on Public Health and Environment

Based on the migration pathways described in Subsection 2.4, it is possible that contaminants are currently present in or will migrate to the soil. As a result, human exposure to contaminants from this SWMU may occur through incidental ingestion or dermal contact with soil. Unexploded cartridges present at the site would pose a potential explosion hazard should they be struck by a heavy object. Additionally, terrestrial animals may be exposed to site contaminants via incidental ingestion or dermal contact with soil.

3. VCA PLAN RATIONALE

The sampling plan for SWMU 0-016 presented in the OU-1071 RFI Work Plan calls for characterization of the site, not remediation. Since the sampling plan was completed, the USFS and a private developer have reached an agreement on a land exchange that includes the former small-arms range. To date, only the land adjacent to the range has been exchanged. The agreement calls for the range to be exchanged also, if it can be cleaned up within two years of the initial exchange. The USFS, the private developer, and the County of Los Alamos want the cleanup to be done in order to open the entire area for development, and have requested DOE to remediate the site immediately. Therefore, this VCA plan is being proposed, instead of following the RFI/CMS process as stated in the Operable Unit (OU) 1071 RFI Work Plan (LANL, May 1992).

3.1. Extent of Contamination

The nature of small-arms ranges dictates that lead bullets and lead fragments be largely restricted to the range itself, with the majority of the lead in the target berms. At SWMU 0-016, some bullets are also present in the area immediately behind the target berms. Thus, the extent of significant contamination is very limited.

Undoubtedly some shots were fired above the tops of the target berms, sending bullets miles beyond the small-arms range, but the number of bullets involved is most likely very small. Given the complete impracticality of addressing the issue of stray bullets scattered over tens of square miles, the domain of this VCA is limited to the range itself and the area immediately adjacent to it on the down-range side (area enclosed by dashed line on Figure 1)..

3.2. Remedy

Given the nature of the site, two remedies were considered: 1) Relocate the soil containing lead bullets and lead fragments to the berms on a currently active small-arms range, 2) Remove any bullets and lead particles from the soil to bring the lead concentration down to the level required for residential use. The first remedy was rejected as an option by Region 6 of the EPA, leaving the second remedy as the only option available.

The LANL screening action level (SAL) for lead in soils is 500 ppm. This SAL is derived from a generic facility risk assessment based on the assumption that sites will be designated for residential use. This is also the lower cleanup level for lead in soils in residential settings established by the U.S. Environmental Protection Agency (EPA) Office of Solid Waste and Emergency Response Directive 9355.4-02 (September, 1989) and the New Mexico Environment Department. The level of 500 ppm will be used as an upper limit for lead in soils for this VCA.

The only known, reasonably priced method of removing lead from soil is a soil washing process that has been successfully used at similar small-arms firing range sites in California and elsewhere. This process has been shown to reduce the lead concentration in soils to well below the 500 ppm screening action level (LANL, Nov 1993).

3.3. Site for Waste Treatment, Storage and Disposal

All of the equipment and the two ponds required for storing the water used in the treatment process will be located within the SWMU boundaries.

Waste storage/disposal is not required. Upon conclusion of the VCA, the site will contain approximately 3000 cubic yards of cleaned soil. The processed soil will be used by the new owner to raise the grade of the access road into the site. The new road will be finished with an asphalt surface.

The lead removed from the soil will be placed into 55-gallon drums and sent to a recycling center by Johnson Controls, Inc. Therefore, the quantity of removed lead is not a problem.

3.4. Permit Requirements

A discharge permit has been obtained for the process water that will be recirculated through two ponds from the New Mexico Environment Department, Ground Water Protection and Remediation Bureau. The water will be allowed to evaporate after the site is cleaned as a further safeguard for the environment.

An excavation permit is required for site operations. It was issued on 6 October 1993.

3.5. Impacts on Human Health and Environment, Cost, and Cleanup Schedule

Lead concentrations will be reduced below 500 ppm, thus bringing the soil within the required level for residential land use. This will ensure that there is no health risk to the future site residents or to the environment.

The total cost of environmental restoration of the site will be reduced by implementing the VCA because the cost of characterization has been eliminated. The funds originally designated for characterization can now be used to pay for part of the cleanup.

The remediation of SWMU 0-016 accelerates the final remedy for the site by about 8 years.

4. VOLUNTARY CORRECTIVE ACTION TASKS

4.1. Detailed Description of Corrective Action Activities

All of the earthen berms at the site and the top 2 feet of soil from the floor of the firing range will be processed to remove lead. The majority of lead is expected to be concentrated in the target berms located at the north end of the small-arms range. Although the berms that parallel the firing lines are presumed to contain only minor amounts of lead, they will also be processed to ensure that no lead-contaminated soil remains at the site.

Lead will be removed from the soil by a soil washing process that uses a modified sand and gravel plant to separate lead from the soil. The plant for treating the soil and the two ponds for storing the water used in the treatment process will be located within the SWMU domain (Figure 1). Soil will be transferred from the berms to the soil washing plant using front-end loaders. The soil will be sprayed with water, as necessary, to minimize the amount of lofted dust.

This soil washing process operates on the principle that most soil particles have average densities of 3 to 4 grams per cubic centimeter (g/cc), while particulate lead has an average density of 11.4 g/cc. This difference in average densities is used to physically separate, concentrate, and remove the fine particulate lead from the soil. Larger lead fragments and bullets will be separated from the coarse fraction of the soil by automated sieves.

The soil washing plant consists of a hopper feeder above a jigging box that is used to sort out coarser material from the soil and to retain larger lead fragments and bullets. After the larger lead fragments and bullets are removed, the remaining soil is fed into two sand screws which, in turn, feed the soil into a series of stacked power hydro-screens with 3/4", 1/4", and 1/8" openings. High-pressure water sprays are used to force the soil through these screens. The finer material that passes through these screens is then sent through a 3-foot diameter centrifugal separator. The centrifugal separator uses water and the greater density of lead to separate out the fine particulate lead.

The washed soil and associated water then flows along a drag tank where most of the soil is removed. Next, the water flows into two large recirculating ponds (200 ft. by 50 ft. each) that are used to separate out the fine soil suspended in the water and to act as reservoirs to recirculate the water used during the soil washing process. The recirculating ponds will be excavated during site preparation. The two recirculating ponds will be lined to prevent the release of any water used in the soil washing process.

Airborne lead will be monitored at the site for health and safety reasons and to gauge and prevent any release of airborne lead to the environment. High-volume air samplers will be positioned both upwind and downwind of the site. Samples from these air samplers will be gathered and analyzed for lead by XRF twice per day. If detectable amounts of lead are found to be released during the soil washing process, engineering controls will be undertaken to prevent further airborne release of lead. Since the soil is wetted during the washing process and dry soil will be sprayed with water before handling, it is unlikely that significant amounts of lead will be released to the air. It is expected that approximately 60 to 90 samples will be gathered from the high-volume air samplers and analyzed in the field during the soil washing process.

A Phase Report documenting the VCA, including all data and results, will be submitted to the EPA when the project is completed. Copies will be provided to the USFS and the future site owner.

4.2. Characterization of Materials for Disposal

The composition of the lead bullets and fragments is predominantly lead with minor amounts of other elements (Heath, *et. al.*, 1991). No characterization of the lead is either necessary or appropriate given the nature of the VCA. The extracted lead will be sent to a recycling center.

4.3. Criteria to Determine Effectiveness of VCA

Sampling and analysis will consist of a comprehensive series of field and laboratory analytical techniques. The soil will be sampled as it is processed throughout the course of the project to ensure that the soil washing procedure is effective and that no contaminants are released to the environment during or after the soil washing process. The soil analyses are summarized in Table 1. Chemical analyses for metals will be done using analytical method SW7421 for Pb and method SW6010 for Cu and Zn.

Field analyses for lead will be conducted using a Spectrace 9000 field portable X-ray fluorescence (XRF) instrument configured to detect lead in soils at low levels (below 100 ppm). The XRF and associated equipment will be housed in a portable field trailer set up at the site. A

120-volt power line will be run to the field laboratory to ensure a consistent and reliable source of electricity for the instrumentation.

Soil samples gathered for analyses in an approved environmental laboratory will be sent to the LANL ER Program Sample Coordination Facility for shipment and analysis, as established in the approved procedures published by the ER Program. The five background soil samples analyzed by a laboratory will also be analyzed by XRF to verify that field screening techniques yield comparable lead level results.

All samples will be analyzed for total lead. Confirmation samples will also be analyzed for copper and zinc, two other metals that commonly occur in above-background levels at small-arms ranges. These additional analyses will serve to provide further evidence that any soil contamination from the small-arms range has been remediated during the soil washing process.

Samples will be gathered from soils outside the SWMU boundary that are similar in composition to those found in the earthen berms. A minimum of 5 background soil samples will be collected from the top 6 inches of soil, following LANL-ER-SOP-6.09, "Spade and Scoop Method for Collection of Soil Samples". These background samples will be analyzed in the field for lead content and by an approved environmental laboratory for lead, copper, and zinc. The background samples will provide information on natural levels of lead in the area of SWMU 0-016.

Samples will be gathered from the soils processed by the washing apparatus on a regular basis. Depending on the rate at which soil is processed by the apparatus, samples will be taken at regular intervals ranging from 30 to 90 minutes. These soil samples will be used to represent a given batch of washed soil and will be analyzed for lead by XRF in the field. If any of these soil samples are above the cleanup level of 500 ppm, that batch of soil will be reprocessed until the lead levels are within satisfactory limits. Based upon initial contractor estimates of soil processing rates, it is expected that approximately 150 to 200 soil samples will be analyzed in the field during the soil washing process.

Soil from the recirculating ponds will be gathered daily and analyzed in the field by XRF to ensure that lead levels are below the cleanup levels. Previous experience with this plant has shown that little, if any, lead is released into the recirculating ponds.

4.4. VCA Verification Plan

The numerous discrete samples that will be analyzed during the soil washing process will provide more than adequate data to confirm that the processed soil meets the cleanup level. Post-processing samples will also be taken to increase the certainty that the cleaned soil meets the cleanup level. One sample will be taken from each pile of about 100 cubic yards of processed soil by running a sampling scoop from the bottom to the top of the pile. Since the expected volume of processed soil is around 3000 cubic yards, approximately 20 confirmation samples will be gathered. These samples will be analyzed for Pb, Cu, and Zn by an approved off-site analytical laboratory.

Additionally, 20 judgmentally selected soil samples will be taken from the top six inches of soil, following LANL-ER-SOP-6.09, "Spade and Scoop Method for Collection of Soil Samples". Seventeen sample locations will be randomly selected from the range floor and areas covered by the berms, and 3 samples will be taken from first-order drainages that capture the bulk of the surface water from the site. These samples will also be analyzed for Pb, Cu, and Zn by an approved off-site analytical laboratory (see Table 1).

TABLE 1
SUMMARY — SOIL ANALYSES FOR SWMU 0-016 VCA

Sample Type	Analytical Method	Quantity	Analytes	Text Section
Background	XRF (field)	20	Pb	4.3.2
Background	Lab	5	Pb, Cu, Zn	4.3.2
Pond soil	XRF (field)	80	Pb	4.3.3
Washed Soil	XRF (field)	150-200	Pb	4.3.3
Airborne Lead	XRF (field)	60-90	Pb	4.3.4
Confirmation	Lab	40	Pb, Cu, Zn	4.3.5

Notes:
All sample quantities are approximate and may vary slightly due to unforeseen field conditions.

A Spectrace 9000 field portable X-ray fluorescence (XRF) instrument will be used to analyze for lead in soils.

"Lab" denotes samples to be analyzed by an approved environmental laboratory.

4.5. Site Restoration Plan

The recirculating ponds will be filled and the site contoured to harmonize with the surroundings.

5. PROJECT MANAGEMENT

5.1. Staffing

Implementation of this VCA will be managed by James Aldrich, the Operable Unit Project Leader (OUPL), with assistance from Jan Novak, Assistant OUPL. Cyndy Kruger (ERM/Golder), will serve as the Field Manager. An outside contractor, Sierra Rock, Inc., is under contract to perform the soil washing.

5.2. DOE Approval

Implementation of this VCA was approved by the DOE on 23 September 1993. See FIELD WORK APPROVAL FORM, attached.

5.3. Regulatory Notification/Permit Modifications

The NMED and EPA have been notified of the planned VCA. A Class III permit modification will be submitted on completion of the project to remove the SWMU from the HSWA permit.

5.4. Stakeholder Notifications

A public tour of the site will be held prior to the start of soil processing activities. Public notifications will be placed in appropriate media and the tour will be conducted by the LANL ER Program Public Involvement Office.

The USFS and prospective future site owner have been notified of this VCA plan .

A public meeting will be held after the cleanup is completed to allow public comment on the VCA. A HSWA Class III permit modification will be submitted after the meeting.

5.5. Resource Requirements

The total cost of the VCA is estimated to be $333,000. This includes approximately $62,000 for site preparation, $105,500 for soil processing, $12,200 for sample analysis, $25,000 for site restoration, $5,100 for surveying, and $122,600 for site management.

5.6. Schedule

Site preparation was begun in the fall of 1993. Soil washing activities are expected to start in mid-March, 1994 and to require approximately 6 to 10 weeks to complete. All analytical results are expected within 40 days of the end of sample collection. Site restoration will be completed within 2 weeks of the time the last water has evaporated from the ponds.

6. REFERENCES

LANL (Los Alamos National Laboratory), May 1992. "RFI Work Plan for Operable Unit 1071 - Environmental Restoration Program," Los Alamos National Laboratory Report LA-UR-92-810.

LANL (Los Alamos National Laboratory), Nov 1993, "Installation Work Plan for Environmental Restoration", Los Alamos National Laboratory Report LAUR-93-3987.

Heath, J.C., L. Karr, V. Novstrup, and B. Nelson, 1991. "Environmental Effects of Small Arms Ranges", NCEL Technical Note N-1836, Naval Civil Engineering Laboratory, Port Hueneme, California.

7. ANNEXES

7.1. Implementation SOPs

See ENVIRONMENTAL RESTORATION STANDARD OPERATING PROCEDURES, Volumes I and II, November 17, 1993, Los Alamos National Laboratory

7.2. Quality Assurance Plan

See QUALITY PROGRAM PLAN AND QUALITY ASSURANCE PROJECT PLAN FOR ENVIRONMENTAL RESTORATION, May 1991, Los Alamos National Laboratory

7.3. Health and Safety Plan

See LANL, Nov 1993, Annex III, Health and Safety Program Plan.

7.4. Records Management Plan

See LANL, Nov 1993, Annex IV, Records Management Program Plan.

7.5. Public Involvement Plan

See LANL, Nov 1993, Annex V, Public Involvement Program Plan.

7.6. Field Work Approval

FIELD WORK APPROVAL FORM, signed 23 September 1993 (attached).

7.7. Other Documents

Memorandum no. 7400, dated 13 April 1992, USFS, Santa Fe National Forest, to the U.S. Coast Guard National Response Center (attached).

FIELD WORK APPROVAL FORM

This form must be completed prior to starting site characterization field work in Operable Units that do not have an Environmental Protection Agency-approved work plan.

I T. J. Taylor, DOE-LAAO, hereby APPROVE the field work as proposed in the accompanying memorandum for Operable Unit 1071 and as described in the DOE-approved voluntary corrective action plan for SWMU 0-016.

I _____, DOE/LAAO, DO NOT APPROVE the field work as proposed for Operable Unit 1071.

The reasons for disapproval are:

Signed: T. J. Taylor

Date: 9-23-93

United States Department of Agriculture
Forest Service
Santa Fe National Forest
P.O. Box 1689
Santa Fe, NM 87504
505 988-6940

Reply To: 7400

Date: April 13, 1992

National Response Center
United States Coast Guard Headquarters
Rm 2611
2100 2nd St. SW
Washington, DC 20593

To Whom it May Concern,

The Santa Fe National Forest is writing to advise you of a situation occurring on lands currently being administered by the Santa Fe National Forest. These lands were previously withdrawn from the Santa Fe National Forest by the Department of War in connection with the Manhattan Project, and were most recently managed by the Department of Energy as a shooting range. These lands are currently under consideration for exchange. The future use of the site could potentially be a residential area.

The Forest Service is providing this information pursuant to 42 U.S.C. 9663. As suggested by 40 CFR 300.405(d), the following information is being provided:

a) The site is referred to as the Cemetery Tract Shooting Range. It is located on Santa Fe National Forest administered lands. The site is adjacent to the City of Los Alamos, in Los Alamos County, New Mexico. The legal description is T19N, R6E, SE 1/4 of Section 4.

b) The type of material present on the site is lead slugs from small arms ammunition.

c) The size of the material ranges from large caliber bullets to grain size fragments. It is estimated that there are several tons of lead slugs in approximately 870 Cubic Yards of potentially contaminated material.

d) The shooting range has been in use since the early 1940's when the site was withdrawn from the Santa Fe National Forest by the Department of War for the Manhattan Project.

e) The DOE released the shooting area and adjacent land back to the National Forest in 1976, after it had been out of service for a while. The site has been used unofficially by the general public in the intervening years. Since that release to the National Forest the DOE declared this site a Solid Waste Management Unit (SWMU).

Since this site was declared a SWMU, it was required that we run a Total Concentrate Leaching Procedure (TCLP) test on soil samples from the site. We question how well this test replicates the natural conditions of the Cemetary Tract since no other waste was apparent, and the site has not been used as a landfill or dump to the best of our knowledge. Preliminary tests of soil samples collected from the site resulted in 11 out of 21 samples failing the TCLP test for leachability of heavy metals. This process is EPA's litmus test for contaminated soil to indicate if enough heavy metal is present to be leached under certain acidic conditions. The acidic level used in the test ranges from a pH of 2.83 to 2.92. In this instance, the samples that failed the test were from backstop berms in the old shooting range.

The TCLP test may be valid for sites that are located in areas or regions that have acid rains, acid dry deposition, or naturally high acid soil conditions, within close proximity to water. However, this is not the case for the old shooting range at Los Alamos. There is a deposit of lead slugs at the site that will leach sufficient amounts of lead to fail the TCLP test when subjected to an artificial acidic condition. The on-site soils at the old shooting range vary in pH from 6.4 to 7.4, with the average pH being 6.97 which is essentially neutral. Therefore, leaching of the lead shot is not likely unless some drastic change occurs at the site.

Possible ground water contamination is an issue raised by the New Mexico Environmental Department and the Environmental Protection Agency. The shooting range is located on top of a small ridge that is composed of the top member of the Bandelier Tuff (Tshirege Member), with associated soils. The thickness of this volcanic unit is about 600 feet. The Bandelier overlies the Puye Formation which is lithic tuff and lahar (mud flow) unit, which is about 700 feet thick. Both of these units overlie the Santa Fe Formation that is an arkosic sediment. The Santa Fe Formation would be the unit that would be the ground water bearing unit. It is unlikely that this unit would ever be adversely effected by the lead shot deposit setting about 1,300 feet above. It is possible, but unlikely, that a stratified water table would exist between the shooting range and the Santa Fe Formation.

The Forest Service, however, takes the position that a Comprehensive Environmental Response Liability and Compensation Act (CERCLA) release of a reportable quantity of a hazardous substance has not occurred at the site for the following reasons:

1) The ammunition is exempt from CERCLA requirements due to the consumer product exemption (42 USC 9601(a)).

2) The lead particles of the size found at the site are not required to be reported by 40 CFR 302.6(d).

3) The TCLP test does not replicate leachability found under the natural conditions occurring at this site.

Until we are advised otherwise, we will assume that we have complied with any possible 42 USC 9603 reporting requirements. We will also assume that until otherwise notified, the Cemetery Tract Shooting Range site will not be registered with the NRC or listed on the Federal Agency Hazardous Waste Compliance Docket. The national ramifications of this situation would be extraordinary since every formal and informal shooting range would be required to be reported under 42 USC. 9603.

Recognizing the potential use of the site, and it's current designation as a SWMU, it is the intention of the Forest Service to work with the Department of Energy to address how to best contain the material prior to the land being exchanged. Final disposition of this matter can not be resolved until there is an official resolution to CERCLA concerns.

If EPA does not agree with the position outlined in this notice, please notify me within 30 days.

Al Defler
FOREST SUPERVISOR

cc: OGC (Pitt)
DOE
RO ENG (H.Kringler)
Espanola Ranger District
EPA Region 6 (J. Burleson)
City of Los Alamos

ER ID 54839.2

Voluntary Corrective Action Plan for

Potential Release Site

0-016

Inactive Small-Arms Firing Range

Field Unit 1

ENVIRONMENTAL
RESTORATION
PROJECT

June 1996
Revision 0

A Department of Energy
Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY
LA-UR-96-XXX

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ATTACHMENTS

ATTACHMENT A. Storm Water Pollution Prevention Plan for TA-72

ATTACHMENT B. Sampling and Analysis Plan for Confirmation/Verification Sampling

1.0 INTRODUCTION

The United States Forest Service (USFS) and the County of Los Alamos have requested the cleanup of Potential Release Site (PRS) 0-016, the Former Small-Arms Firing Range, prior to transfer of the land from the USFS to a local developer as part of a larger public-private land exchange. This Voluntary Corrective Action (VCA) plan is being proposed due to time constraints placed on the Los Alamos National Laboratory (LANL) Environmental Restoration (ER) Project by the pending land exchange. The site is located immediately west of Guaje Pines Cemetery (Figure 8.3-1).

An earlier VCA plan was prepared in 1993 and partially executed in 1993 and 1994. The previous VCA plan involved remediation of the firing range berms through soil washing to remove the lead and lead fragments from the soil. Approximately 6000 cubic yards (yd^3) of the lead-contaminated soil was cleaned by soil washing at the end of the 1994 field season, and approximately 5000 yd^3 remain.

At the beginning of the 1995 field season, the active Protection Technology of Los Alamos (PTLA) firing range in Tech Area 72 (TA-72) indicated several thousand cubic yards of soil was needed to improve the berms at the existing ranges. The option of moving the soil to the active PTLA firing range was considered by the New Mexico Environment Department (NMED) to be a cost-effective and "good common-sense" alternative to washing the remaining soil. Approval from the NMED to proceed with this option was not officially granted; however, the soil washing operations were discontinued based on an indication from the NMED that they would approve moving the soil if certain conditions were met. After LANL complied with the conditions of the approval, the NMED and U.S. Environmental Protection Agency (EPA) determined that the soil should not be moved without first being processed to remove the lead, or unless LANL establishes a Corrective Action Management Unit (CAMU) at the active PTLA firing range in TA-72. Due to the time required to prepare and process a CAMU application and a Class 3 permit modification, LANL has determined that the best way to move forward with the site cleanup is to remove and recycle the remaining bullets in the soil. This VCA plan provides the approach to removing a sufficient quantity of the lead from the remaining soil using an equivalent method to facilitate transferring the soil to the active PTLA firing range for re-use.

1.1 Site Type and Description

The Former Small-Arms Firing Range is located on a ridge between two small valleys which converge about one-quarter mile to the east (Figure 8.3-2). The ephemeral streams in these valleys feed into the upper end of Rendija Canyon. The terrain at the site varies from relatively flat on the ridge top to steep grades at the edges of the site which are associated with the valley walls.

With the exception of the areas with soil stockpiles, the site is covered by a thin veneer of soil overlying the Bandelier Tuff. In places, weathered Bandelier Tuff crops out. Soil thickness increases in the colluvial soils on the adjacent valley slopes and is thickest in the alluvial deposits on the valley bottoms.

Ephemeral surface-water conditions occur in the adjacent drainages and are associated with snow-melt runoff in the spring and localized thunderstorms during the period of July through September. The main aquifer beneath the site is approximately 1300 feet below the land surface and occurs within the Puye Formation and Santa Fe Group sediments.

The site is identified in Module VIII of LANL's Resource Conservation and Recovery Act (RCRA) permit, also known as the Hazardous and Solid Waste Amendments (HSWA) permit, as a Solid Waste Management Unit (SWMU) requiring a RCRA Facility Investigation (RFI). This PRS was not included in Table A of the 1990 HSWA permit and was subsequently added to the permit in 1994, via a February 1993 Class 3 permit modification.

1.1.1 Operational History

The Inactive Small-Arms Firing Range was constructed for use by security forces for the Atomic Energy Commission (AEC). Construction of the range was conducted after January, 1947, when control of all Manhattan Project sites was transferred to the AEC. The range was used by security forces for small-arms target practice until the present firing range in Sandia Canyon was built in the early 1960s. The site has been used unofficially by the general public in the intervening years. The Department of Energy (DOE) released the Inactive Small-Arms Firing Range and surrounding areas to the USFS in 1976.

1.1.2 COPCs and Rationale for Proposed Remedial Action

The composition of the bullets and fragments is predominantly lead with minor amounts of other elements. The extracted lead will be containerized and sent to a recycling center or reclamation facility.

Studies conducted by the Naval Engineering Laboratory indicate that metallic (elemental) lead (Pb) is the prime contaminant in small-arms firing ranges, but copper (Cu) and zinc (Zn) may also be found (Heath, et. al., 1991). Other forms of lead, such as oxidized lead, are not commonly found in small-arms ranges and would not be expected to be present in the arid environment found in Los Alamos. Existing analytical data indicate Cu and Zn are not present in concentrations exceeding 140 and 120 mg/kg, respectively.

2.0 SITE CHARACTERIZATION

2.1 RFI Information/Other Decision Data

The USFS conducted a study of the area in 1991 in which 11 of 21 judgmental samples taken from the backstops and other berms failed the toxicity characteristic leaching procedure (TCLP) test for lead. The data are not available, but a summary is given in Memorandum 7400, USFS, 1992; however, the contamination was attributed to the presence of lead bullets and fragments within the earthen berms. USFS Memorandum 7400 concludes that, because the TCLP test did not reproduce the essentially pH-neutral soil conditions at the site, the lead-contaminated soil does not constitute a release of a hazardous substance under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The Forest Service memorandum further maintains that the lead in the earthen berms does not constitute a threat to the ground water in the area due to the great depth to water (approximately 1300 feet below ground surface).

In 1993, the USFS and a private developer reached an agreement on a land exchange that includes the Former Small-Arms Firing Range. To date, only the land adjacent to the range has been exchanged. The agreement calls for the range to be exchanged also, if it could be cleaned up within two years of the initial exchange. Although more than two years has passed, the range land is still available to the developer, but he is now in jeopardy of losing it. The USFS, the private developer, and the County of Los Alamos want the cleanup to be completed in order to open the entire area for development, and have requested DOE to remediate the site immediately.

2.2 Nature and Extent of Contamination

The nature of small-arms ranges dictates that lead bullets and lead fragments be largely restricted to the range itself, with the majority of the lead in the target and backstop berms. At PRS 0-016, bullets were also found to be present in the area immediately behind the backstop berms. Thus, the extent of significant contamination is very limited. The area behind the backstop berms was found to contain a significant number of bullets upon initial investigation, and was subsequently cleaned up in 1994 by removing the soils containing elevated levels of lead. These soils were added to the stockpiled soils in the central portion of the site.

3.0 PROPOSED REMEDY

3.1 Description of the Proposed Remedial Action

Approximately 5000 yd^3 of stockpiled soil will be processed to remove the lead bullets. Most of the bullets in the soil are approximately .38 caliber. A dry screening process will be used to separate out the fraction of the soil that contains bullets of this size. Removal of the bullet-size fraction of the soils will greatly reduce the total lead content and lead leachability. Depending on the amount of oxidation, the bullets could leach on the order of 2 percent of the lead.

The bullets will be separated from the stockpiled soil using a sand and gravel dry-sieving apparatus, referred to as a Shaker Plant, that is equipped with various sizes of slotted wire screens. The soil will be processed through the Shaker Plant twice to facilitate removal of the fraction containing the bullets (bullet-size). First, the soil will be sieved using a 3/16-inch screen which will allow the material that is finer than the bullet-size fraction (fines) to be segregated from the bullets and larger material. The fines will be stockpiled and sampled at regular intervals for waste characterization. This larger fraction, containing the bullets, will then be sieved a second time using a 1/2-inch screen which will allow the bullets and bullet-sized material to pass through, and all materials greater than 1/2-inch (oversize) will be captured by the screen. The screen sequence may be reversed, if necessary, to increase the efficiency and effectiveness of the process. The oversize fraction consisting of boulders, cobbles, and larger gravels (>1/2 inch) will be considered non-hazardous because the bullets and fines will have been removed from this fraction through the sieving process. Visual observation will be used as a guide to determine if uncommonly large lead slugs (>50 caliber) or clods of fine material are present in the oversize fraction.

The processed soil will be sampled for waste characterization in 25 yd^3 units to ensure adequate characterization and facilitate waste minimization. One representative soil sample will be collected from each 25 yd^3 unit of processed soil at a randomly selected location on each pile and analyzed for lead by TCLP. Sample collection will be conducted using a thin-wall tube sampler with a length of 5 feet and a diameter of 1.5 inches. The sampler will be advanced to its entire length into each stockpile at a single location, to collect a composite sample of soil ranging from the middle of the outer flank (side-slope) to the center of the pile, as illustrated on Figure 8.3-5. Because each 25 yd^3 stockpile consists of six loader buckets of material at 4.2 yd^3 per bucket, that are placed consecutively on top of each other, the first bucket-load removed from the shaker is located at the bottom center of the stockpile and the last bucket-load is essentially the outer surface of the pile (Figure 8.3-5). The 25 yd^3 stockpiles are 6 feet high and 20 feet wide at the base, therefore, the distance from the middle of the side-slope to the center of the pile is

approximately 5 feet. The 5-foot core of soil extracted from each pile of fines will be thoroughly homogenized before being placed in a sample container for subsequent laboratory analysis. If the TCLP lead concentration in the soil exceeds the RCRA hazardous waste limit of 5 mg/L, the soil will be managed as hazardous waste.

Visual observations will also be used as a guide to segregating soils with potentially higher lead concentrations. As the soil is processed through the Shaker Plant, observations will be made as to how many bullets accumulate on the screen with respect to the quantity of soil passing through the plant. If observations indicate that there is a relatively high density of bullets in portions of the soil, then these materials will be segregated from soils that yield fewer bullets until analytical results are available to characterize the material.

Soil will be transferred from the soil stockpiles to the Shaker Plant using a front-end loader. The soil and range floor will be sprayed with water, as necessary, to minimize the amount of lofted dust. Total airborne dust will be visually monitored at the site in accordance with the Site-Specific Health and Safety Plan (SSHASP) dated 26 March 1996. Personnel and area monitoring for lead was conducted during the Shaker Plant pilot study to determine if there was a potential for site workers to be exposed to airborne lead during soil processing operations. The results of the personnel and area monitoring indicate that there are no lead inhalation concerns at the site, and monitoring has been discontinued based on this initial negative determination, in accordance with 29 CFR 1926.62 (Lead Standard).

A VCA Report will be prepared and submitted to the EPA when the project is completed. Copies will be provided to the USFS and the future site owner.

3.2 Comparison of Soil Washing and Shaker Plant Processes

A Shaker Plant pilot study was conducted at the site in April 1996 to determine the effectiveness of the dry-sieving process on the soils present at PRS 0-016. The results of the pilot study indicate that the Shaker Plant process is comparable to Soil Washing for removing lead bullets and fragments from the firing range berm material, and either method would be equally effective for removing lead from the soils to the extent that cleanup levels are achieved. Based on archival data, Soil Washing operations, and the Shaker Plant pilot study, the soils at the Inactive Firing Range do not contain a significant amount of fine lead fragments with respect to the bulk of the lead, that is contained in the bullet-size fraction (>$^3/_{16}$ and ≤$^1/_2$-inch). This bullet-size fraction is extracted from the soils through the Shaker Plant process and contains bullets ranging from .22 to .50 caliber, and all fragments greater than $^3/_{16}$-inch. Although Soil Washing can extract some of the finer lead fragments, there is little benefit over dry sieving because abundant fine lead is not characteristic of the soils at this site. Both Soil Washing and Dry Sieving are physical separation methods that

extract lead as a function of size and/or density. Dissolved or leachable lead, if present at elevated concentrations, can not be extracted or otherwise processed out by either method.

A total of 375 cubic yards (15 piles of 25 yd^3 each) of fine soils was generated during the Shaker Plant pilot study. Each of the 15 piles of fines was sampled for total lead by x-ray fluorescence (XRF) and inductively-coupled plasma (ICP)/atomic emission spectroscopy (SW 846 Method 6010), and for TCLP metals. Analytical results for total lead in processed soils from the Shaker Plant were compared to processed soils from soil washing operations conducted at the site in 1994, as illustrated on Figures 8.3-3 and -4, for ICP and XRF, respectively. Total lead concentrations (ICP) in soils processed through the Shaker Plant ranged from 56 to 340 mg/kg with a mean of 99 mg/kg, and by comparison, soils processed through the Soil Washing Plant contained total lead concentrations (ICP) ranging from 5 to 660 mg/kg with a mean of 102 mg/kg. XRF results for total lead in soils processed through the Shaker Plant ranged from below the detection limit of 19 ppm to a maximum of 87 ppm, and XRF results for total lead in soils from the soil washing process ranged from below the detection limit of 19 ppm to a maximum of 268 ppm. This data comparison demonstrates that both methods effectively remove total lead to concentrations well below the target level of 400 ppm.

3.3 Basis for Cleanup Levels

Cleanup levels for the soil stockpiles (following removal of the bullets) will be based on the RCRA hazardous waste determination limit of 5 mg/L for TCLP lead. Processed soils that meet this criteria will be moved to the active PTLA Firing Range in TA-72.

Lead concentrations at the Former Small-Arms Firing Range, following the removal of the soil stockpiles, will be at or below the LANL Screening Action Level (SAL) of 400 ppm. This SAL for chemical constituents is based on EPA Region IX preliminary remediation goals for residential soil, and will ensure that there is minimal health risk to future site residents and to the environment. Verification/confirmation samples will be collected from the range floor to ensure that all soils containing total lead concentrations above the SAL have been removed from the site.

3.4 Site Restoration

Following VCA activities, the site will be released to the USFS for completion of the land transfer to the land developer. Site restoration activities will be minimal, at the request of the land developer.

4.0 WASTE MANAGEMENT

4.1 Estimated Types and Volumes of Waste

The types of waste and recyclable materials to be generated as a result of the VCA activities will include the bullet-size fraction to be recycled, processed soil (fines) that is non-hazardous; oversize material that is non-hazardous, and possibly, processed soil that is hazardous. All of these materials will be re-used or recycled, with the exception of the processed soil that is determined to be hazardous, if any.

It is estimated that approximately 300 yd^3 of material comprised of bullets and bullet-size gravels will be generated and stored on-site until arrangements are in place to transfer the lead/gravel to a recycling center or reclamation facility. If the bullets comprise less than 50 percent of the gravel mixture by volume, based on visual observation, further separation and processing will be conducted to reduce the amount of gravel in the mixture. The gravel must consist of a minimum of 50 percent bullets by volume to be acceptable for recycling or reclamation.

The processed soil that is determined to be non-hazardous based on TCLP lead analysis, will be stockpiled on-site pending transfer to the active PTLA Firing Range (TA-72) for re-use as firing range berm material.

The soils processed through the Shaker Plant are not expected to exceed the TCLP limit for lead; however, in the event that portions of the material are determined to be hazardous based on TCLP lead analysis, these portions will be segregated, properly contained, and stored on-site until proper shipping and disposal can be arranged.

4.2 Method of Management and Disposal

The processed soil (fines) that is determined to be non-hazardous will be stockpiled on-site pending transfer to the TA-72 PTLA Firing Range. Soil (fines) that is determined to be hazardous will be containerized and stored on-site pending appropriate transportation and disposal at a LANL-approved treatment, storage, and disposal facility (TSDF). The bullet-size fraction will be stored on-site pending transfer to a recycling center or smelting facility. The oversize fraction will be stockpiled on-site pending transfer to a LANL facility for use as fill material in an industrial application.

4.3 Placement and Management of Processed Soils at TA-72

The processed soils provided to TA-72 will be used to construct firing range berms to improve the current configuration of the active PTLA firing lanes. Concerns regarding the potential for berm material to erode into the wash that

passes through the range area have been addressed through development of a Storm Water Pollution Prevention (SWPP) Plan for TA-72 (Attachment A). The SWPP Plan describes the soil placement and structural controls that will be emplaced to divert surface water away from the firing range berms and prevent potential erosion and transport of materials that may contain elevated total lead concentrations.

5.0 DESCRIPTION OF CONFIRMATORY/VERIFICATION SAMPLING

Following removal of the soil stockpiles containing bullets, samples will be collected from the firing range floor and from first-order drainages that originate on the site in accordance with the Sampling and Analysis Plan (Attachment B). If samples indicate the presence of lead concentrations above the cleanup level, the soils will be further excavated and added to the soil to be processed through the Shaker Plant.

Twenty discrete grab samples will be collected from the upper 6 inches of the firing range floor to confirm that all soils containing total lead concentrations above 400 ppm have been removed from the site. Sample locations will be determined through random selection of twenty cells on a grid, with a 50-foot spacing, projected over the entire range area. An additional three discrete grab samples will be collected from the upper 6 inches of sediment in first-order drainages that capture the bulk of the surface water from the site. Locations of channel sediment samples will be determined in the field, based on examination of the surface drainage system.

Confirmation/verification samples will be analyzed by an approved contract laboratory for total lead, copper, and zinc by EPA SW-846 Method 6010.

6.0 ESTIMATED TIME TO COMPLETE THE ACTION AND UNCERTAINTIES

The estimated duration of the VCA activities is 8 weeks. Mobilization of equipment and site preparation will require approximately 1 week and Shaker Plant soil processing will require approximately 6 weeks. Verification sampling will require approximately 1 week. Soil hauling will be conducted simultaneously with Shaker Plant processing operations.

7.0 REFERENCES

Heath, J.C., L. Karr, V. Novstrup, and B. Nelson, 1991, "Environmental Effects of Small Arms Ranges," NCEL Technical Note N-1836, Naval Civil Engineering Laboratory, Port Hueneme, California.

United States Forest Service, Santa Fe National Forest, 13 April, 1992, Memorandum No. 7400, to the U.S. Coast Guard National Response Center.

8.0 ANNEXES

ANNEX 8.1

Risk-Based Cleanup Level Assumptions and Calculations

The cleanup level for PRS 0-016 is based on the LANL Chemical SAL of 400 ppm for lead in soil. SALs for chemical constituents are based on EPA Region IX preliminary remediation goals for residential soil, and will ensure that there is minimal risk to future site residents and to the environment. No site-specific calculations or risk analyses are necessary for this site.

ANNEX 8.2

RFI Analytical Results

This section does not apply because no RFI field investigations have been conducted at this site. VCA analytical results are provided in Section 3.2 of this VCA plan.

ANNEX 8.3

Site Maps and Figures

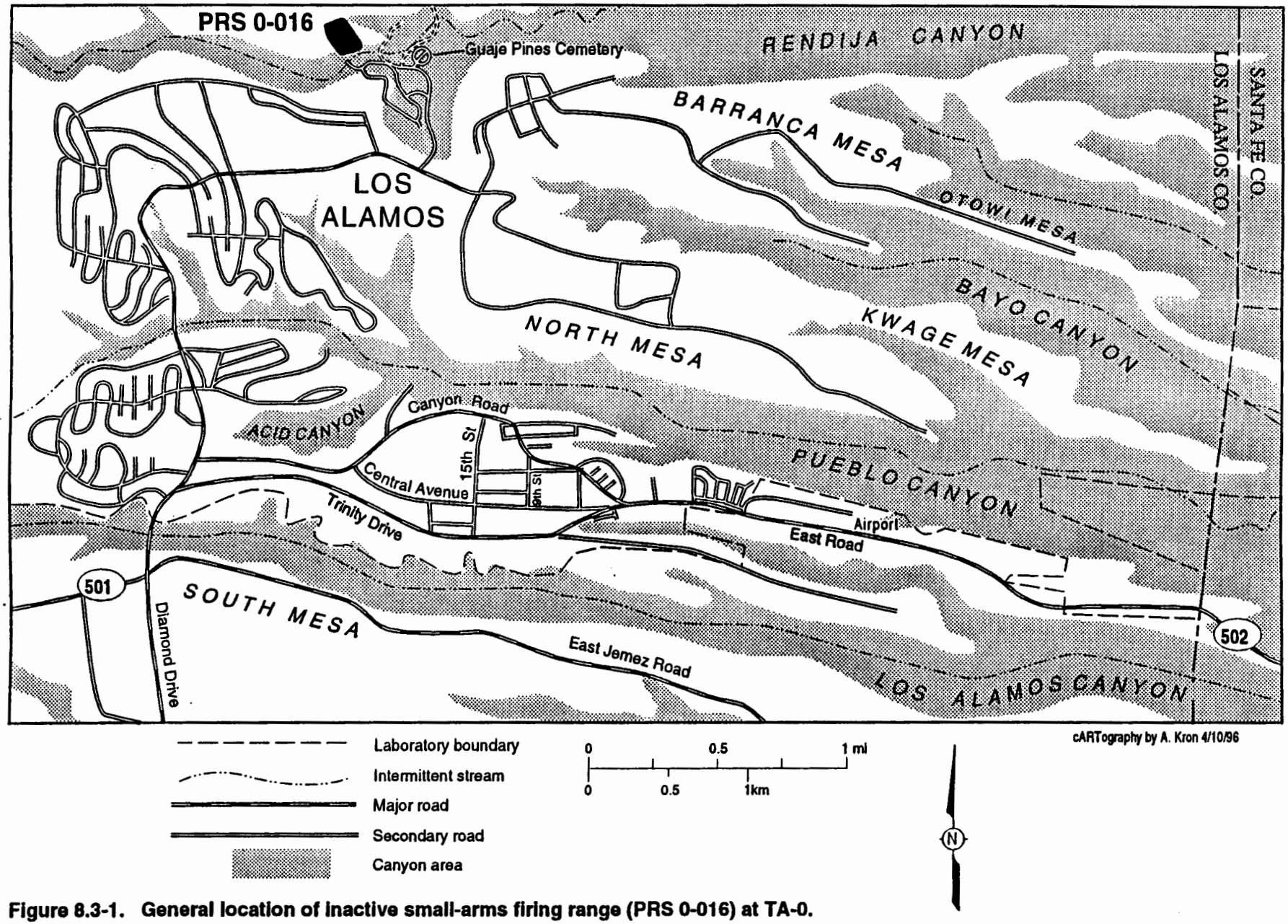
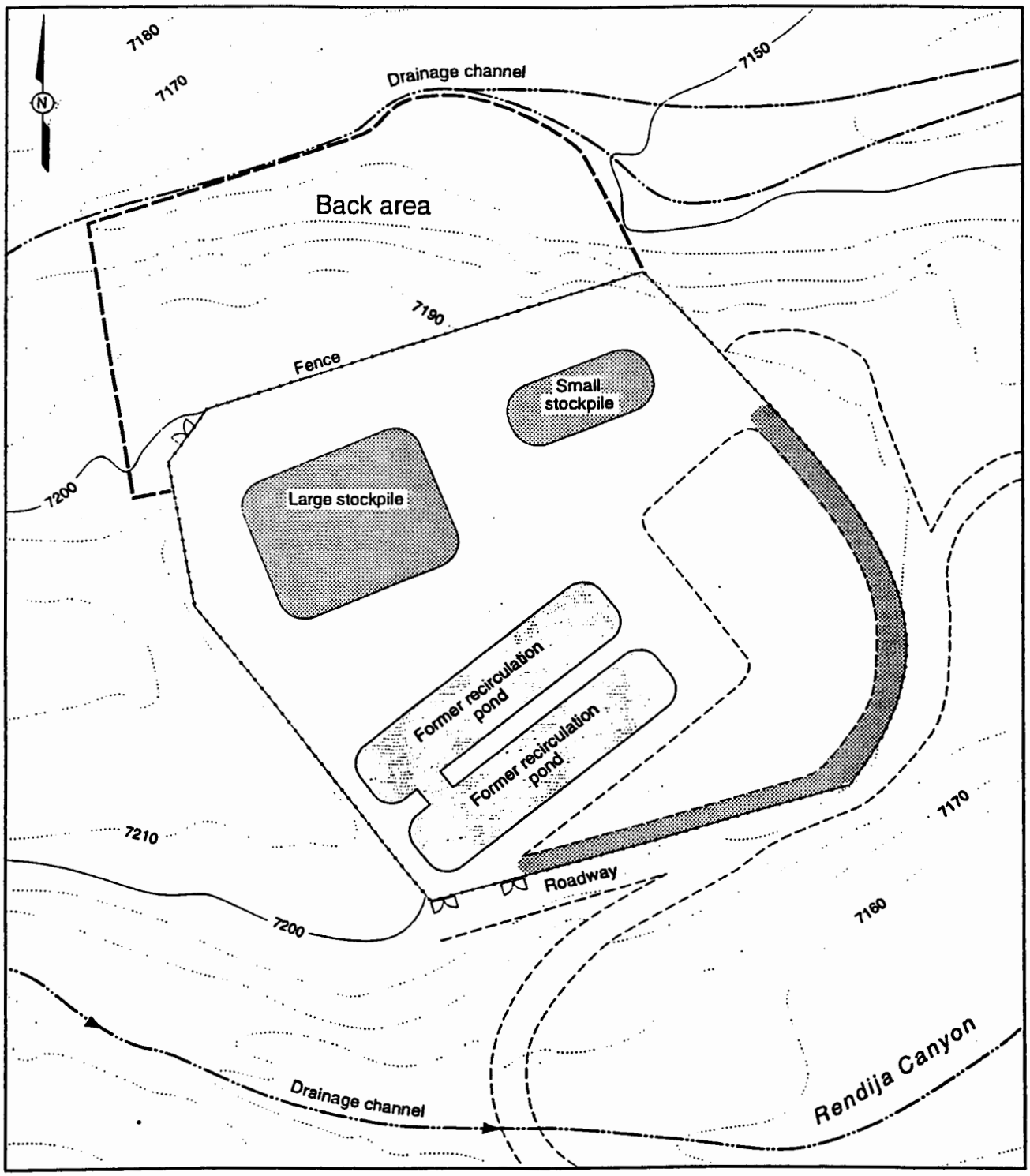


Figure 8.3-1. General location of inactive small-arms firing range (PRS 0-016) at TA-0.



Soil stockpile locations are approximate

Approximate Scale

0 100 200 ft

cARTography by A. Kron 4/2/96

Figure 8.3-2. Inactive Small-Arms Firing Range site map, PRS 0-016.

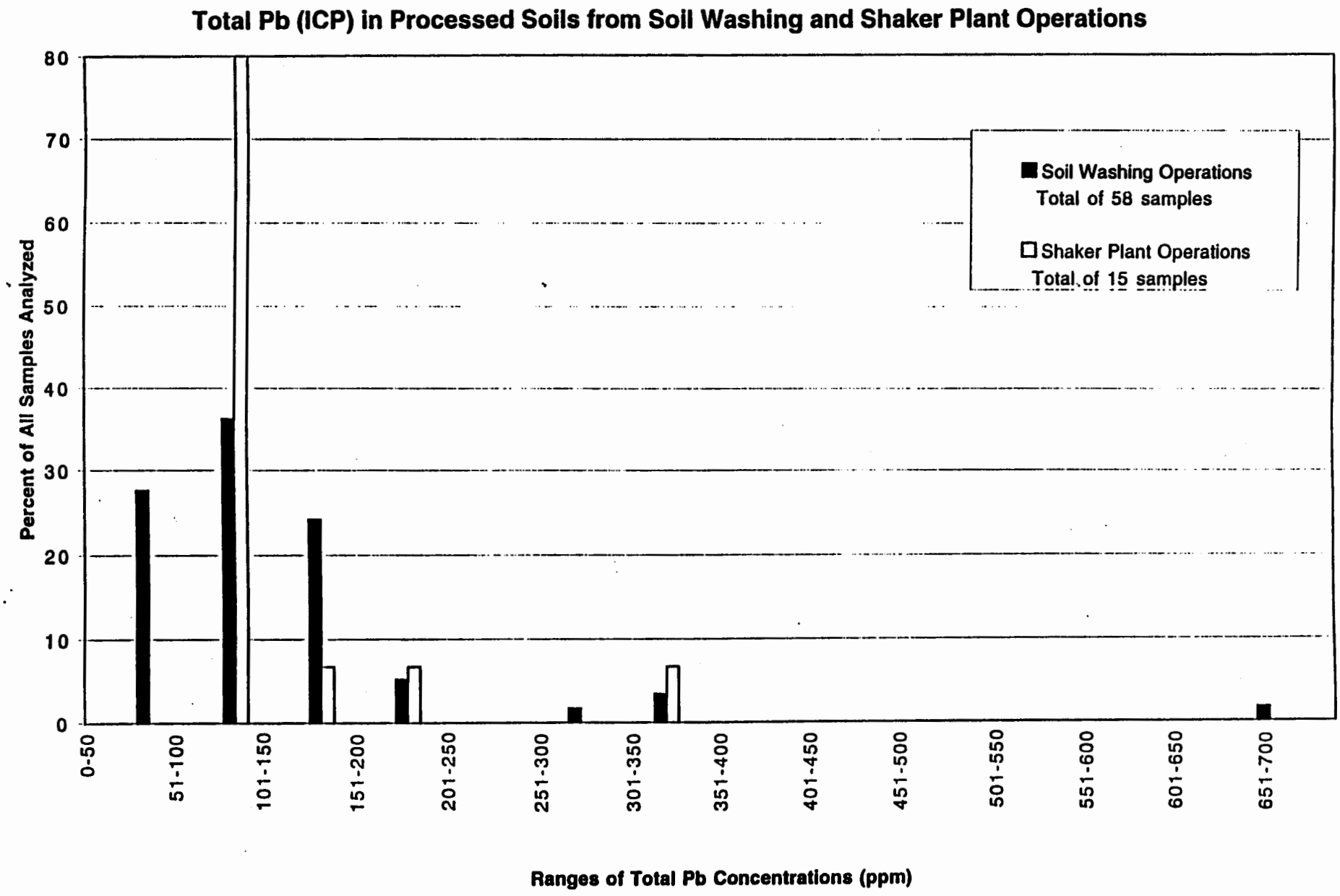
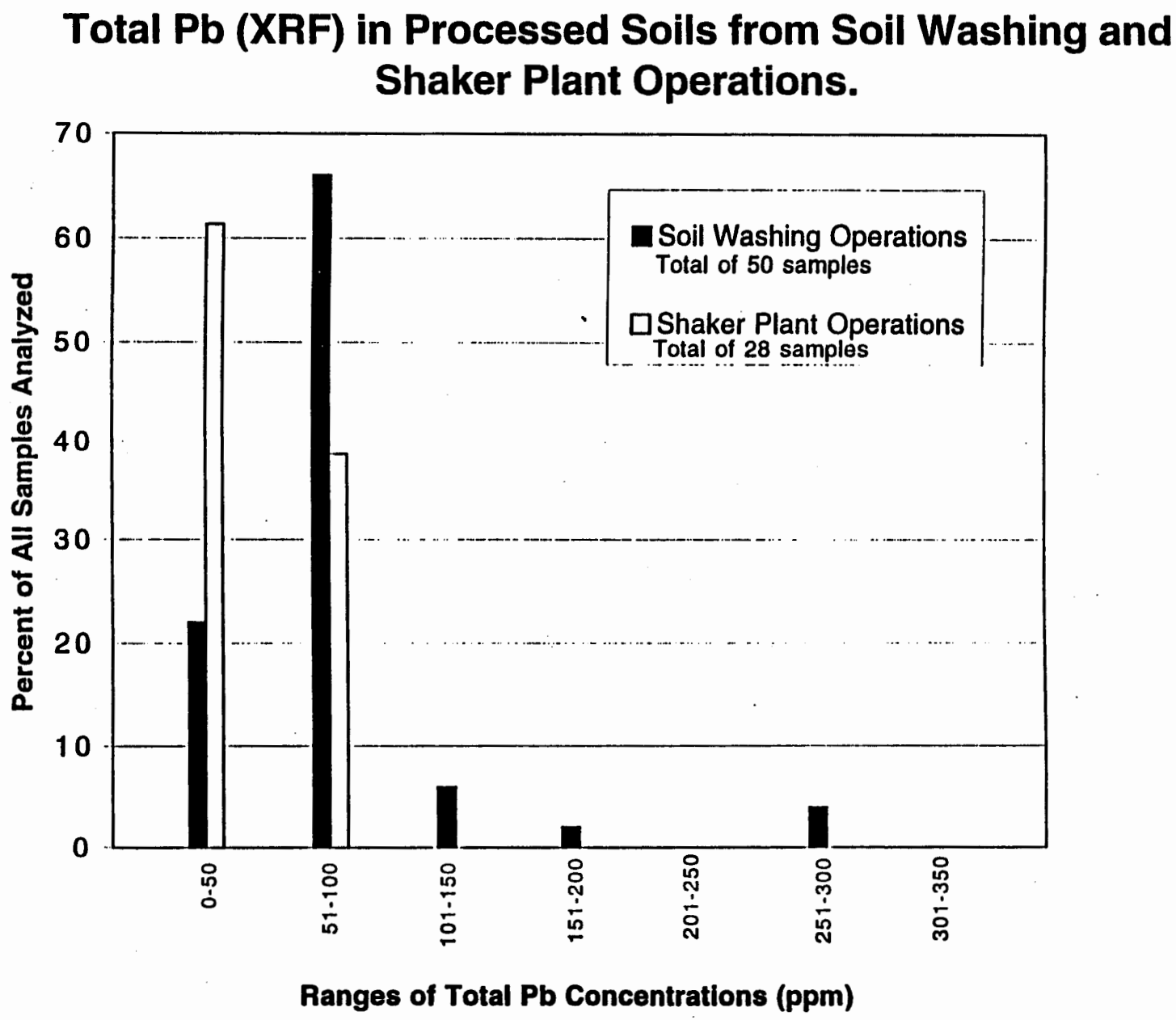


Figure 8.3-3. Comparison of total lead in processed soils by ICP analysis.



Figu· 9.3-4. Comparison of total lead in processed soils by XRF analysis.

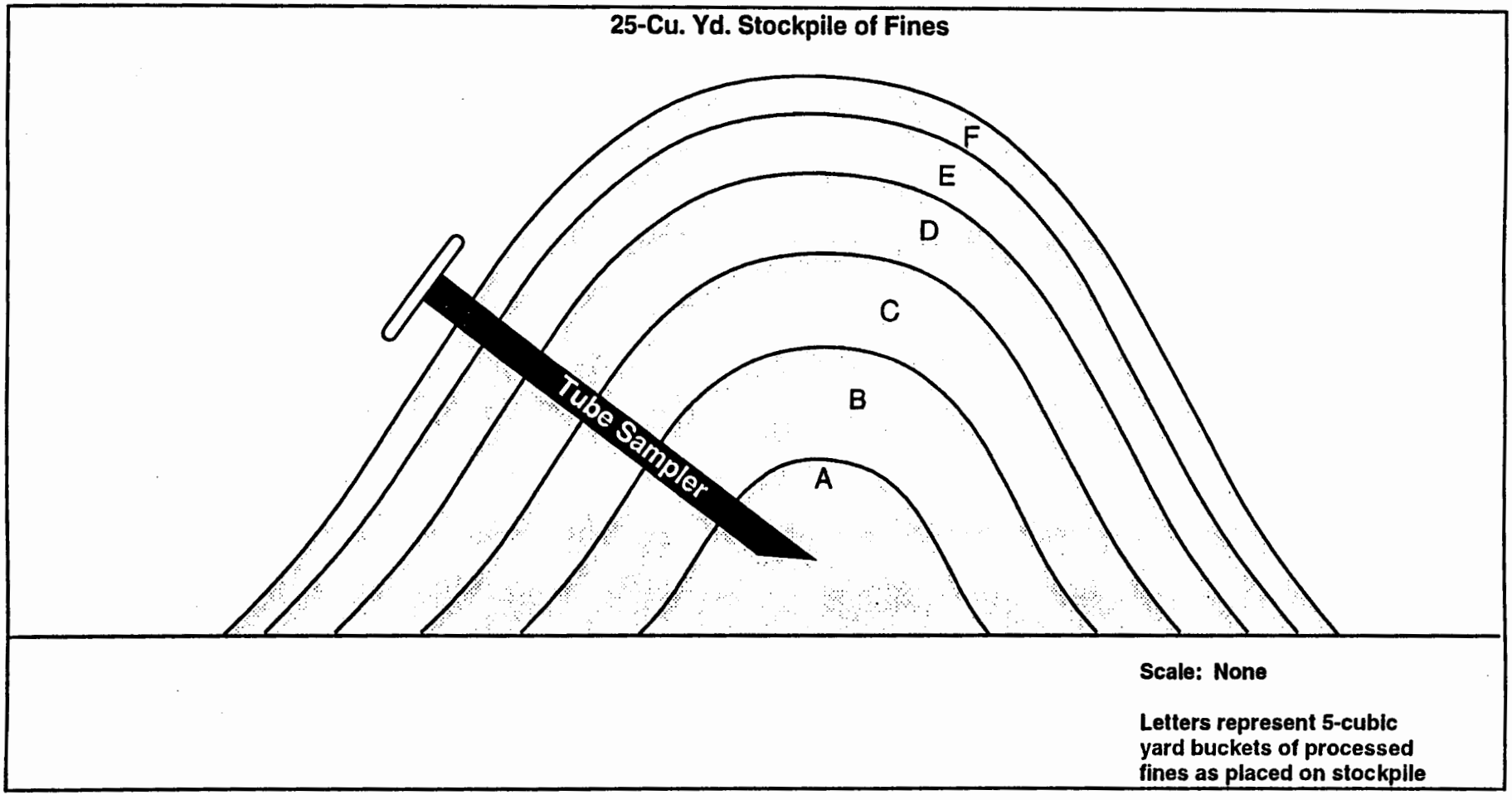


Figure 8.3-5. Stockpile sampling strategy for soils processed through Shaker Plant

APPENDIX J PHOTOGRAPHS OF VCA ACTIVITIES

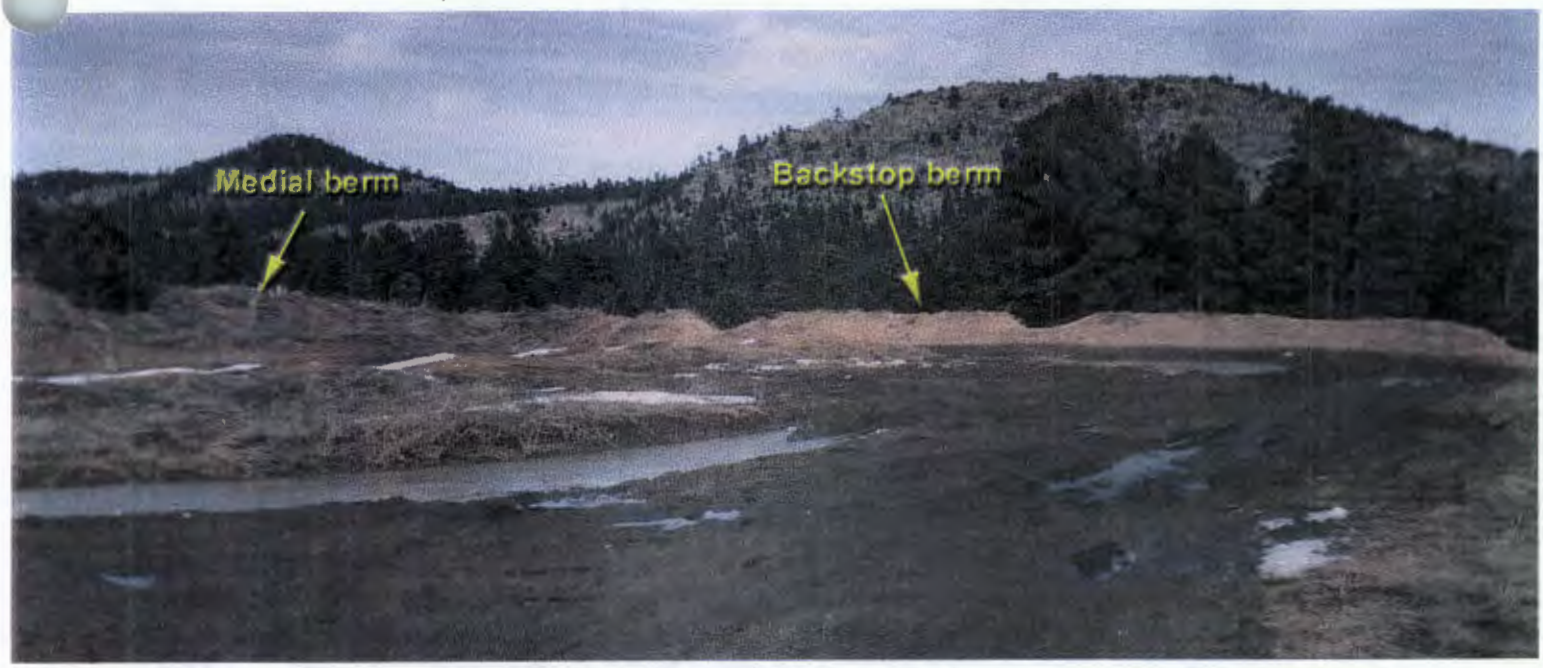


Photo 1: PRS 0-016 prior to initiation of VCA activities showing eastern backstop berm in background and medial berm on left. View to north.

Photo 2: Eastern side of berm. View to north.

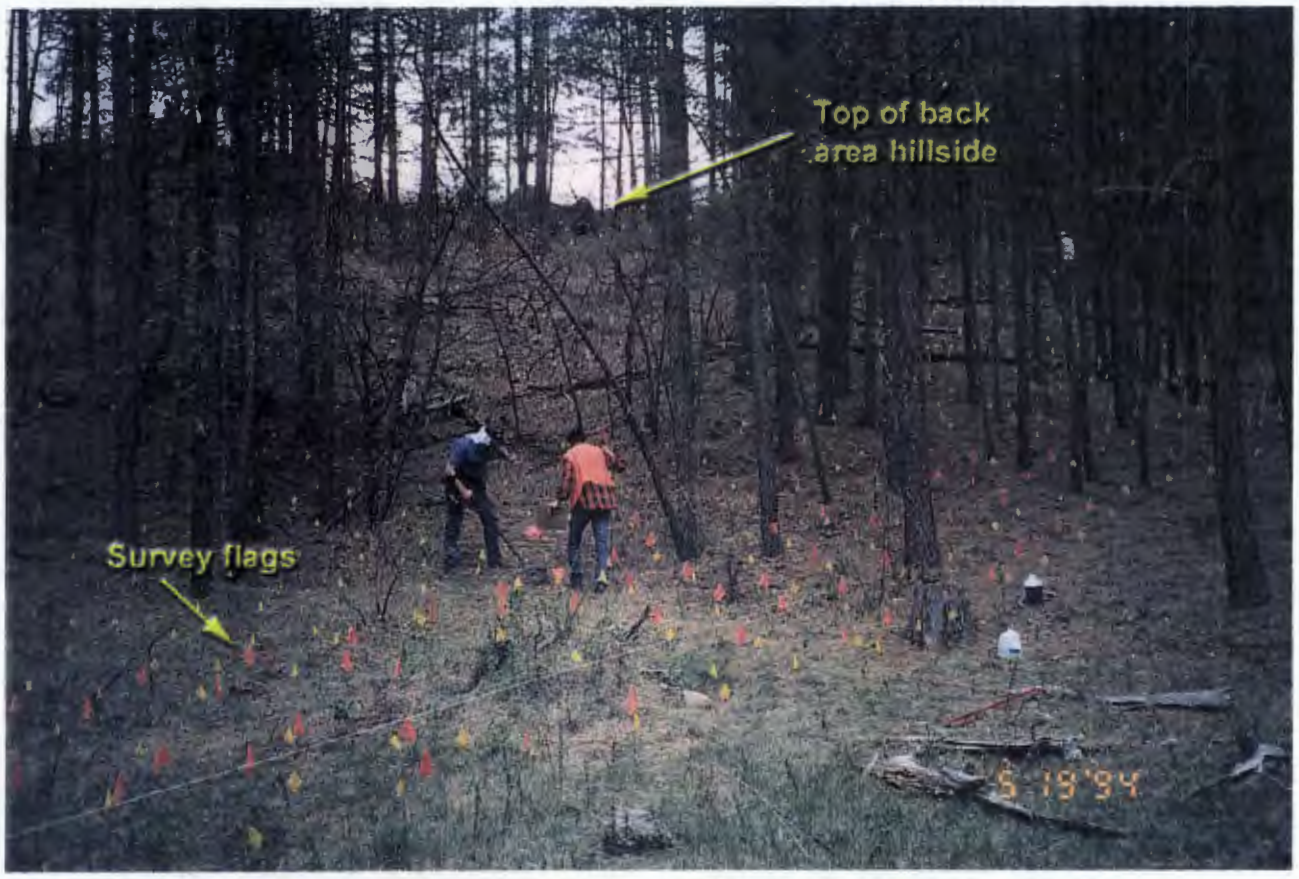


Photo 3: Back area metal detector survey to delineate contaminated areas.

Photo 4: Back area metal detector survey flagging. View to west.

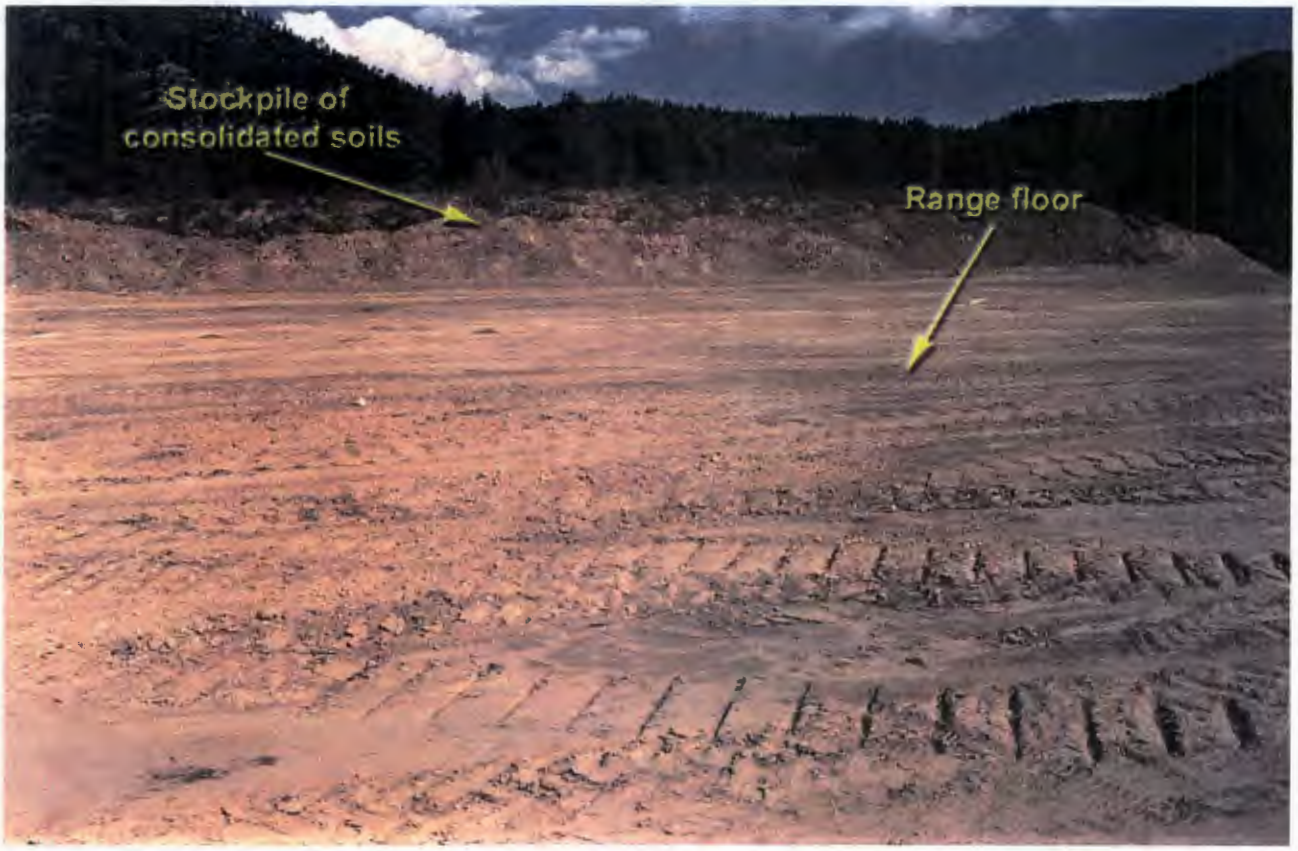


Photo 5: Range floor (foreground) and berm materials (background) following initial cosolidation. View to north.

Photo 6: Clearing slope in back area in preparation for excavation of contaminated materials.

Photo 7: Soil washing plant in operation. View to west.

Photo 8: Soil washing plant and recirculation ponds. View to southeast.

Photo 9: Washed soil beaching area and soil washing plant discharge. View to northwest

Photo 10: On site XRF laboratory.

Photo 11: Shaker plant test run showing fines, bullet-size, and oversize fractions (left to right).

Photo 12: Shaker plant separation of bullet-sized and fine fractions in operation. View to east-northeast.

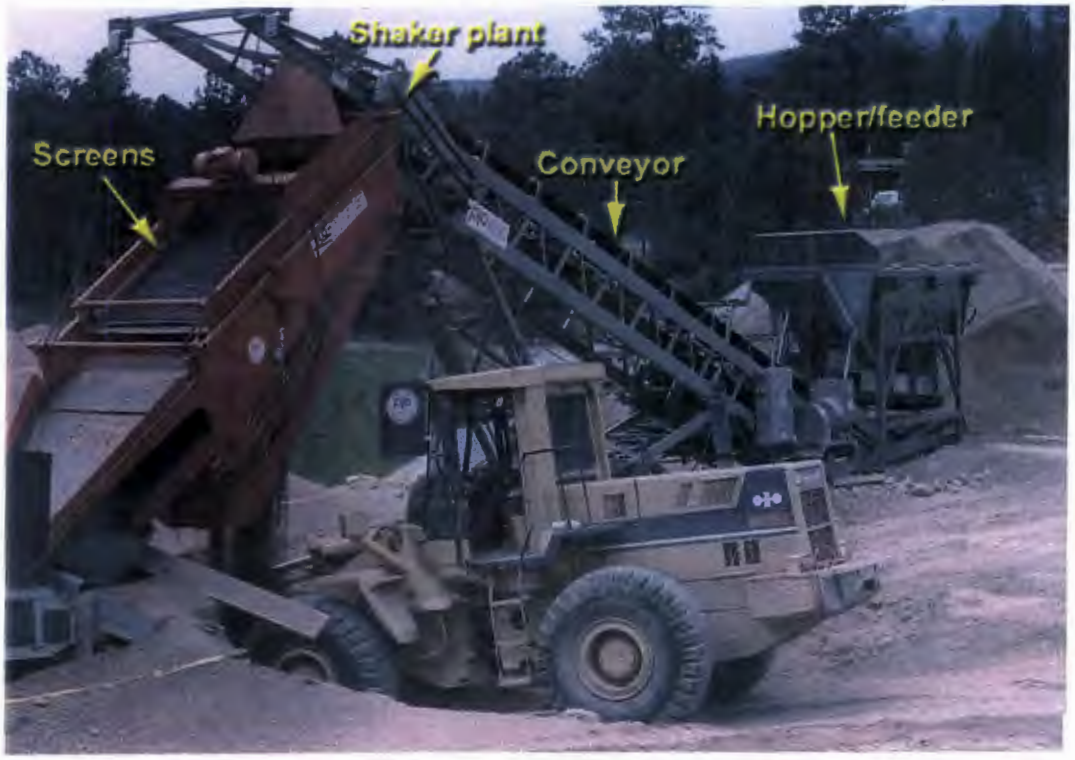


Photo 13: Removing fines from beneath shaker plant. View to west.

Photo 14: Bullet-size fraction coming off conveyor after segregation from fines. View to south.

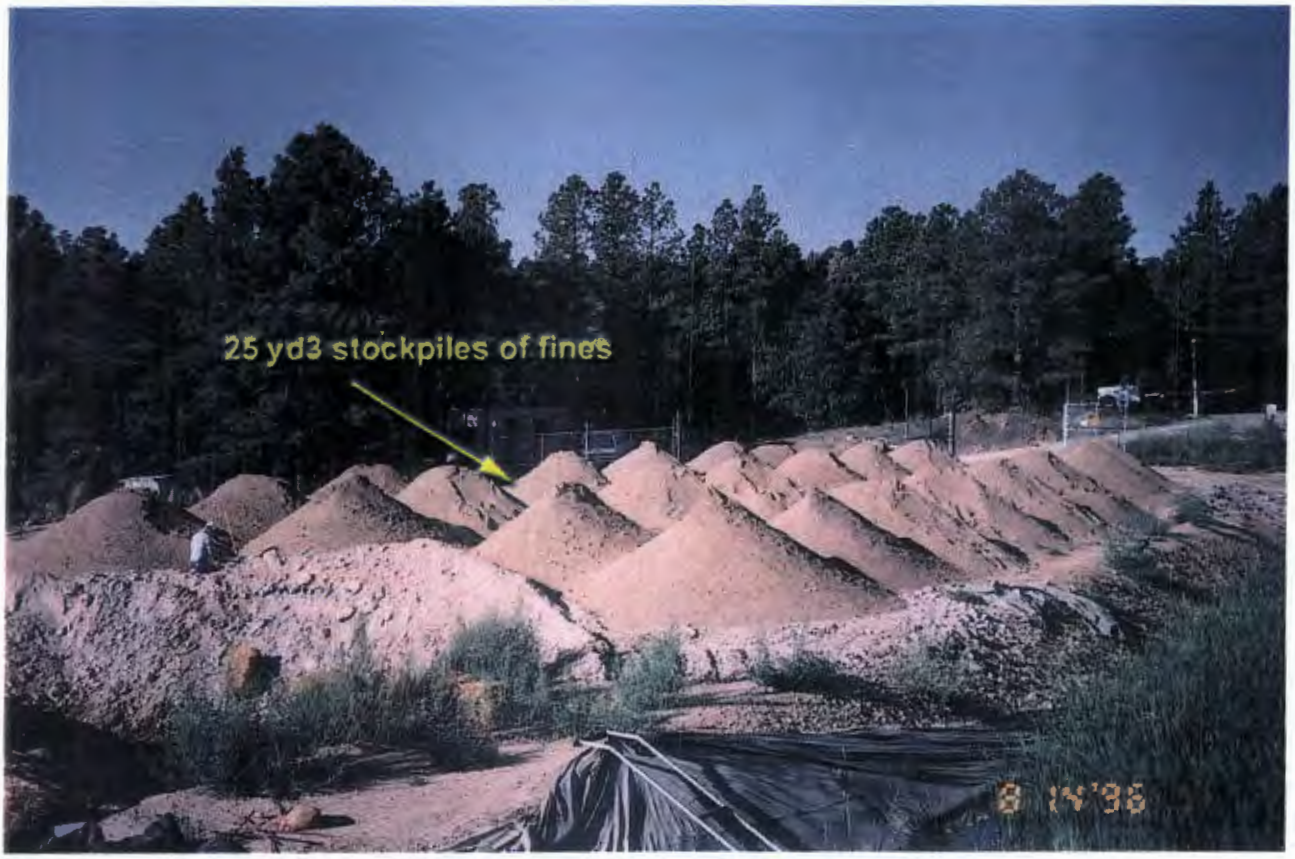


Photo 15: Sampling stockpiled fines. View to southwest.

Photo 16: Impact crusher reducing gravels to fines. View to northeast.

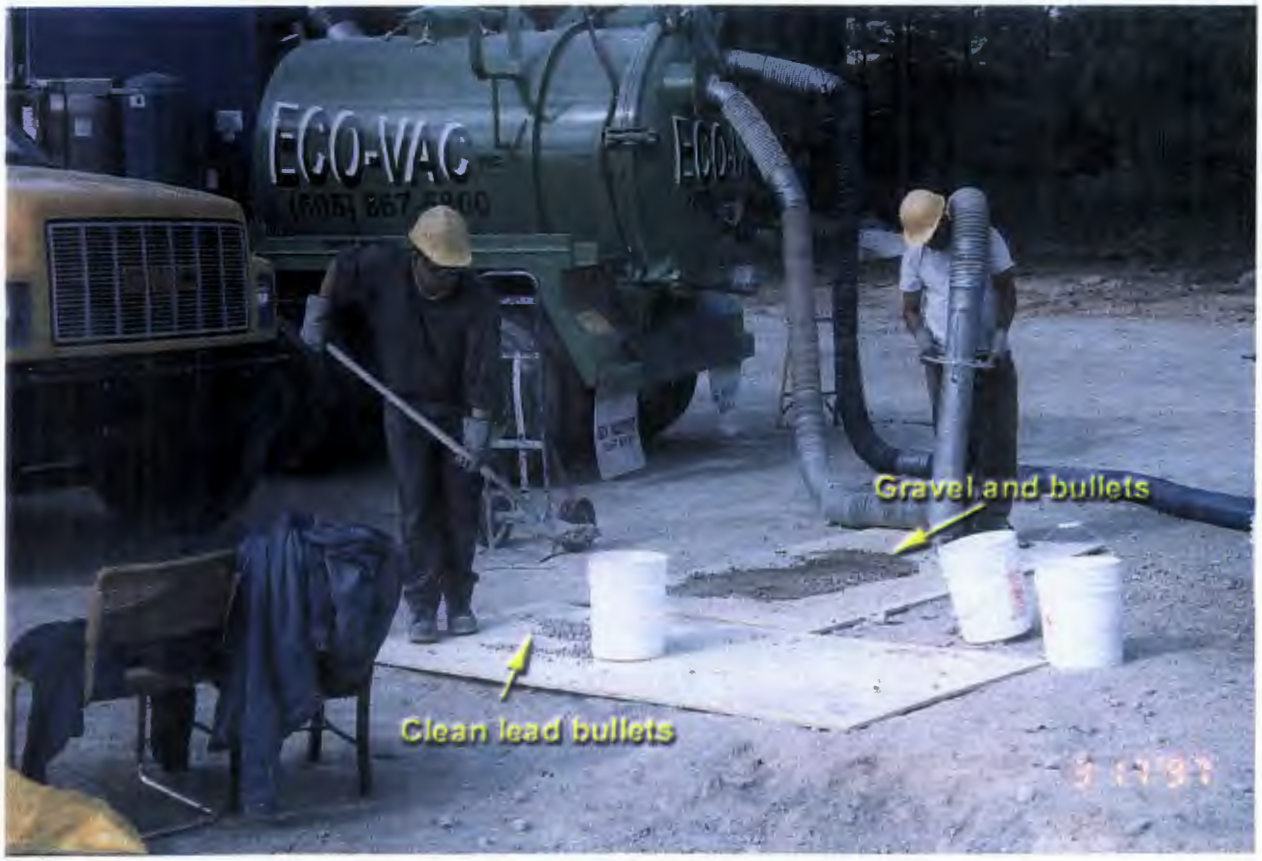


Photo 17: Vacuuming operation to lift gravel away from lead. View to west.

Photo 18: Back area revegetation results. View to northwest.

Photo 19: PRS 0-016 back area hillside, October 1998. View to east.

Photo 20: PRS 0-016 back area hillside, October 1998. View to south.

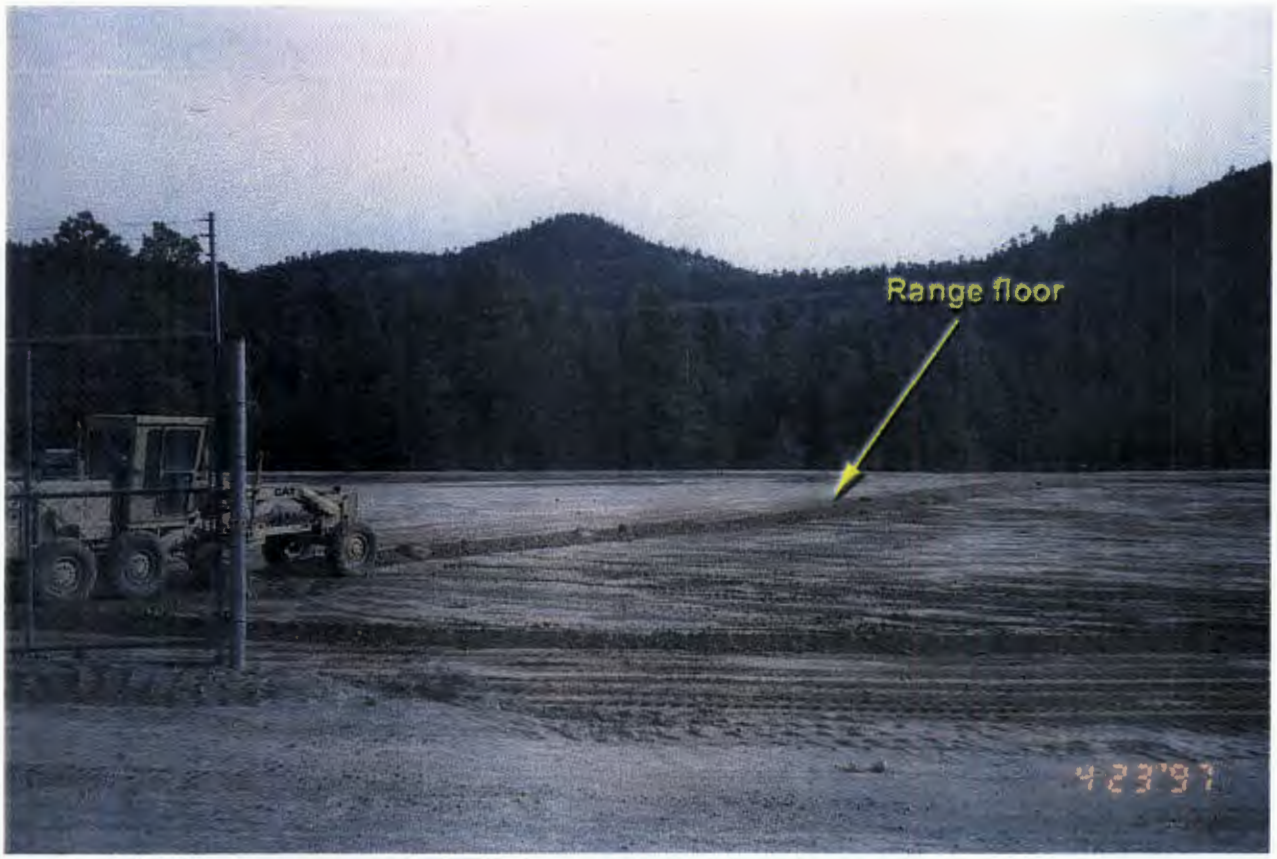


Photo 21: Final grading of site by developer. View to north.

Photo 22: PRS 0-016 after final grading and basecoarse application. View to west.

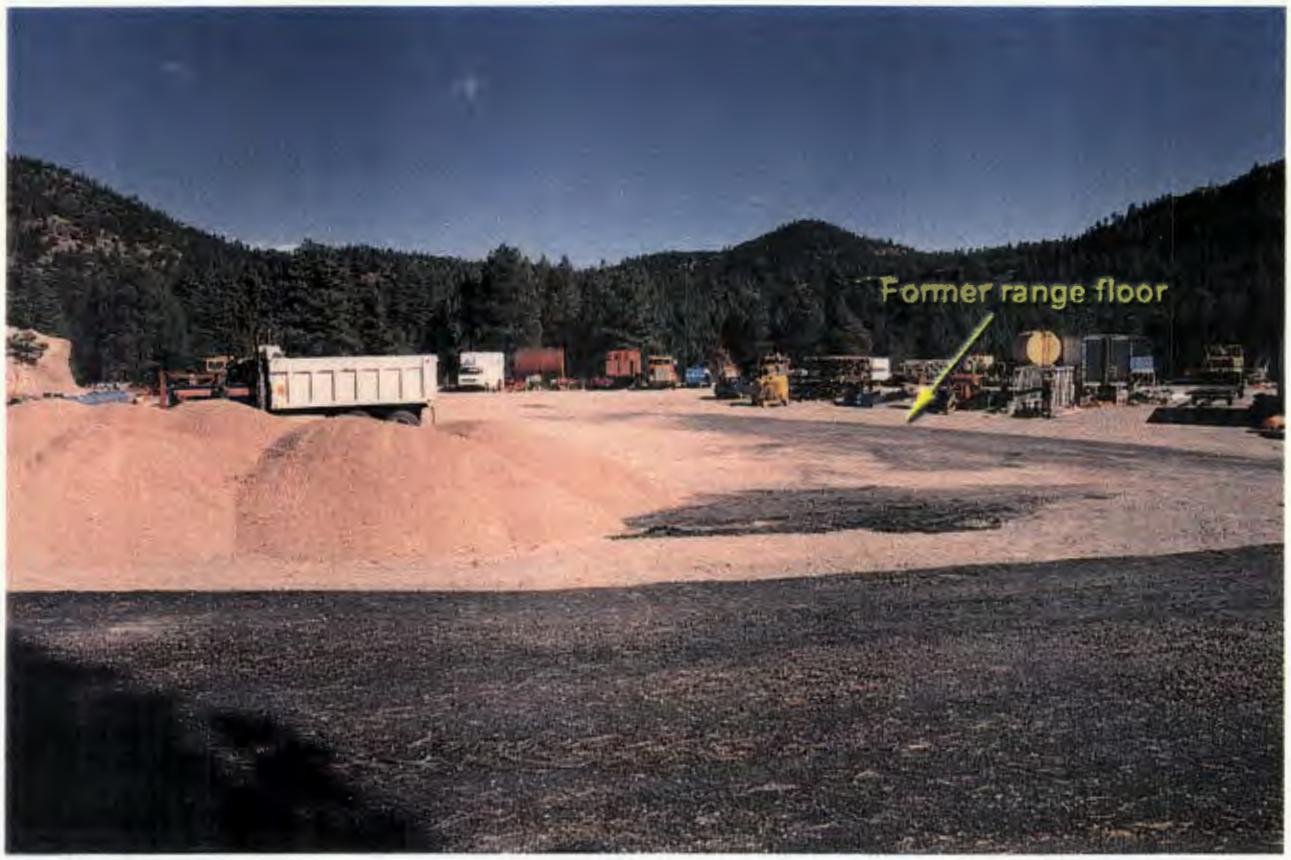


Photo 23: Post-VCA use of PRS 0-016 as equipment and material staging area by developer. View to north.

Photo 24: Post-VCA use of PRS 0-016 as equipment and material staging area by developer. View to east.

Photo 25: Discharging recirculation pond slurry at borrows pit accross from TA-53.

Photo 26: Washed soil stockpile. View to north.

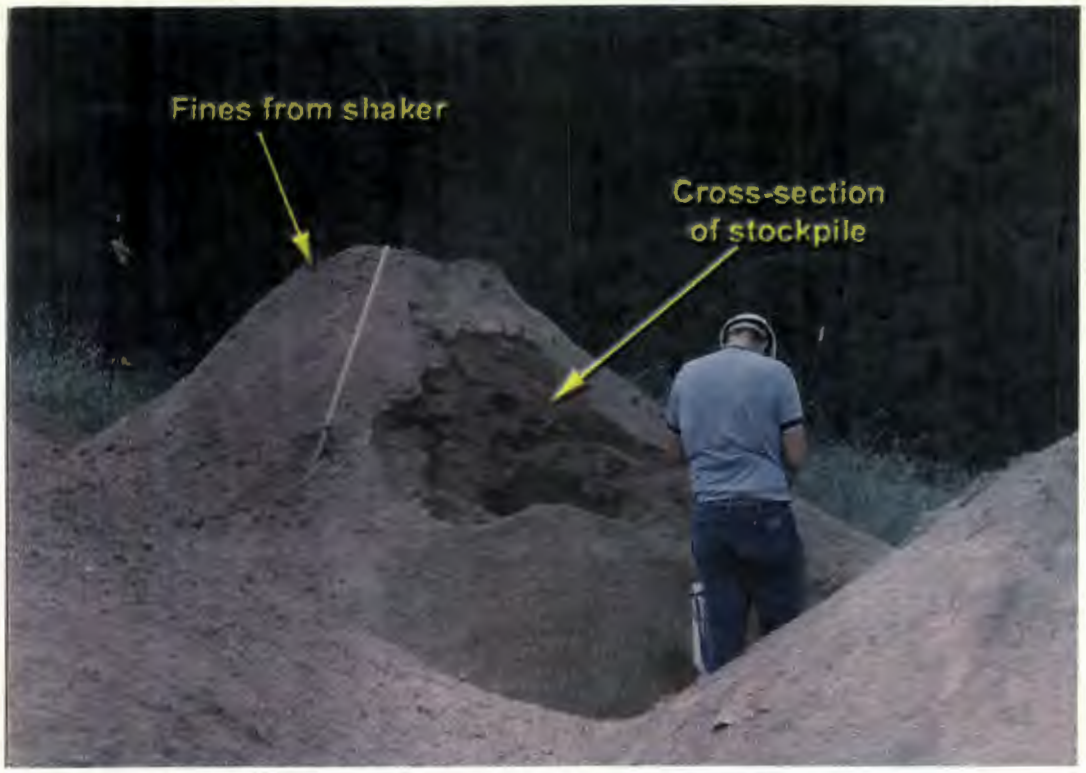


Photo 27: Sampling cross-section of stockpiled fines for TCLP lead analysis. View to north.

Photo 28: Oversize fraction (7-1/2") in borrows pit at TA-16.

Photo 29: Backstop berm at TA-72 constructed from fines processed through the shaker plant at PRS 0-016.

Photo 30: 1,235 yd3 stockpile of bullet-sized material awaiting further processing.