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Voluntary Corrective Action Plan

for

Solid Waste Management Units

at TA-33

33-010(a), Canyon-Side Disposal Area
33-010(b), Canyon-Side Disposal Area
33-010(d), Surface Disposal Area
33-010(g), Canyon-Side Disposal Area
33-011(b), General Storage Area

Field Unit 3

Environmental
Restoration
Project

November 1995

A Department of Energy
Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY

37262

FIELD WORK APPROVAL FORM

This form must be completed prior to starting remediation field work for Voluntary Corrective Action (VCA) for SWMUs 33-010(a,b,d,g) and 33-011(b).

I, _____, DOE-LAAO, APPROVE the field work as proposed in the accompanying Voluntary Corrective Action Plan for SWMUs 33-010(a,b,d,g) and 33-011(b).

I, _____, DOE-LAAO, DO NOT APPROVE the field work as proposed in the accompanying Voluntary Corrective Action Plan for SWMUs 33-010(a,b,d,g) and 33-011(b).

The following reasons reflect the decision for disapproval:

Signed: _____ Date:_____

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Table of Contents

1.0 INTRODUCTION 1

2.0 SITE TYPE AND DESCRIPTION 1

3.0 PROPOSED REMEDY 6

3.1 Objectives and Criteria 7

3.2 East Site VCAs 9

3.2.1 SWMU 33-010(a), Canyon-Side Disposal Area 9

3.2.2 SWMU 33-010(b), Canyon-Side Disposal Area 9

3.2.3 SWMU 33-010(d), Canyon-Side Disposal Area 10

3.3 South Site 11

3.4 NRAO Site 11

4.0 JUSTIFICATION/RATIONALE 12

5.0 ESTIMATED WASTE VOLUMES BY TYPE 13

6.0 CLEANUP LEVELS 14

7.0 DESCRIPTION OF CONFIRMATORY SAMPLING 15

8.0 ESTIMATED SCHEDULE AND COST TO COMPLETE EACH VCA 17

9.0 REFERENCES 18

APPENDIX A FIELD SCREENING PROCEDURES A-1

APPENDIX B CHARACTERIZATION STRATEGY FORMS B-1

APPENDIX C FRAMEWORK FOR RECONSIDERING OR STOPPING WORK ON EXPEDITED CLEANUPS AND VOLUNTARY CORRECTIVE ACTIONS C-1

APPENDIX D SAMPLING DATA D-1

APPENDIX E METHODOLOGIES FOR DEVELOPING SITE-SPECIFIC PRELIMINARY REMEDIAL GOALS TO DEMONSTRATE CLEAN CLOSURE E-1

APPENDIX F PARAMETERS USED FOR RESRAD CALCULATION OF URANIUM CLEAN UP LEVEL F-1

APPENDIX G COST ESTIMATE DETAILED SUMMARY G-1

1.0 INTRODUCTION

Solid Waste Management Units (SWMUs) 33-010(a,b,d,g) and 33-011(b) are disposal and storage areas and associated soil located at Technical Area (TA)-33 in Operable Unit (OU) 1122 at Los Alamos National Laboratory (LANL). From 1947 to 1972 TA-33 was used for weapons' experiments employing conventional high explosives (HE), uranium, beryllium, and polonium. The site contains gun-firing areas, firing sites, an office, and a laboratory and shop complex. A tritium facility operated at TA-33 from 1955 to 1990. The National Radio Astronomy Observatory's (NRAO) Very Large Baseline Radiotelescope is currently operational at TA-33.

These SWMUs are considered in one Voluntary Corrective Action (VCA) plan because they are similar in nature and have similar remediation plans. Four SWMUs contain debris that has been disposed over the canyon rim. SWMU 33-011(b) is a storage area containing debris.

The SWMUs addressed in this VCA plan will be implemented by Field Unit 3 Project Leader, Brad Martin. The corrective actions for these SWMUs include screening and removal of debris that will be segregated into hazardous, radioactive, nonhazardous, and nonradioactive wastes. At SWMU ~~16~~ 33-010(b), some contaminated soil will be removed incidentally during the removal of small pieces of debris.

2.0 SITE TYPE AND DESCRIPTION

Table 2-1 identifies each SWMU to be remediated, its location, its description, and a description of the waste to be remediated.

TABLE 2-1

SWMU DESCRIPTION

SWMU NUMBER	SWMU LOCATION	SWMU DESCRIPTION	WASTE DESCRIPTION
33-010(a)	SE corner of East Site, White Rock Canyon	Canyon-side disposal area	Debris, metal, wood, plastic foam
33-010(b)	SW of TA-33-89, East Site, White Rock Canyon	Canyon-side disposal area	Metal scrap, plastic foam
33-010(d)	N edge of East Site, S rim of Ancho Canyon	Surface disposal area	Debris, foam, glass, concrete, metal scrap
33-010(g)	S and E edge of South Site, North Chaquehui Canyon	Canyon-side disposal area	Debris, metal scrap
33-011(b)	NRAO Site	Storage area	Debris, metal, wood

Figures 2-1, 2-2, 2-3, and 2-4 are location maps for SWMUs 33-010(a,b,d,g) and 33-011(b) and include RFI Phase I sample locations.

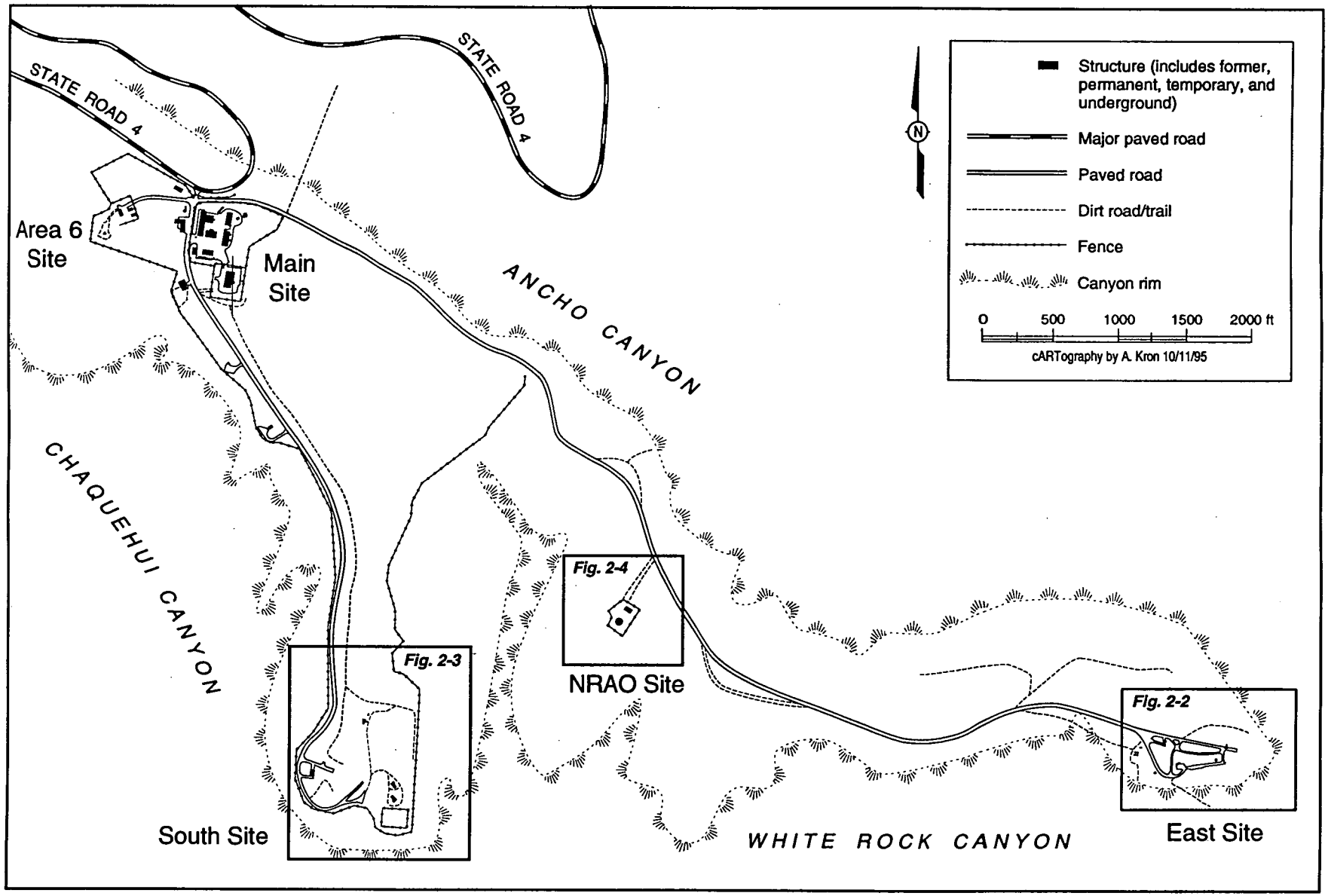

Fig. 2-1. General Location Map of TA-33.

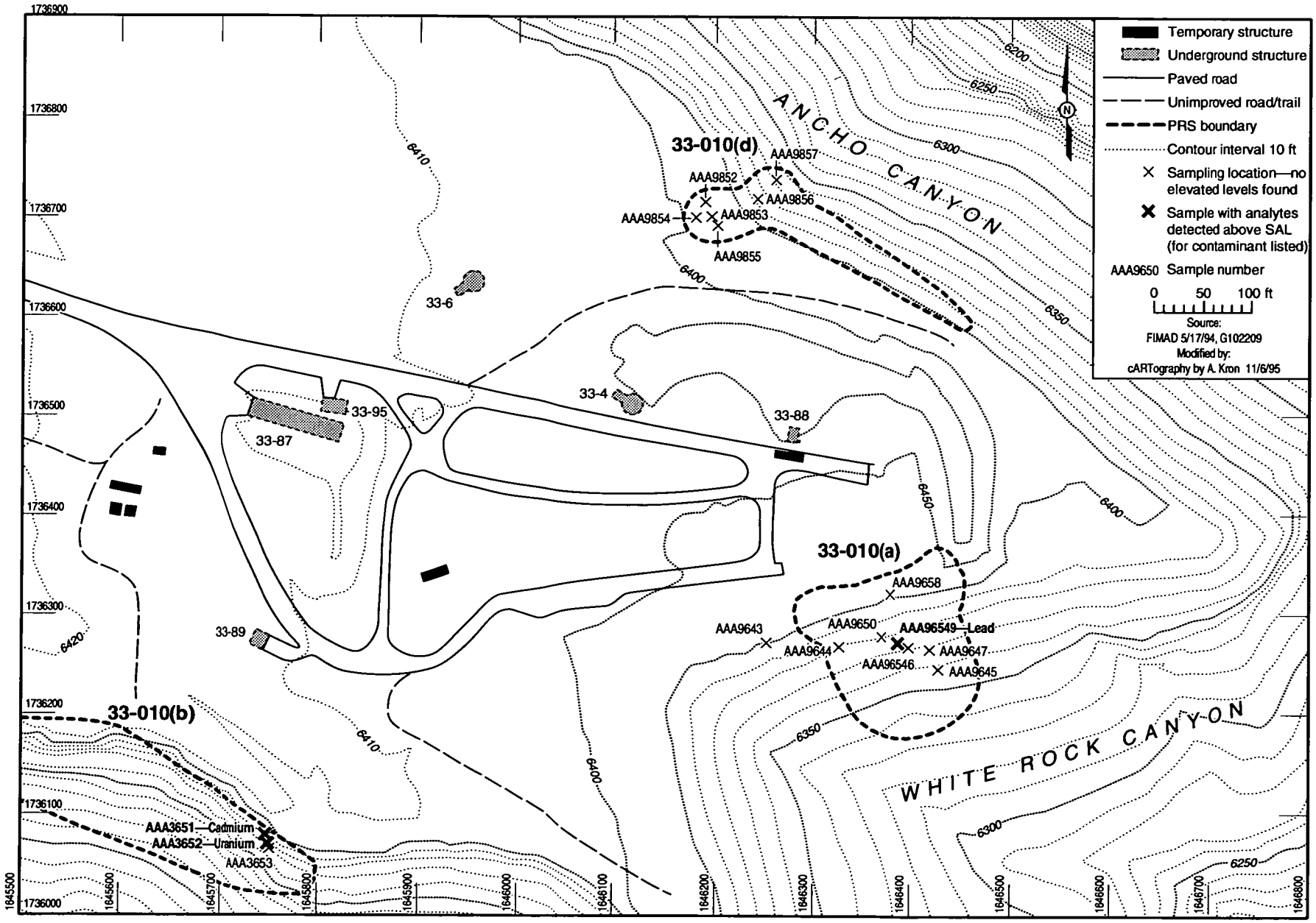

Fig. 2-2. Location map of SWMUs 33-010(a,b,d) at East Site.

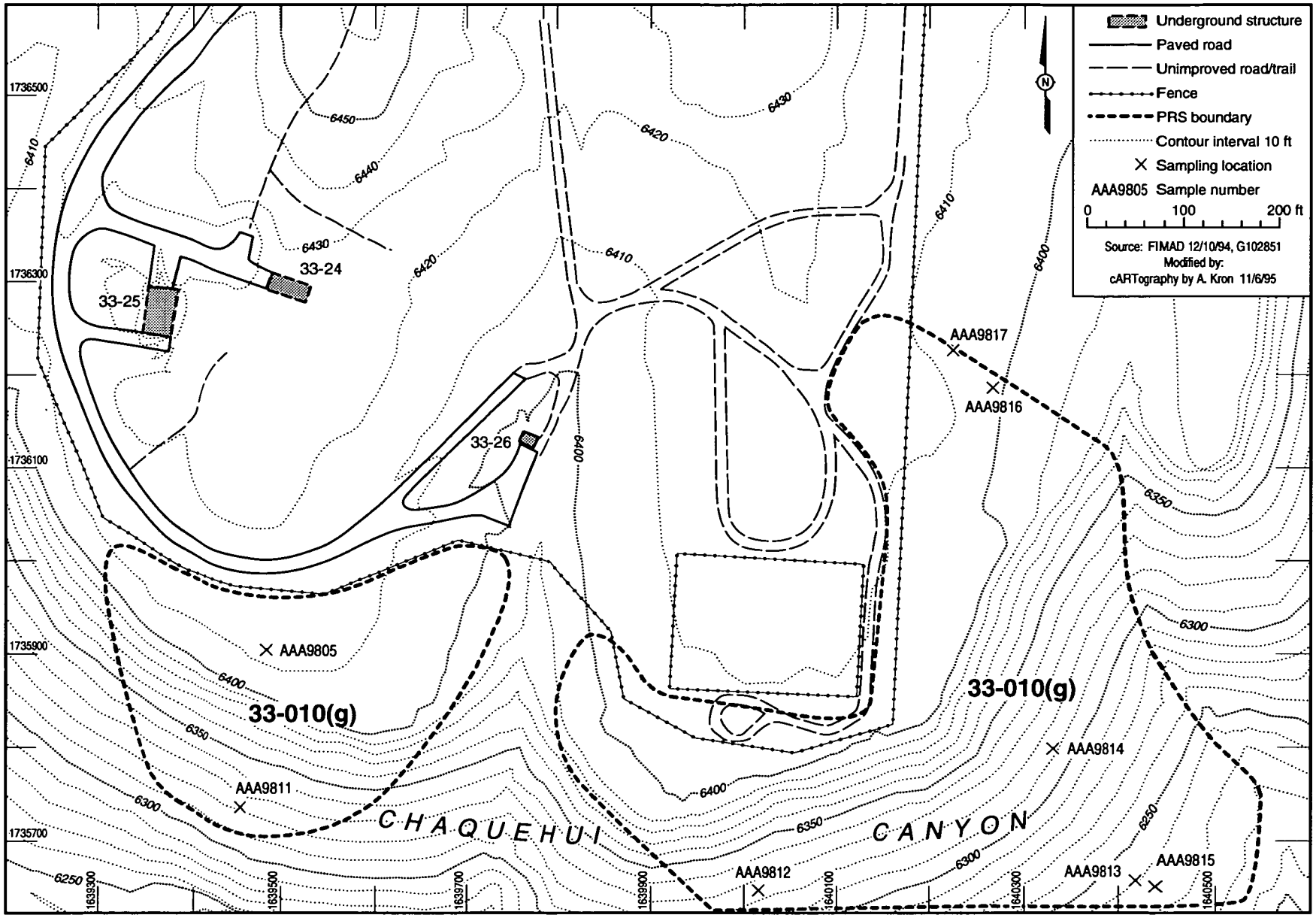

Fig. 2-3. Location map of SWMU 33-010(g) at South Site.

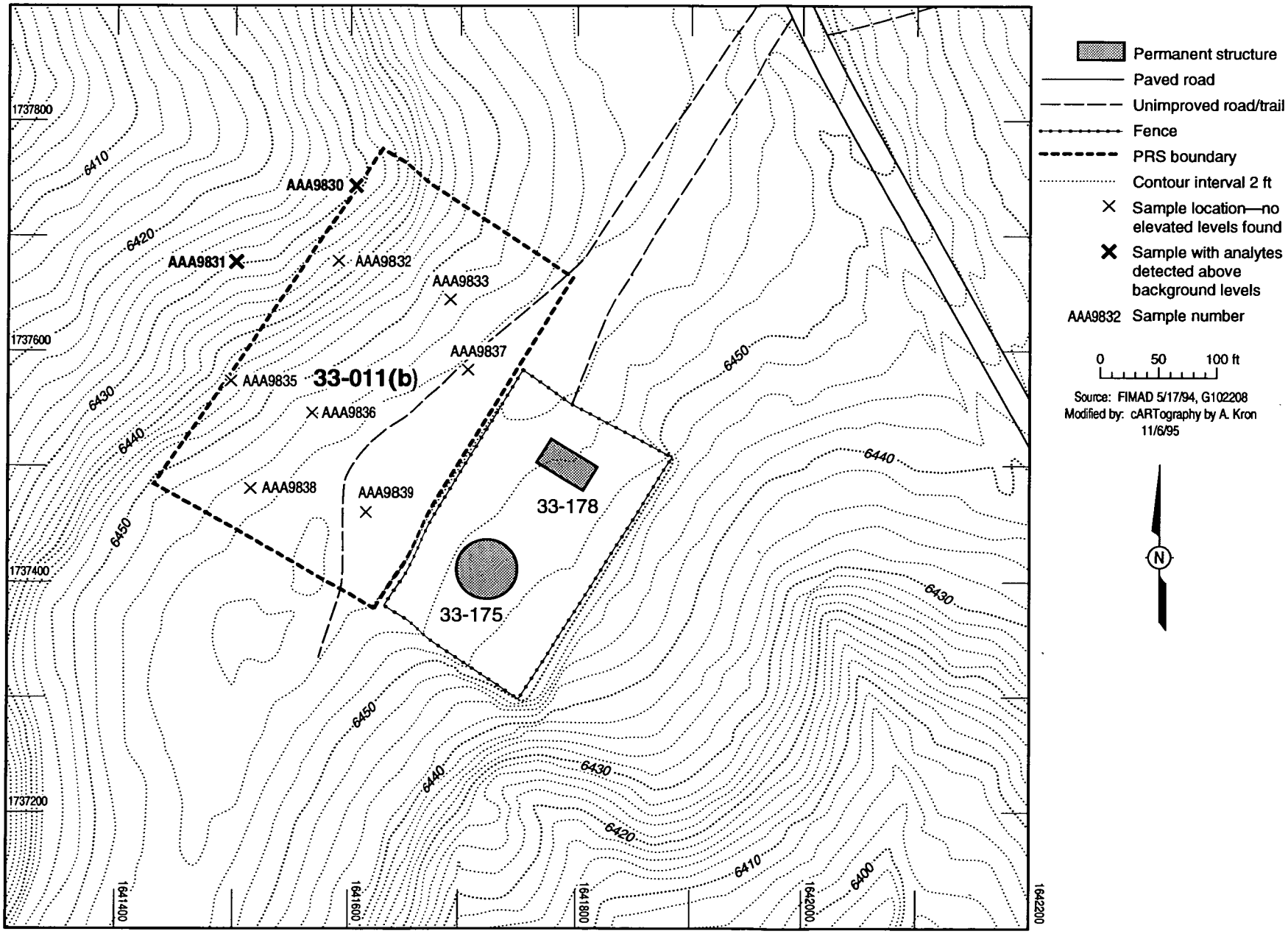

Fig. 2-4. Location map of SWMU 33-011(b) at NRAO Site.

3.0 PROPOSED REMEDY

The general remedy for these sites involves picking up man-made debris and characterizing the debris for segregation into waste categories based on field analyses to detect the presence of metals or radioactivity: hazardous, radioactive, nonhazardous, and nonradioactive. A generic field screening plan is described in Appendix A of this plan.

In lieu of a detailed waste management plan (WMP), each SWMU has been detailed on a characterization strategy form (CSF) included in Appendix B of this plan. The CSF includes a site description, remediation waste description, volume estimate, a characterization strategy, preliminary RCRA determination, and a listing of analyte suites to be characterized. Once waste characterization analyses have been received, the waste profile form (WPF) and chemical waste disposal request (CWDR) will be prepared for shipment of wastes to TA-54 or to an approved off-site Treatment, Storage, and Disposal facility (TSD). All waste will be managed in compliance with the suspected waste type detailed on the CSF. Waste materials confirmed to be nonhazardous or nonradioactive, and not subject to the Toxic Substances Control Act (TSCA), will be disposed of in the proper manner at an industrial landfill.

Remediation of the disposal areas and storage area at TA-33 will involve laborers removing debris with hand tools and transporting (mechanically and/or manually) the debris to a controlled area at the top of the cliff sides. All debris will be analyzed for radioactivity in place. Selected debris will be analyzed for hazardous constituents based on knowledge of process and best judgment. After analyses, large debris will be placed in piles and small debris will be placed into industrial grade bags. The waste will be segregated into the categories discussed above. Hazardous waste will be stored in a satellite storage or less than 90 day storage area. Radioactive waste will be stored in a radioactive material waste holding area. Industrial waste will be stored on site until it is transported to an industrial landfill. Disturbance of existing vegetation will be minimized. All disturbed areas will be regraded to match adjacent contours and reseeded if necessary. The remediation process will be guided by restrictions established in Framework for Reconsidering or Stopping Work on Expedited Cleanups and Voluntary Corrective Actions in Appendix C.

Prior sampling data are available for all the SWMUs in this report. The data are tabulated in Appendix D. Relevant data are summarized within the description of the proposed remedy for each SWMU.

3.1 Objectives And Criteria

Objectives:

To clean up (remove) industrial debris generated from historical activities at five disposal site PRSs. Debris will be analyzed in the field for hazardous and radioactive constituents for waste characterization purposes. Waste will be separated into four categories: radioactive waste; hazardous waste; mixed waste; and industrial waste.

Criteria for Collection of Debris:

Debris from lab operations found within the current PRS boundary will be removed. In addition, debris outside the current boundary of the PRS will be removed if this debris is located in close proximity. The PRS boundary may be expanded to include the entire removal area.

Debris that will not be removed includes:

- natural materials
- debris from overlapping PRSs
- food and beverage containers
- nails, nuts, and bolts (unless above radioactive background)
- wood or concrete (unless above radioactive background)
- foam insulation smaller than approximately 3 inches in diameter (unless above radioactive background)
- debris associated with lab operations, containing no hazardous or radioactive constituents, that could pose safety risks to workers during removal. (Note if any of this type of debris has been found to be hazardous or radioactive elsewhere, then this criterion will be re-visited).

Following the above criteria will assure that clean-up (removal) is complete.

Criteria for Waste Characterization Procedures:

Radioactive Waste Determinations: All industrial debris will be analyzed in place for radioactivity for both waste characterization and health and safety purposes. The ESP-1 and E-600 instruments will be used in accordance with ESH-1 guidance. Background determinations will be made each morning and/or afternoon for the specific location and instrument. Debris which have greater than background activity will be stored as potential radioactive waste until further determinations are made. The waste will be stored in the Radioactive Material Holding Area adjacent to building TA-33-2 at Area 6.

Hazardous Waste Determinations: Acceptable knowledge and best judgment will be used to determine the debris which will be analyzed for hazardous constituents. Debris from experimental devices (such as initiators or unknown devices) and industrial debris suspected to contain hazardous constituents (such as paint cans, metal cuttings, etc.) will be analyzed for metal constituents. This material will be brought to the CRZ and analyzed using the XRF in accordance to the appropriate LANL-ER-SOP. Cans or bottles which contain unknown potentially hazardous liquids will be stored as hazardous waste until further determinations are made. Hazardous waste will be stored in the Satellite Storage Area at the field trailer.

Mixed Waste Determinations: Radioactive waste will be analyzed for hazardous metals to determine the presence of mixed waste. (Note that the potential hazardous waste will have been analyzed for radioactivity in place). Mixed waste is not anticipated, however if it is present, it will be stored in the Satellite Storage Area at the field trailer.

Industrial Waste: Using acceptable knowledge and best judgment, industrial debris and household debris not associated with hazardous materials or processes will not be analyzed for hazardous constituents for waste characterization purposes. The debris will be analyzed for radioactivity. Waste which is neither radioactive nor hazardous will be stored in industrial grade bags and in piles (for the large debris) at the PRS. The waste will be labeled as 'Industrial Waste, Non Hazardous Non Radioactive'.

3.2 East Site VCAs

3.2.1 SWMU 33-010(a), Canyon-Side Disposal Area

SWMU 33-010(a) is a canyon-side disposal area located on a cliff ledge at East Site (Fig. 2-2). Much of the debris resulted from the initial clearing of the site and consists of dead tree trunks, rocks, and scraped earth. In addition, metal scrap, timbers, plastic foam, and other man-made debris were thrown over the canyon rim at various times. Debris is scattered at the rim and within 15-ft below the rim.

The canyon side just south of the East Site double berm slopes steeply approximately 20-ft into White Rock Canyon, then levels to a more gentle grade to a bench. The steep area contains broken rocks and soil. The eastern end of the site contains dead tree trunks. The remedy for this site is the general remedy described above in section 3.0. Debris from site clearing, such as tree trunks and rocks, will not be removed during the VCA operations.

Preliminary Phase I RFI sampling consisted of five samples collected on the face of the slope and analyzed for metals, uranium, and cesium-137. Three separate samples for SWMU 33-007(a), an overlapping SWMU, were collected within the boundary of SWMU 33-010(a) and analyzed for metals, uranium, cesium-137, semi-volatile organic compounds (SVOCs), and HE. Three samples had uranium well below the screening action level (SAL). Traces of mercury were found in three samples. Lead was found in two samples, one sample contained 989 mg/kg which is above the SAL for lead of 400 mg/kg, yet below the 1 000 mg/kg industrial cleanup level. No other contaminants were found.

SWMU 33-010(a) can be accessed from the top of the canyon by a paved road. The volume of debris that will be removed from the site is estimated to be 10.5 cubic yards.

3.2.2 SWMU 33-010(b), Canyon-Side Disposal Area

SWMU 33-010(b) is a canyon-side disposal area on a narrow ledge located below a 30-ft sheer cliff at the southern edge of East Site (Fig. 2-2). The ledge is on bedrock and approximately 10- to 15-ft wide. Below the ledge is a steep pumice slope descending approximately 1 000-ft into White Rock Canyon. Timbers are scattered along the ledge. One large ball, approximately 10-ft in diameter and composed of metal turnings and strapping strips, is the most prominent object in the SWMU. Asbestos boards are also present among the debris. The time frame for deposition of this debris is not known but is presumed to be between the 1950s and 1972.

Preliminary Phase I RFI sampling consisted of three surface samples taken at the base of the large metal ball and analyzed for metals, uranium, and gamma emitters. All samples contained uranium above LANL background, with one sample containing 762 mg/kg which is above the SAL of 230 mg/kg. All samples contained cadmium above the LANL background, with one sample containing 182 mg/kg which is above the SAL of 38 mg/kg. Nickel, lead, and zinc were detected below SALs.

The proposed remedy for this site follows the general remedy described in section 3.0. Four samples of the metal ball will be removed and screened by LIBS or XRF for cadmium and RAD screened for uranium. If the ball contains one of these metals and contamination could be spread during removal, the surface of the metal ball will be stabilized with spray paint or plastic before removal.

If the samples of the metal ball are found to be contaminated with hazardous or radioactive material, one surface soil sample will be collected near the footprint of the ball and analyzed for cadmium and uranium once the large ball of metal scrap has been removed. Cleanup levels for uranium and cadmium are located in Section 6.0 of this plan.

SWMU 33-010(b) has very difficult access due to its very steep slope and distance (approximately 100-ft) from a maintained road. It also has a fence that may need to be cut and a large drainage ditch which runs along the fence between the road and the SWMU. The volume of debris that will be removed from the site is estimated to be 40 cubic yards.

3.2.3 SWMU 33-010(d), Canyon-Side Disposal Area

SWMU 33-010(d) is a surface disposal area on the rim of Ancho canyon at East Site (Fig. 2-2). Debris was dumped in a small drainage leading to the canyon and along the canyon rim. Much of the debris is concrete blocks, including a part of the surface cable holder from the underground TA-33-6 shot chamber. At the top of the drainage are approximately 30 empty unbroken glass specimen vials. Garbage, such as foam chunks and metal cans, lies along the edge of the canyon just below the rim. The proposed remedy for this site follows the general remedy described in section 3.0.

Preliminary Phase I RFI sampling consisted of four surface samples taken on the mesa top amid the debris and two samples taken in the drainage area near the specimen bottles. All six samples were analyzed for metals, uranium, and gamma emitters. Lead was detected in one sample at a level well below SAL. No other contamination was detected.

SWMU 33-010(d) is accessible from a maintained dirt road located at the top of the sloping site. The volume of debris that will be removed from the site is estimated to be 6.5 cubic yards.

3.3 South Site

SWMU 33-010(g), Canyon-Side Disposal Area

SWMU 33-010(g) is a canyon-side disposal area located on the mesa top and adjacent steep slope at South Site (Fig. 2-3). Some of the debris at this site resulted from initial site clearing and consists of dead tree trunks, rocks, and scraped earth. In addition, metal chunks and other debris were thrown over the canyon rim at various times. Debris is scattered along the rim and within 20-ft below the rim on the steep slope. Three small piles of debris are located on the mesa top near the canyon rim. The proposed remedy for this site will follow the general remedy described in section 3.0. Site clearing debris, such as tree trunks, will not be removed during the VCA process. Before disposal, debris will be visually surveyed by an HE expert for chunks of HE.

Preliminary Phase I RFI sampling consisted of four surface samples taken on the face of the slope. Three additional samples for SWMU 33-006(a), an overlapping SWMU, were collected within the SWMU 33-010(g) boundary. All samples were analyzed for metals, uranium, gamma emitters, and HE. One sample was analyzed for herbicides. One of the samples contained cesium-137 at a level well below the SAL. Trace levels of a propellant were found in two samples on the slope. No other contaminants were found above LANL background.

SWMU 33-010(g) can be accessed by a dirt road located at the top of the cliff and a fence may need to be cut for access to the site. The volume of debris that will be removed from the site is estimated to be six cubic yards.

3.4 NRAO Site

SWMU 33-011(b), Storage Area

SWMU 33-011(b) is located just west of the NRAO fenced complex near the center of TA-33 (Fig. 2-4). The SWMU occupies a 300 x 600-ft area. From the 1950s to the early 1990s, the site was used as material storage for equipment and metals such as tungsten, uranium, and beryllium (Hoard 1990, 02-019). About three-quarters of the site have been scraped and leveled to or near bedrock tuff. The site was cleaned in 1984; however, a few bits of scrap and debris still litter the area (Buhl 1988, 02-038). During a site visit a piece of metal was found with

a Geiger counter and is expected to be uranium. A small (4-ft x 4-ft x 4-ft) wooden bunker with a periscope exists on the site and will not be removed during this VCA. The proposed remedy for this site follows the general remedy described in section 3.0.

Preliminary Phase I RFI sampling consisted of ten surface samples. Three samples were reanalyzed. The duplicate sample mentioned in the RFI Work Plan for OU 1122 was not collected (LANL 1992, 0784). All samples were analyzed for metals, uranium, and cesium-137. One sample was also analyzed for herbicides. Two samples had cesium-137 at levels well below the SAL. No other contaminants were found.

SWMU 33-011(b) is accessible from a maintained gravel road. The volume of debris that will be removed from the site is estimated to be approximately 6.5 cubic yards.

4.0 JUSTIFICATION/RATIONALE

SWMUs 33-010(a,b,d,g) are listed in Table A of the Laboratory's Hazardous and Solid Wastes Amendment (HSWA) permit. These SWMUs will be approached as a VCA for removal from the permit list. SWMU 33-011(b) is not listed in the Laboratory's HSWA permit.

Soils and sediments at each of these PRSs were sampled during a Phase I RFI investigation with the objective of determining if contaminants were present within the PRSs at levels of potential concern. Only at PRS 33-010(b) were contaminants detected in soils at levels of potential concern. Although the Phase I RFI investigation objective was met at each PRS relative to the soils and sediments, debris is also present within each of these PRSs. It was not determined if contaminants were present within the debris. To complete the objectives of the Phase I RFI investigation, this question must be resolved. Therefore, the relevant data quality objective (DQO) for the VCA work is to determine if contaminants on or in the debris are present within the PRSs at levels of concern.

Due to the nature of the debris, this objective is most expeditiously met through removal of the debris from the PRSs. By removal of the debris, any contaminants of potential concern on or in the debris will no longer be present within the PRS.

Because contaminants of potential concern were detected in soils at PRS 33-010(b), an additional DQO for this PRS is to determine if contaminants remain within the PRSs at levels of concern following removal of the debris (including incidental soil removal).

While the waste materials associated with these sites are of relatively low volume and restricted to well-defined areas, contamination could be spread by wind, rainfall runoff, and possibly foot traffic. The preferred remedy for the cleanup of these sites is obvious and straightforward to implement. Physical site access is not a problem at most of these sites. Access at SWMU 33-010(b) will make cleanup difficult.

5.0 ESTIMATED WASTE VOLUMES BY TYPE

Table 5-1 displays each SWMU, the waste types, the waste description, an estimated bulk volume, proposed disposal containers, and the anticipated disposal destination.

TABLE 5-1

ESTIMATED WASTE VOLUMES BY TYPE

SWMU NUMBER	WASTE TYPE[a]	WASTE DESCRIPTION	ESTIMATED BULK VOLUME	DISPOSAL CONTAINER TYPE	ANTICIPATED DISPOSAL SITE
33-010(a)	Industrial	Debris, wood, plastic	10 yd^3	Roll-off or dump truck	Industrial landfill
33-010(a)	Haz(b)	Metal	0.5 yd^3	55-gallon drum	Off-site hazardous waste facility
33-010(b)	Industrial	Debris, plastic	24 yd^3	Roll-off or dump truck	Industrial landfill
33-010(b)	Haz(b)	Metal, soil	14 yd^3	Roll-off	Off-site hazardous waste facility
33-010(b)	Radioactive	Metal, soil	2 yd^3	55-gallon drum	TA-54
33-010(d)	Industrial	Debris, foam concrete, glass, metal	6 yd^3	Roll-off or dump truck	Industrial landfill
33-010(d)	Haz(b)	Metal, soil	0.5 yd^3	55-gallon drum	Off-site hazardous waste facility
33-010(g)	Industrial	Debris, plastic, metal	6 yd^3	Roll-off or dump truck	Industrial landfill
33-011(b)	Industrial	Debris, wood	6 yd^3	Roll-off or dump truck	Industrial landfill
33-011(b)	Radioactive	Metal	0.25 yd^3	55-gallon drum	TA-54

[a] Waste Type: Haz(b) = RCRA Metals

6.0 CLEANUP LEVELS

Identification of the chemicals of potential concern (COPCs) considered for this VCA Plan was based on simple comparisons of Phase I RFI analytical results to background and SAL concentrations. As presented in Appendix D, analytical results from the Phase I RFI sampling indicate that SWMU 33-010(b) is the only site failing a soil screening assessment requiring further evaluation. Inspection of the data indicates that cadmium and uranium are the primary COPCs for soil contamination at the site. Due to the location of this SWMU (close proximity to Bandelier National Monument and on a cliff face), a recreational exposure scenario was chosen as the most likely receptor model for future risk. Current security fencing and lack of receptor activity at the site precludes the estimation of current human exposure.

An exposure unit corresponding to a likely area of receptor activity is traditionally defined in action level derivation calculations. In this case, however, it is more feasible to evaluate exposure within the actual bounds of the contaminated area rather than calculate a fraction of a predefined exposure area corresponding to the contaminated zone. This decision is based on topography of the canyon wall, which inhibits free access to a large continuous area, and the sensitivity of a radiological dose estimate (in the case of uranium) to the true shape and area of the contaminated zone. Potential exposure pathways evaluated for the recreational receptor for this site include ingestion of soil, inhalation of fugitive dust, inhalation of radon, and exposure to external gamma radiation. Dermal exposure was not considered a viable pathway because the only COPCs identified are inorganic metals with little ability to be absorbed through the skin. A summary of the cleanup levels calculated, and the rationale for derivation based on the recreational exposure scenario for each the COPCs identified is provided below.

CHEMICAL	CLEANUP LEVEL (mg/kg)	RATIONALE
Cadmium	170	Carcinogen - 10^{-6} risk level.
Total uranium	4 790	RESRAD code based on a 15 mrem/yr dose.

The soil cleanup level for cadmium was calculated based on its potential to act as a human carcinogen at an acceptable level of risk of 1E-06. Based on this approach the cleanup level for cadmium is 170 mg/kg. The equation and assumptions used to calculate the cleanup level for cadmium are presented in Appendix E.

The RESRAD computer code, Version 5.60, was used to calculate cleanup levels based on committed effective dose equivalents for the natural uranium isotopes. Contribution of daughter products is included in the dose estimates for these primary radionuclides. The calculated cleanup level is based on a 15 mrem/yr dose level, which is the annual dose limit proposed in EPA's Radiation Site Cleanup Regulation (40 CFR 196 Proposed Rule). A summary of the RESRAD output file, including all input parameters used in the RESRAD calculations, are provided in Appendix F.

The cleanup level of 4 790 mg/kg total uranium is based on isotopic abundance of natural uranium. These relative abundances are 0.0058%, 0.72%, and 99.28%, by mass, for uranium-234, uranium-235, and uranium-238 respectively. The specific activities of the uranium isotopes are 6.24E+09 pCi/g, 6.24E+09 pCi/g, and 6.24E+09 pCi/g for uranium-234, uranium-235, and uranium-238 respectively. A mass-based cleanup level for total uranium in soil, based on a natural abundance of each isotope, can be calculated according to the following equation:

$$C_t = \frac{1}{\sum_1^i \left\{ F_i / C_i \right\}}$$

Where:

C_t = Cleanup level for mixed isotopes (ppm)

C_i = Cleanup level for isotope i (ppm)

F_i = Fractional amount of isotope i

7.0 DESCRIPTION OF CONFIRMATORY SAMPLING

Confirmatory analyses will be done by a fixed laboratory. Both contaminated and uncontaminated materials will be handled and prepared for disposal, storage, or shipment as noted on the completed characterization strategy forms in Appendix B. Confirmatory sampling will not be required at SWMUs 33-010(a,d,g) and 33-011(b) because Phase I analytical results indicated that the soil was not contaminated. Confirmatory soil samples will be collected under the metal ball at SWMU 33-010(b) and analyzed for metals and radioactivity.

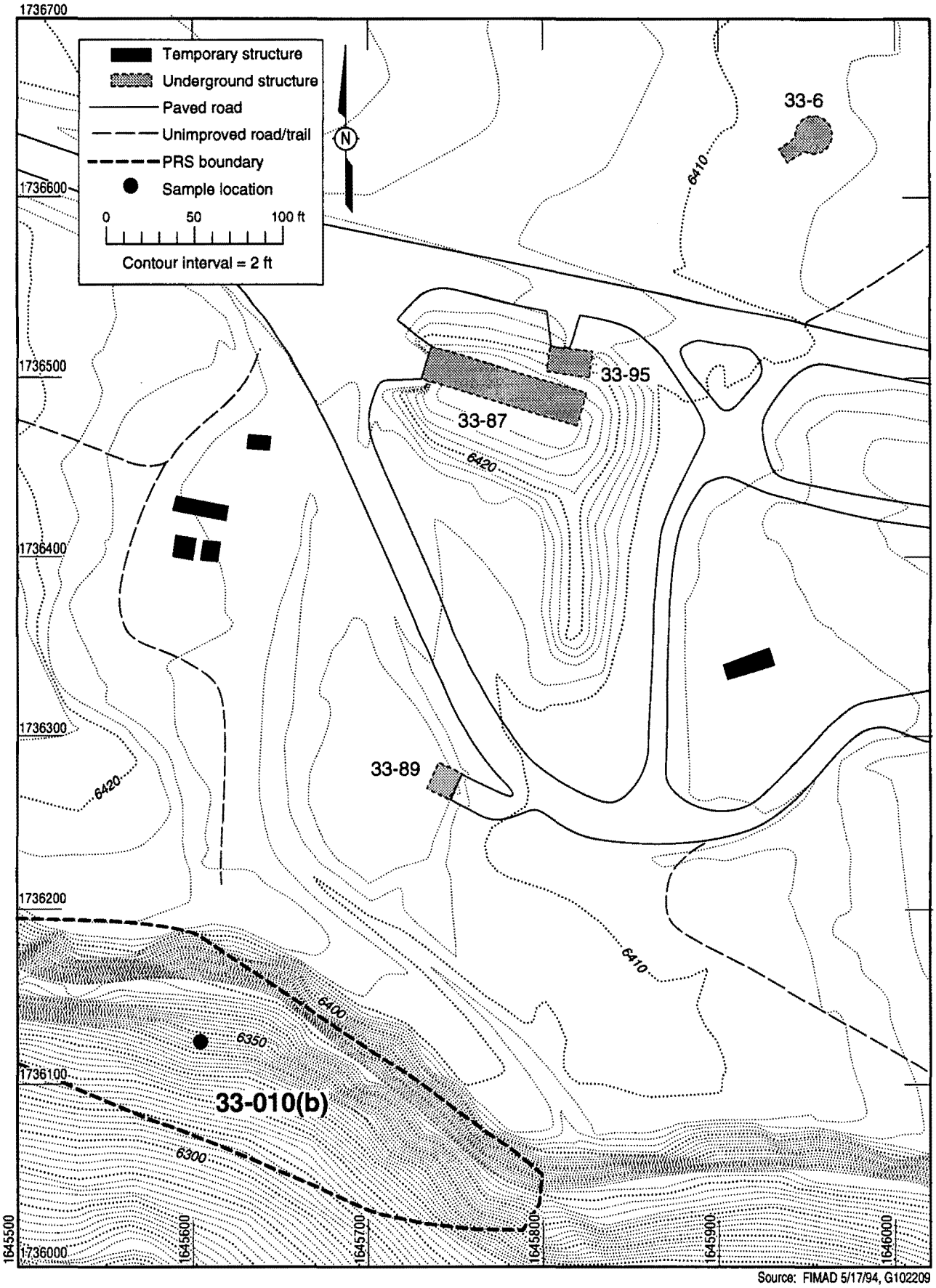

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Fig. 7-1. Sampling locations for SWMU 33-010(b).

8.0 ESTIMATED SCHEDULE AND COST TO COMPLETE EACH VCA

Table 8-1 lists each SWMU and details estimated scheduling and costs to be incurred in the implementation of each VCA. Cost estimates include the cost of characterization, confirmatory sampling, and analysis. Cost estimate summaries by SWMU have been included in Appendix G.

TABLE 8-1

ESTIMATED SCHEDULE AND COSTS

SWMU NUMBER	START DATE	COMPLETION DATE	ESTIMATED COST
33-010(a)	11/2/95	11/17/95	$ 11 700
33-010(b)	11/20/95	11/30/95	$ 18 950
33-010(d)	11/15/95	11/21/95	$ 11 700
33-010(g)	11/7/95	11/15/95	$ 11 700
33-011(b)	10/31/95	11/8/95	$ 11 700
		TOTAL	$ 65 750

9.0 REFERENCES

Buhl, T.E., June 28, 1988. "Clean-up of Two Firing Site Areas at TA-33," unpublished draft of a report, Los Alamos National Laboratory, Los Alamos, New Mexico. **(Buhl 1988, 02-038)**

Hoard, D., July 11, 1990. "Conversations with John Dougherty Re TA-33," Los Alamos National Laboratory Memorandum CLS-1/91-304-DH to CLS-1 file from D. Hoard (CLS-1), Los Alamos, New Mexico. **(Hoard 1990, 02-022)**

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

APPENDIX A FIELD SCREENING PROCEDURES

Field Screening Procedures

This plan outlines the steps to be taken during VCAs at the Laboratory for field screening of debris. Field screening will determine the segregation of debris into waste categories. Details not explicitly stated will be developed in the field and will be implemented as appropriate. All screening will be done by field personnel assigned to the VCA task. Portable hand-held field equipment will be used for radiation and heavy metal screening. Debris will be RAD screened in place prior to removal. Based on knowledge of process and best judgment, select debris will be screened with the XRF for hazardous constituents. The select debris will be screened with the XRF in the contamination reduction zone (CRZ). CONFIRM

Field screening of debris will be used to detect alpha, beta, and gamma radiation; and heavy metals.

In the field screening process, the following steps will be followed, in order, where the chemical of potential concern (COPC) is suspected:

1. Visual Survey
2. Radiation Screening
3. Heavy Metals Screening

The visual survey of each PRS involves a walk around of the site before and during debris removal. The purpose of visually surveying the site before the start of work activities is to identify the work area perimeter and the specific material(s) to be removed. Personnel performing this visual survey will be looking for surface debris, evidence of mounds or piles, flags or stakes from previous surveys or investigations, and any other evidence delineating the site. Visual survey will also be used to select and segregate those pieces of debris that will be screened with the XRF. Conditions that may hamper this activity include rain; regrading, recontouring, or revegetation of the site; discovery of archaeological artifacts; active Laboratory work; vegetation covering the site; and anything else that may inhibit the visual survey.

In addition to the visual survey, radiation screening will be done during the field work activities at each site. Screening equipment to be used will be approved by the Laboratory Health Physics Measurements Group (ESH-4) prior to their utilization. Each site will be surveyed for gross radiation using radiation detectors. Alpha, beta, gamma, and gross radiation detectors may be used. The frequency of debris or soil screening will be done at the discretion of the

on-site radiation screening personnel (RSP). Personnel will be screened for radiation at the end of the personal decontamination process prior to entering the support zone.

For sites where radioactive contamination is identified as being above background, additional radiation screening will ensure that preliminary information is sufficient and that the waste is consistent with anticipated radiation levels. Soil or debris samples will be collected to determine specific radioisotopes present in the waste. Swipes may also be used to determine radioactive contamination if the overseeing HPT determines this to be an appropriate means of field screening. Personnel will be screened when leaving the regulated area.

XRF or LIBS will be used to screen in the field where heavy metals are COPCs. The field test will be performed during work activities to screen debris and underlying soil and at the end of the removal. Confirmatory samples will be sent to an off-site laboratory, as applicable.

As field work progresses, decisions may be made by the Field Team Leader in conjunction with the Field Team Manager to reduce or increase the frequency of field screening. Field testing is for internal purposes only, and therefore, will not be validated. The field screening identified herein is expected to provide adequate information for waste segregation purposes. Other screening measures may be implemented if additional information is obtained concerning previously unidentified contaminants, or if more appropriate field screening measures are identified.

ASK IF THIS HAPPENED

Samples will be collected for waste characterization by an on-site mobile radiation screening laboratory and mobile chemical screening laboratory. These characterization analyses will provide data for waste management and transportation. Because the mobile labs will have limited capabilities, the samples may be shipped off-site for further analysis.

APPENDIX B CHARACTERIZATION STRATEGY FORMS

PENDING FINAL APPROVAL

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APPENDIX C FRAMEWORK FOR RECONSIDERING OR STOPPING WORK ON

Expedited Cleanups and Voluntary Corrective Actions

FRAMEWORK FOR RECONSIDERING OR STOPPING WORK ON EXPEDITED CLEANUPS AND VOLUNTARY CORRECTIVE ACTIONS

During the conduct of expedited cleanups (ECs) or voluntary corrective actions (VCAs), it is important to **preplan** a framework for understanding when the potential release site (PRS) conceptual model is flawed to the extent that continuing an EC or VCA should be **reconsidered**. This determination may not be straight forward and may be complicated by factors that are not readily apparent. While pursuing the EC or VCA is important to the ER project success, we must be careful to ensure that the pursuit of a "bean" does not tempt us to ignore emerging problems during the field work. The Field Project Leader (FPL) should reconsider any time information becomes available that indicates the site conceptual model may be off target. Furthermore, if the additional information warrants, **work should be stopped.**

Several past examples demonstrate the need for reconsideration and stopping criteria:

Waste type was thought to be solely hazardous, but was in reality "mixed waste".

Volume of waste was thought to be small , but was, in fact, much larger.

Spatial boundaries of the site were thought to be defined, but subsequently were found to be much larger.

Waste was thought to be uncontaminated debris, but upon disposal was determined to be contaminated with radionuclides.

Have we just been unlucky? Probably not. These are classic examples of the old maxim that if something can go wrong, it will. We must, therefore, maximize the opportunity to reconsider or stop work before it becomes a safety hazard, a professional embarrassment, or a bottomless pit for scarce resources, such as budget dollars or site disposal capacity.

If one or more factors change the prevailing site conceptual model, then **reconsider** the consequences of the change(s) and **stop work** if the change warrants it. Consider the following as a framework, **not** as a prescriptive solution to this difficult problem. The examples provided below are **not** intended to be an exhaustive listing of all possible changes, only an indication of changes frequently encountered.

When stopping work is determined to be the appropriate action, it is crucial to have a plan that describes 'safe' shutdown for the site EC or VCA operation. "Safe" in this context should consider such things as worker and trespasser safety, safe storage of wastes generated to date, and a shutdown configuration that ensures conditions at the site do not further mobilize contaminants or provide enhanced pathways for off site migration (an appropriate shutdown configuration will be determined in conjunction with appropriate interaction with the New Mexico Environment Department.)

POSSIBLE CRITERIA FOR RECONSIDERING AND/OR STOPPING WORK ON ECs/VCAs

1) **WASTE** - Changes in type, volume, disposal capacity, disposal location, etc. If the composition of waste changes and there is limited capacity for the site waste, such as mixed wastes,

   If the volume of waste begins to grow by more than 50%1 of the initial estimate, or

   If the disposal or treatment capacity for the site waste is not immediately available and would require waste storage for more than 90 days.

   Reconsider the consequences of the change(s) and **Stop** , if the change warrants it.

2) **COST** - Changes in available budget, total cost of project, etc.

   If the budget for site EC or VCA grows by more than 50%1 of the initial estimate,

   If sites are prioritization similarly, those with increasing costs may go down in project priority due to added costs, as the project would accomplish fewer

   EC/VCAs, or

   If continuation will affect the program's ability to take action at sites of equal or greater urgency.

   Reconsider the consequences of the change(s) and **Stop** , if the change warrants it.

3) **LEVEL OF PROBLEM UNDERSTANDING** - Changes in contamination type or level, job difficulty, etc.

   If the waste constituents change and impact the selected treatment/disposal alternatives,

If the extent of contaminant movement or the contaminant transport mechanism affects the overall job difficulty, or

Initial estimates of engineering costs are typically only good within a range of + or 50%. The relationship of waste management volume to waste management cost is usually linear, so that if volume increases 50% then so do costs.

If the impact of continuing the action creates a greater problem (e.g., regulatory, public relations, ecological, etc.) than stopping work.

Reconsider the consequences of the change(s) and **Stop** , if the change warrants it.

4) **RESOURCES** - Changes in knowledge, expertise, equipment, services, etc.

If new or additional site data causes the site problem to change from understood/ Documented historical site data,

If the remediation equipment needed for the changed site problem is unavailable,

If the expertise of available staff does not match the changed site problem, or

* If the sensitivity or analytical detection limits of available analytical methods for the changed site problem does not meet the revised site cleanup requirements.

Reconsider the consequences of the change(s) and **Stop** , if the change warrants it.

5) **SAFETY** - Changes in engineering plan or risk to remedial site worker, LANL worker, or off -site citizen, etc.

If additional site findings suggest a new or greatly increased risk of an acute or chronic nature to remedial site worker, LANL worker, or off-site citizen,

If a change to the remedial engineering plan, such as the depth of excavation, differs from the site safety plan, or

If getting a "bean' by end of the fiscal year appears to compromise safety.

Reconsider the consequences of the continued action(s) and **Stop** , if the finding warrants it.

6) **"LAUGH" TEST** - Question the appropriateness of what is being done.

If you doubt that your actions are consistent with common sense, or

If you think you are being asked to do something stupid, but in a smarter way.

Reconsider the consequences of the continued action(s) and **Stop** , if the finding warrants it.

SAMPLE INFORMATION

SWMU 33-010(a): Canyonside Disposal

NO.	SAMPLE ID	SITE ID	ASSIGNED PRS	TYPE	MATRIX	BEGIN DEPTH (in.)	END DEPTH (in.)	ANALYSES PERFORMED							
											ORGANICS				
								Inorganics	Rad	VOCs[a]	SVOCs[b]	PCBs[c]	HE[d]	Pesticides	Herbicides
1	AAA9646	33-1414	33-010(a)	*Surface*	Soil			19258	19957						
2	AAA9647	33-1415	33-010(a)	*Surface*	Soil	0	6	19258	19957						
3	AAA9648	33-1416	33-010(a)	*Surface*	Soil	0	6	19258	19957						
4	AAA9649	33-1417	33-010(a)	*Surface*	Soil	0	6	19258	19957						
5	AAA9650	33-1418 55	33-010(a)	*Surface*	Soil	0	6	19258	19957						
6	AAA9643	33-1392	007(a)	*Surface*	Soil	0	6	19253	19358		17674		17676		
7	AAA9644	33-1393	007(a)	*Surface*	Soil	0	6	19253	19358		17674		17676		
8	AAA9645	33-1394	007(a)	*Surface*	Soil	0	6	19253	19358		17674		17676		
9	AAA9658	33-1317	004(a)	surface	soil	0	6	19253			17674				

RESULTS OF ANALYSES

SWMU 33-010(a): Canyonside Disposal

NO.	SAMPLE ID	RADIONUCLIDES			INORGANICS											
		Uranium	Cesium-137	Cobolt-60	Silver	Arsenic	Barium	Berillium	Cadmium	Chromium	Mercury	Nickel	Lead	Antimony	Selenium	Zinc
		mg/kg	pCi/g	pCi/g	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	AAA9646	2.75	0.093	0.012	<0.76	<1.1	44.1	<0.45	<0.35	3.3	<0.02	3.2	7	<4.3	<0.57	19
	AAA9646R	NA[f]	NA	NA	<0.76	0.8	45.5	0.43	<0.35	5.1	*0.03*	<4.1	7	<4.3	<0.51	20
2	AAA9647	2.87	0.101	-0.007	<0.8	<1.3	99.3	<0.86	<0.37	7	<0.02	<5.9	6	<4.5	<0.54	30
	AAA9647R	2.81	0.111	-0.006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	AAA9648	*5.46*	0.175	-0.009	<0.78	<1.7	92.7	<0.88	1.4	12.8	*0.42*	<7.2	*35*	<4.4	<0.53	*204*
4	AAA9649	*8.34*	0.093	-0.016	<0.76	<0.83	50.5	<0.5	<0.35	4.1	*0.13*	<3.3	*989*	<4.3	<0.52	26
5	AAA9650	2.8	0.071	-0.008	<0.76	<0.55	57.5	<0.48	<0.35	6.1	<0.09	<2.8	*84*	<4.3	<0.51	40
26	AAA9643	0	0.396	-0.021	<0.77	<1.2	129	0.74	<0.39	*34.0*	<0.02	<8.4	*24.*	*6.1*	<0.52	32
	AAA9643R	NA	NA	NA	<0.77	1.1	141	<0.77	0.64	*32.4*	<0.02	9.1	*26*	<4.4	<0.52	34
27	AAA9644	0	1.019	-0.009	<0.81	<1.6	129	<0.81	<0.69	*22.7*	<0.05	<7.5	18	<4.6	<0.55	44
28	AAA9645	0.49	0.837	0.002	<0.79	<1.2	78	<0.88	<0.43	7.4	<0.02	<6.2	10	<4.5	<0.53	27
AAA9658 → add from other table	*SALs[g]*	*230*	*5.1*	*1.1*	*383*	*bkg*	*5 340*	*bkg*	*38*	*210*	*23*	*1 534*	*400*	*31*	*383*	*23 004*
	EQLs[h]	*1.4*	*1*	*NA*	*2*	*2*	*40*	*1*	*1*	*2*	*0.1*	*8*	*1*	*12*	*1*	*4*
	LANL UTLs[i]	*5.45*	*1.4*	*NA*	*NA*	*7.82*	*315*	*1.95*	*2.7*	*19.3*	*0.1*	*15.2*	*23.3*	*1*	*1.7*	*50.8*
	TA-33 UTLs	*4.12*	*2.068*	*NA*	*NA*	*3.77*	*139*	*1.22*	*NA*	*14.6*	*NA*	*11.1*	*25.2*	*0.17*	*0.92*	*57.3*

No organics detected

[a] VOCs = Volatile organic compounds.
[b] SVOCs = Semivolatile organic compounds.
[c] PCBs = Polychlorinated biphenyls.
[d] HE = High explosive.
[e] R = Reanalyzed.
[f] NA = Not applicable.
[g] SALs = Screening action levels.
[h] EQLs = Estimated quantitation limits.
[i] UTLs = Upper tolerance limits.

SAMPLE INFORMATION

SWMU 33-010(b): Canyonside Disposal

NO.	SAMPLE ID	SITE ID	ASSIGNED PRS	TYPE	MATRIX	BEGIN DEPTH (in.)	END DEPTH (in.)	ANALYSES PERFORMED							
											ORGANICS				
								Inorganics	Rad	VOCs[a]	SVOCs[b]	PCBs[c]	HE[d]	Pesticides	Herbicides
1	AAA9651	33-1418	33-010(b)	*Surface*	Soil	0	6	19258	19957						
2	AAA9652	33-1419	33-010(b)	*Surface*	Soil	0	6	19258	19957						
3	AAA9653	33-1420	33-010(b)	*Surface*	Soil	0	6	19258	19957						

RESULTS OF ANALYSES

SWMU 33-010(b): Canyonside Disposal

NO.	SAMPLE ID	RADIONUCLIDES			INORGANICS											
		Uranium	Cesium-137	Cobalt-60	Silver	Arsenic	Barium	Berilium	Cadmium	Chromium	Mercury	Nickel	Lead	Antimony	Selenium	Zinc
		mg/kg	pCi/g	pCi/g	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	AAA9651	*13.26*	0.77	-0.013	<0.76	<1.8	78	<0.7	*182*	*43.2*	0.13	<3.3	*83.7*	<4.3	<0.52	*402*
2	AAA9652	*761.62*	*1.52*	-0.006	<0.81	<2.2	135	<0.83	*53.7*	*34.2*	<0.03	*207*	*122*	<4.3	<0.51	*222*
3	AAA9653	5.19	0.68	-0.006	<0.79	<1.9	107	<0.83	*5.7*	6.7	<0.05	*429*	6.9	<4.6	<0.55	48.9
	SALs[f]	*230*	*5.1*	*1.1*	*383*	*bkg*	*5 340*	*bkg*	*38*	*210*	*23*	*1 534*	*400*	*31*	*383*	*23 004*
	EQLs[g]	*1.4*	*1*	*NA[e]*	*2*	*2*	*40*	*1*	*1*	*2*	*0.1*	*8*	*1*	*12*	*1*	*4*
	LANL UTLs[h]	*5.45*	*1.4*	*NA*	*NA*	*7.82*	*315*	*1.95*	*2.7*	*19.3*	*0.1*	*15.2*	*23.3*	*1*	*1.7*	*50.8*
	TA-33 UTLs	*4.12*	*2.068*	*NA*	*NA*	*3.77*	*139*	*1.22*	*NA*	*14.6*	*NA*	*11.1*	*25.2*	*0.17*	*0.92*	*57.3*

No organics analyzed

[a] VOCs = Volatile organic compounds.
[b] SVOCs = Semivolatile organic compounds.
[c] PCBs = Polychlorinated biphenyls.
[d] HE = High explosive.
[e] NA = Not applicable.
[f] SALs = Screening action levels.
[g] EQLs = Estimated quantitation limits.
[h] UTLs = Upper tolerance limits.

SAMPLE INFORMATION

SWMU 33-010(d): Canyonside Disposal

NO.	SAMPLE ID	SITE ID	ASSIGNED PRS	TYPE	MATRIX	BEGIN DEPTH (in.)	END DEPTH (in.)	ANALYSES PERFORMED							
											ORGANICS				
								Inorganics	Rad	VOCs[a]	SVOCs[b]	PCBs[c]	HE[d]	Pesticides	Herbicides
1	AAA9852	33-1422	33-010(d)	*Surface*	Surface soil	0	6	17843	19352						
2	AAA9853	33-1423	33-010(d)	*Surface*	Surface soil	0	6	17843	19352						
3	AAA9854	33-1424	33-010(d)	*Surface*	Surface soil	0	6	17843	19352						
4	AAA9855	33-1425	33-010(d)	*Surface*	Surface soil	0	6	17843	19352						
5	AAA9856	33-1426	33-010(d)	*Surface*	Surface soil	0	6	17843	19352						
6	AAA9857	33-1427	33-010(d)	*Surface*	Surface soil	0	6	17843	19352						

RESULTS OF ANALYSES

SWMU 33-010(d): Canyonside Disposal

NO.	SAMPLE ID	RADIONUCLIDES			INORGANICS											
		Uranium	Cesium-137	Cobalt-60	Silver	Arsenic	Barium	Beryllium	Cadmium	Chromium	Mercury	Nickel	Lead	Antimony	Selenium	Zinc
		mg/kg	pCi/g	pCi/g	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	AAA9852	0.36	0.779	0.003	<1	1.4	110	0.4	0.4	9.2	NA[e]	4	59	<0.25	<0.3	77
2	AAA9853	0.55	0.191	0.01	<1	1.3	68	0.09	0.4	6.8	NA	7	28	<0.25	<0.3	36
3	AAA9854	1.62	0.841	<0.002	<1	0.9	63	0.3	<0.4	6.3	NA	<2	7	<0.25	<0.3	45
4	AAA9855	1.09	0.849	0.022	<1	1.1	95	0.6	0.4	6.8	NA	4	9	<0.25	<0.3	29
5	AAA9856	0.34	0.519	0.004	<1	1	68	0.3	<0.4	3.6	NA	<2	4	<0.25	<0.3	20
6	AAA9857	0.54	0.754	0.013	<1	1	89	0.2	<0.4	4.2	NA	2	7	<0.25	<0.3	18
	SALs[f]	*230*	*5.1*	*1.1*	*383*	*bkg*	*5 340*	*bkg*	*38*	*210*	*23*	*1 534*	*400*	*31*	*383*	*23 004*
	EQLs[g]	*1.4*	*1*	*NA*	*2*	*2*	*40*	*1*	*1*	*2*	*0.1*	*8*	*1*	*12*	*1*	*4*
	LANL UTLs[h]	*5.45*	*1.4*	*NA*	*NA*	*7.82*	*315*	*1.95*	*2.7*	*19.3*	*0.1*	*15.2*	*23.3*	*1*	*1.7*	*50.8*
	TA-33 UTLs	*4.12*	*2.068*	*NA*	*NA*	*3.77*	*139*	*1.22*	*NA*	*14.6*	*NA*	*11.1*	*25.2*	*0.17*	*0.92*	*57.3*

No organics analyzed

[a] VOCs = Volatile organic compounds.
[b] SVOCs = Semivolatile organic compounds.
[c] PCBs = Polychlorinated biphenyls.
[d] HE = High explosive.
[e] NA = Not applicable.
[f] SALs = Screening action levels.
[g] EQLs = Estimated quantitation limits.
[h] UTLs = Upper tolerance limits.

SAMPLE INFORMATION

SWMU 33-010(g): Canyonside disposal SE of MDA-K

NO.	SAMPLE ID	SITE ID	ASSIGNED PRS	TYPE	MATRIX	BEGIN DEPTH (in.)	END DEPTH (in.)	ANALYSES PERFORMED							
										ORGANICS					
								Inorganics	Rad	VOCs[a]	SVOCs[b]	PCBs[c]	HE[d]	Pesticides	Herbicides
1	AAA9814	33-1428	33-010(g)	*canyonside*	soil	0	6	19283	19471				17831		
2	AAA9815	33-1429	33-010(g)	*canyonside*		0	6	19283	19471				17831		
3	AAA9816	33-1431	33-010(g)	*rubble pile*		0	6	19283	19471				17831		
4	AAA9817	33-1430	33-010(g)	*drainage*		0	6	19283	19471				17831		17798
5	AAA9804	33-1345	006A-31	*canyonside*		0	6	19396	19462				17732		
6	AAA9812	33-1352	006A-38	*canyonside*		0	6	19283	19471				17831		
7	AAA9813	33-1353	006A-39	*canyonside*		0	6	19283	19471				17831		
	AAA9805	33-1346	006A-32	SURFACE		0	6	19396	19462				17732		
	AAA9811	33-1351	006A-37	"		0	6	19283	19471				17831		

RESULTS OF ANALYSES

SWMU 33-010(g): Canyonside disposal SE of MDA-K

AAA9805 ?
9811

33-006(a)

NO.	SAMPLE ID	RADIONUCLIDES		INORGANICS											
		Uranium	Cesium-137	Silver	Arsenic	Barium	Beriliu m	Cadmium	Chromium	Mercury	Nickel	Lead	Antimony	Selenium	Zinc
		mg/kg	pCi/g	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	AAA9814	0.55	0.107	<.78	<1.1	85.6	1.5	<.36	4.8	<.02	<6.8	10.9	<4.4	<.53	34.3
2	AAA9815	0.18	0.056	<.84	<.61	53.7	<.62	<.39	2.8	<.02	<5	3.3	<4.8	<.57	19
3	AAA9816	1.57	0.588	<.75	<.55	<24.8	<.62	<.34	2.3	0.56	<1.3	6.4	<4.3	<.51	32.4
4	AAA9817	1.16	0.244	<.76	<.61	78.8	1.1	<.35	4.2	<.02	<6.2	6	<4.3	<.52	30.4
	AAA9817R[e]	1.27	NA[f]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5	AAA9804	2.33	1.12	<0.76	<1.6	55.9	<0.91	<0.51	4.4	<0.02	<4.5	14.7	<4.3	<0.51	45.8
	AAA9804R	2.12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	AAA9812	1.35	2.085	<.77	<.95	54.8	1.6	<.52	3.4	<.03	<4	21	<4.4	<.52	54.2
7	AAA9813	0.62	1.202	<.82	<.92	74.1	<1.1	<.59	4.9	<.02	<5.7	13.7	<4.7	<.55	43.1
	SALs[g]	*230*	*5.1*	*383*	*bkg*	*5 340*	*bkg*	*38*	*210*	*23*	*1 534*	*400*	*31*	*383*	*23 004*
	EQLs[h]	*1.4*	*1*	*2*	*2*	*40*	*1*	*1*	*2*	*0.1*	*8*	*1*	*12*	*1*	*4*
	LANL UTLs[i]	*5.45*	*1.4*	*NA*	*7.82*	*315*	*1.95*	*2.7*	*19.3*	*0.1*	*15.2*	*23.3*	*1*	*1.7*	*50.8*
	TA-33 UTLs	*4.12*	*2.068*	*NA*	*3.77*	*139*	*1.22*	*NA*	*14.6*	*NA*	*11.1*	*25.2*	*0.17*	*0.92*	*57.3*

	ORGANICS DETECTED					
NO.	SAMPLE ID	HE	RESULT	*SAL*	*EQL*	UNITS
5	AAA9804	Tetryl(methyl-2,4,6-trinitrophenylnitramine)	0.69	*NC*		mg/kg
7	AAA9813	Amino-4,6-dinitrotoluene [2-]	0.36	*NC*		mg/kg
	AAA9813	Amino-2,6-dinitrotoluene [4-]	0.36	*NC*		mg/kg

LIST ORGANICS
AAA9811

[a] VOCs = Volatile organic compounds.
[b] SVOCs = Semivolatile organic compounds.
[c] PCBs = Polychlorinated biphenyls.
[d] HE = High explosive.
[e] R = Reanalyzed.
[f] NA = Not applicable.
[g] SALs = Screening action levels.
[h] EQLs = Estimated quantitation limits.
[i] UTLs = Upper tolerance limits.

SAMPLE INFORMATION

SWMU 33-011(b): NRAO Storage Area

NO.	SAMPLE ID	SITE ID	ASSIGNED PRS	TYPE	MATRIX	BEGIN DEPTH (in.)	END DEPTH (in.)	ANALYSES PERFORMED							
										ORGANICS					
								Inorganics	Rad	VOCs[a]	SVOCs[b]	PCBs[c]	HE[d]	Pesticides	Herbicides
1	AAA9830	33-1433	33-011(b)	*surface*	soil	0	6	19255	19417						
2	AAA9831	33-1434	33-011(b)	*surface*	soil	0	6	19255	19417						
3	AAA9832	33-1435	33-011(b)	*surface*	soil	0	6	19255	19417						
4	AAA9833	33-1436	33-011(b)	*surface*	soil	0	6	19255	19417						
5	AAA9834	33-1471	33-011(b)	*collocated*	soil	0	6	19255	19417						
6	AAA9835	33-1437	33-011(b)	*surface*	soil	0	6	19255	19417						17897
7	AAA9836	33-1438	33-011(b)	*surface*	soil	0	6	19255	19417						
8	AAA9837	33-1439	33-011(b)	*surface*	soil	0	6	19255	19417						
9	AAA9838	33-1440	33-011(b)	*surface*	soil	0	6	19255	19417						
10	AAA9839	33-1441	33-011(b)	*surface*	soil	0	6	19255	19417						

RESULTS OF ANALYSES

SWMU 33-011(b): NRAO Storage Area

NO.	SAMPLE ID	RADIONUCLIDES		INORGANICS											
		Uranium	Cesium-137	Silver	Arsenic	Barium	Beriliium	Cadmium	Chromium	Mercury	Nickel	Lead	Antimony	Selenium	Zinc
		mg/kg	pCi/g	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	AAA9830	0.4	*1.938*	<0.86	1.8	110	0.68	<.4	6.2	<0.02	<7	10.1	<4.9	<0.58	34.2
	AAA9830R[e]	NA[f]	NA	<0.86	<1.8	110	<.71	0.48	5.6	<0.02	7.5	15.5	<4.9	<0.58	34.2
2	AAA9831	0.22	*1.651*	<0.88	<1.8	193	<0.72	<0.4	4.7	<.04	<5.8	10.8	<5	<0.59	28.6
	AAA9831R	0.32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	AAA9832	0.33	0.943	<0.8	<1.5	99.6	<0.68	<0.7	4.8	<0.02	<4.9	11	<4.5	<0.54	27.9
	AAA9832R	NA	1.019	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	AAA9833	0.41	0.906	<0.78	<1.6	94.9	<0.66	<0.51	5.6	<0.02	<6.8	14.6	<4.4	<0.52	27.8
5	AAA9834	0.23	0.702	<0.79	<1.6	105	<0.76	<0.51	6.1	<0.02	<7.1	14.4	<4.5	<0.54	30.1
6	AAA9835	0.41	1.271	<0.76	<1.3	81.1	<0.63	<0.45	4.5	<0.02	<6.2	8.5	<4.3	<0.52	21.8
7	AAA9836	0.68	0.502	<0.79	<1	92.5	<0.86	<0.36	5.8	<0.02	<7.1	8.9	<4.5	<0.53	25.4
8	AAA9837	0.49	0.04	<0.75	<1.4	103	<0.39	<0.34	5.4	<0.02	<4.9	4.6	<4.3	<0.51	15.8
9	AAA9838	0.53	1.262	<0.82	<1.1	84.7	<0.59	<0.38	4.6	<0.02	<4.2	13.2	<4.7	<0.55	31.9
10	AAA9839	0.49	0.081	<0.76	<1.3	82.5	<0.9	<0.35	5.4	<0.02	<4.6	9.5	<4.3	<0.52	25.7
SALs[g]		*230*	*5.1*	*383*	*bkg*	*5 340*	*bkg*	*38*	*210*	*23*	*1 534*	*400*	*31*	*383*	*23 004*
EQLs[h]		*1.4*	*1*	*2*	*2*	*40*	*1*	*1*	*2*	*0.1*	*8*	*1*	*12*	*1*	*4*
LANL UTLs[i]		*5.45*	*1.4*	*NA*	*7.82*	*315*	*1.95*	*2.7*	*19.3*	*0.1*	*15.2*	*23.3*	*1*	*1.7*	*50.8*
TA-33 UTLs		*4.12*	*2.068*	*NA*	*3.77*	*139*	*1.22*	*NA*	*14.6*	*NA*	*11.1*	*25.2*	*0.17*	*0.92*	*57.3*

No Organics Detected

[a] VOCs = Volatile organic compounds.
[b] SVOCs = Semivolatile organic compounds.
[c] PCBs = Polychlorinated biphenyls.
[d] HE = High explosive.
[e] R = Reanalyzed.
[f] NA = Not applicable.
[g] SALs = Screening action levels.
[h] EQLs = Estimated quantitation limits.
[i] UTLs = Upper tolerance limits.

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APPENDIX E METHODOLOGIES FOR DEVELOPING SITE-SPECIFIC PRELIMINARY REMEDIAL GOALS TO DEMONSTRATE CLEAN CLOSURE

The following equation was used to derive cleanup levels for carcinogenic compounds in soil for the recreational scenario:

$$C = \frac{TR \times AT \times 365 \ \ days/year}{\left(SF_o \times 10^{-6} \ \ kg/mg \times EF \times IR_{soil}\right) + \left(SF_i \times EF \times IR_{air} \times \left(1/Y\right)\right)}$$

Where:

PARAMETER	DEFINITION	UNITS	VALUE
C	Cleanup level - chemical concentration in soil	mg/kg	—
TR	Target excess individual lifetime cancer risk	unitless	10^{-6}
AT	Carcinogenic averaging time	yr	70
EF	Exposure frequency	days/yr	28
SF_o	Oral cancer slope factor	$(mg/kg\text{-}day)^{-1}$	chemical-specific
IR_{soil}	Age adjusted soil ingestion factor	mg-yr/kg-day	93
SF_i	Inhalation cancer slope factor	$(mg/kg\text{-}day)^{-1}$	chemical-specific
IR_{air}	Age adjusted inhalation factor	m^3-yr/kg-day	9.5
Y	Particulate emission factor (PEF) for non-volatiles	m^3/kg	1.11×10^7

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APPENDIX F PARAMETERS USED FOR RESRAD CALCULATION OF URANIUM CLEAN UP LEVEL

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Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary ... 2
Site-Specific Parameter Summary 4
Summary of Pathway Selections 9
Contaminated Zone and Total Dose Summary 10
Total Dose Components
Time = 0.000E+00 11
Time = 1.000E-01 12
Time = 1.000E+00 13
Time = 1.000E+01 14
Time = 5.000E+01 15
Time = 1.000E+02 16
Time = 5.000E+02 17
Time = 1.000E+03 18
Time = 5.000E+03 19
Time = 1.000E+04 20
Dose/Source Ratios Summed Over All Pathways 21
Single Radionuclide Soil Guidelines 21
Dose Per Nuclide Summed Over All Pathways 22
Soil Concentration Per Nuclide 23

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

Menu	Parameter	Current Value	Default	Parameter Name
-1	Dose conversion factors for inhalation, mrem/pCi:			
-1	Ac-227+D			
-1	Pa-231	6.720E+00	6.720E+00	DCF2(1)
-1	Pb-210+D	1.280E+00	1.280E+00	DCF2(2)
-1	Ra-226+D	2.320E-02	2.320E-02	DCF2(3)
-1	Th-230	8.600E-03	8.600E-03	DCF2(4)
-1	U-234	3.260E-01	3.260E-01	DCF2(5)
-1	U-235+D	1.320E-01	1.320E-01	DCF2(6)
-1	U-238+D	1.230E-01	1.230E-01	DCF2(7)
		1.180E-01	1.180E-01	DCF2(8)
1	Dose conversion factors for ingestion, mrem/pCi:			
1	Ac-227+D			
1	Pa-231	1.480E-02	1.480E-02	DCF3(1)
1	Pb-210+D	1.060E-02	1.060E-02	DCF3(2)
1	Ra-226+D	7.270E-03	7.270E-03	DCF3(3)
1	Th-230	1.330E-03	1.330E-03	DCF3(4)
1	U-234	5.480E-04	5.480E-04	DCF3(5)
1	U-235+D	2.830E-04	2.830E-04	DCF3(6)
1	U-238+D	2.670E-04	2.670E-04	DCF3(7)
		2.690E-04	2.690E-04	DCF3(8)
4	Food transfer factors:			
4	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
4	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
4	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
4	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
4	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
4	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(3,1)
	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(3,2)
	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(3,3)
	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(4,1)
	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,2)
	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,3)
	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(5,1)
	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(5,2)
	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(5,3)
	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(6,1)
	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(6,2)
	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(6,3)
	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(7,1)
	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(7,2)
	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(7,3)

Dose Conversion Factor (and Related) Parameter Summary (continued)

File: DOSFAC.BIN

Menu	Parameter	Current Value	Default	Parameter Name
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(8,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(8,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(8,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(4,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(5,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(5,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(6,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(6,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(7,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(7,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(8,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(8,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	2.500E+02	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.800E+01	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E-01	1.000E+00	---	T(2)
R011	Times for calculations (yr)	1.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	5.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	5.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	5.000E+03	0.000E+00	---	T(9)
R011	Times for calculations (yr)	1.000E+04	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): U-234	4.100E+02	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g): U-235	1.900E+01	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/g): U-238	3.700E+02	0.000E+00	---	S1(8)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1(6)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1(7)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1(8)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	0.000E+00	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	4.400E+02	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/cm**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.990E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	4.800E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	5.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSAQ
	Saturated zone total porosity	3.000E-01	4.000E-01	---	TPSZ
	Saturated zone effective porosity	3.000E-01	2.000E-01	---	EPSZ
	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
	Saturated zone b parameter	4.050E+00	5.300E+00	---	BSZ
	Water table drop rate (m/yr)	3.000E-01	1.000E-03	---	VWT
	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Number of unsaturated zone strata	not used	1	---	NS
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R015	Unsat. zone 2, thickness (m)	not used	0.000E+00	---	H(2)
R015	Unsat. zone 2, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(2)
R015	Unsat. zone 2, total porosity	not used	4.000E-01	---	TPUZ(2)
R015	Unsat. zone 2, effective porosity	not used	2.000E-01	---	EPUZ(2)
R015	Unsat. zone 2, soil-specific b parameter	not used	5.300E+00	---	BUZ(2)
R015	Unsat. zone 2, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(2)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(6,1)
R016	Unsaturated zone 2 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(6,2)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.996E-06	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(7,1)
R016	Unsaturated zone 2 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(7,2)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.996E-06	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(8,1)
R016	Unsaturated zone 2 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(8,2)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.996E-06	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,1)
R016	Unsaturated zone 2 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,2)
R016	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.474E-06	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(2,1)
R016	Unsaturated zone 2 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(2,2)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.996E-06	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,1)
R016	Unsaturated zone 2 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,2)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.499E-06	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(4,1)
R016	Unsaturated zone 2 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(4,2)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.141E-06	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(5,1)
R016	Unsaturated zone 2 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(5,2)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.500E-09	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R017	Inhalation rate (m**3/yr)	1.840E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	---	LM
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	FIND
	Fraction of time spent outdoors (on site)	6.650E-03	2.500E-01	---	FOTD
	Shape factor flag, external gamma	-1.000E+00	1.000E+00	-1 shows non-circular AREA.	FS

Site-Specific Parameter Summary (continued)

Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
Radii of shape factor array (used if FS = -1):				
Outer annular radius (m), ring 1:	1.000E+00	5.000E+01	---	RAD_SHAPE(1)
Outer annular radius (m), ring 2:	2.500E+00	7.071E+01	---	RAD_SHAPE(2)
Outer annular radius (m), ring 3:	5.000E+00	0.000E+00	---	RAD_SHAPE(3)
Outer annular radius (m), ring 4:	1.000E+01	0.000E+00	---	RAD_SHAPE(4)
Outer annular radius (m), ring 5:	2.000E+01	0.000E+00	---	RAD_SHAPE(5)
Outer annular radius (m), ring 6:	0.000E+00	0.000E+00	---	RAD_SHAPE(6)
Outer annular radius (m), ring 7:	0.000E+00	0.000E+00	---	RAD_SHAPE(7)
Outer annular radius (m), ring 8:	0.000E+00	0.000E+00	---	RAD_SHAPE(8)
Outer annular radius (m), ring 9:	0.000E+00	0.000E+00	---	RAD_SHAPE(9)
Outer annular radius (m), ring 10:	0.000E+00	0.000E+00	---	RAD_SHAPE(10)
Outer annular radius (m), ring 11:	0.000E+00	0.000E+00	---	RAD_SHAPE(11)
Outer annular radius (m), ring 12:	0.000E+00	0.000E+00	---	RAD_SHAPE(12)
Fractions of annular areas within AREA:				
Ring 1	1.000E+00	1.000E+00	---	FRACA(1)
Ring 2	1.000E+00	2.732E-01	---	FRACA(2)
Ring 3	1.000E+00	0.000E+00	---	FRACA(3)
Ring 4	7.400E-01	0.000E+00	---	FRACA(4)
Ring 5	0.000E+00	0.000E+00	---	FRACA(5)
Ring 6	0.000E+00	0.000E+00	---	FRACA(6)
Ring 7	0.000E+00	0.000E+00	---	FRACA(7)
Ring 8	0.000E+00	0.000E+00	---	FRACA(8)
Ring 9	0.000E+00	0.000E+00	---	FRACA(9)
Ring 10	0.000E+00	0.000E+00	---	FRACA(10)
Ring 11	0.000E+00	0.000E+00	---	FRACA(11)
Ring 12	0.000E+00	0.000E+00	---	FRACA(12)
Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
Contamination fraction of drinking water	not used	1.000E+00	---	FDW
Contamination fraction of household water	0.000E+00	1.000E+00	---	FHHW
Contamination fraction of livestock water	not used	1.000E+00	---	FLW
Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
Contamination fraction of plant food	not used	-1	---	FPLANT
Contamination fraction of meat	not used	-1	---	FMEAT
Contamination fraction of milk	not used	-1	---	FMILK
Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	not used	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	not used	1.000E+00	---	STOR_T(2)
STOR	Milk	not used	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	not used	2.000E+01	---	STOR_T(4)
STOR	Fish	not used	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	not used	7.000E+00	---	STOR_T(6)
STOR	Well water	not used	1.000E+00	---	STOR_T(7)
STOR	Surface water	not used	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	not used	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	2.000E-06	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	2.000E+00	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	3.000E+00	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	code computed (time dependent)	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	code computed (time dependent)	DMFL
R021	Emanating power of Rn-222 gas	2.500E-01	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Summary of Pathway Selections

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

Contaminated Zone Dimensions

Area:	250.00 square meters
Thickness:	1.00 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g

U-234	4.100E+02
U-235	1.900E+01
U-238	3.700E+02

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 15 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E-01	1.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03	5.000E+03	1.000E+04
TDOSE(t):	1.409E+00	1.409E+00	1.409E+00	1.409E+00	1.410E+00	1.413E+00	1.443E+00	1.497E+00	2.297E+00	3.521E+00
M(t):	9.391E-02	9.391E-02	9.391E-02	9.393E-02	9.402E-02	9.419E-02	9.617E-02	9.983E-02	1.531E-01	2.347E-01

Maximum TDOSE(t): 3.521E+00 mrem/yr at t = 1.000E+04 years

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	9.650E-04	0.0007	5.566E-01	0.3951	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.041E-03	0.0050
U-235	8.254E-02	0.0586	2.404E-02	0.0171	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.078E-04	0.0002
U-238	2.821E-01	0.2003	4.490E-01	0.3188	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.040E-03	0.0043
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	3.656E-01	0.2596	1.030E+00	0.7309	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.339E-02	0.0095

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.646E-01	0.4008
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.069E-01	0.0759
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.372E-01	0.5233
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.409E+00	1.0000

*[illegible] of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	frac
U-234	9.651E-04	0.0007	5.566E-01	0.3951	6.580E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.041E-03	0.0
U-235	8.254E-02	0.0586	2.404E-02	0.0171	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.079E-04	0.00
U-238	2.821E-01	0.2003	4.490E-01	0.3188	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.040E-03	0.00
Total	3.656E-01	0.2596	1.030E+00	0.7309	6.580E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.339E-02	0.00

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.646E-01	0.400
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.069E-01	0.075
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.372E-01	0.523
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.409E+00	1.000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	9.651E-04	0.0007	5.566E-01	0.3951	6.579E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.041E-03	0.0050
U-235	8.254E-02	0.0586	2.404E-02	0.0171	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.081E-04	0.0002
U-238	2.821E-01	0.2003	4.490E-01	0.3188	5.531E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.040E-03	0.0043
Total	3.656E-01	0.2596	1.030E+00	0.7309	6.579E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.339E-02	0.0095

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.646E-01	0.4008
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.069E-01	0.0759
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.372E-01	0.5233
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.409E+00	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	9.702E-04	0.0007	5.567E-01	0.3951	6.570E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.042E-03	0.0050
U-235	8.254E-02	0.0586	2.413E-02	0.0171	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.109E-04	0.0002
U-238	2.821E-01	0.2002	4.490E-01	0.3187	5.593E-16	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.040E-03	0.0043
Total	3.656E-01	0.2595	1.030E+00	0.7310	6.570E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.339E-02	0.0095

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.647E-01	0.4008
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.070E-01	0.0759
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.372E-01	0.5232
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.409E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
o-	áááááááááááááááá		áááááááááááááááá		áááááááááááááááá		áááááááááááááááá		áááááááááááááááá		áááááááááááááááá		áááááááááááááááá	
ide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
áááááá	áááááááááá	áááááá	áááááááááá	áááááá	áááááááááá	áááááá	áááááááááá	áááááá	áááááááááá	áááááá	áááááááááá	áááááá	áááááááááá	áááááá
	1.089E-03	0.0008	5.571E-01	0.3950	1.633E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.045E-03	0.0050
	8.266E-02	0.0586	2.499E-02	0.0177	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.297E-04	0.0002
233	2.821E-01	0.2000	4.490E-01	0.3184	6.960E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.040E-03	0.0043
	ëëëëëëëëëë	ëëëëëë	ëëëëëëëëëë	ëëëëëë	ëëëëëëëëëë	ëëëëëë	ëëëëëëëëëë	ëëëëëë	ëëëëëëëëëë	ëëëëëë	ëëëëëëëëëë	ëëëëëë	ëëëëëëëëëë	ëëëëëë
	3.658E-01	0.2594	1.031E+00	0.7311	1.633E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.341E-02	0.0095

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
dio-	áááááááááááááááá		áááááááááááááááá		áááááááááááááááá		áááááááááááááááá		áááááááááááááááá		áááááááááááááááá		áááááááááááááááá	
de	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
áááá	áááááááááá	áááááá	áááááááááá	áááááá	áááááááááá	áááááá	áááááááááá	áááááá	áááááááááá	áááááá	áááááááááá	áááááá	áááááááááá	áááááá
234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.652E-01	0.4008
	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.080E-01	0.0766
	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.372E-01	0.5227
ëëëëë	ëëëëëëëëëë	ëëëëëë	ëëëëëëëëëë	ëëëëëë	ëëëëëëëëëë	ëëëëëë	ëëëëëëëëëë	ëëëëëë	ëëëëëëëëëë	ëëëëëë	ëëëëëëëëëë	ëëëëëë	ëëëëëëëëëë	ëëëëëë
	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.410E+00	1.0000

m of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
U-234	1.457E-03	0.0010	5.575E-01	0.3946	6.482E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.052E-03	0.00
U-235	9.287E-02	0.0587	2.549E-02	0.0188	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.587E-04	0.00
U-238	2.820E-01	0.1996	4.490E-01	0.3178	5.537E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.040E-03	0.00
Total	3.664E-01	0.2593	1.033E+00	0.7312	6.482E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.345E-02	0.00

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.660E-01	0.400
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.097E-01	0.077
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.371E-01	0.521
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.413E+00	1.000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	1.251E-02	0.0087	5.612E-01	0.3890	1.528E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.169E-03	0.0050
U-235	8.475E-02	0.0587	3.954E-02	0.0274	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.035E-04	0.0004
U-238	2.817E-01	0.1953	4.491E-01	0.3113	6.620E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.040E-03	0.0042
Total	3.790E-01	0.2627	1.050E+00	0.7277	1.529E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.381E-02	0.0096

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.809E-01	0.4027
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.249E-01	0.0866
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.368E-01	0.5108
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.443E+00	1.0000

Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	4.397E-02	0.0294	5.659E-01	0.3779	5.691E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.465E-03	0.005
U-235	8.707E-02	0.0581	5.570E-02	0.0372	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.064E-04	0.001
U-238	2.813E-01	0.1879	4.491E-01	0.2999	5.017E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.040E-03	0.004
Total	4.124E-01	0.2754	1.071E+00	0.7150	5.696E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.441E-02	0.009

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

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.173E-01	0.4122
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.437E-01	0.0959
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.365E-01	0.4918
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.497E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	6.586E-01	0.2867	6.037E-01	0.2628	8.706E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.291E-02	0.0056
U-235	1.045E-01	0.0455	1.773E-01	0.0772	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.186E-03	0.0014
U-238	2.812E-01	0.1224	4.497E-01	0.1958	4.288E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.068E-03	0.0026
Total	1.044E+00	0.4546	1.231E+00	0.5357	8.749E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.216E-02	0.0096

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.275E+00	0.5551
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.850E-01	0.1241
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.370E-01	0.3208
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.297E+00	1.0000

Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+04 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	1.661E+00	0.4717	6.487E-01	0.1842	2.197E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.167E-02	0.0062
U-235	1.236E-01	0.0351	3.116E-01	0.0885	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.703E-03	0.0016
U-238	2.917E-01	0.0828	4.510E-01	0.1281	2.364E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.197E-03	0.0018
Total	2.076E+00	0.5896	1.411E+00	0.4008	2.221E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.357E-02	0.0095

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+04 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.331E+00	0.6621
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.410E-01	0.1252
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.488E-01	0.2127
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.521E+00	1.0000

*Sum of all water independent and dependent pathways.

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

Parent (i)	Product (j)	Branch Fraction	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E-01	1.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03	5.000E+03	1.000E+04
áááááá	áááááááá	ááááááááá	ááááááááá	ááááááááá	ááááááááá	ááááááááá	ááááááááá	ááááááááá	ááááááááá	ááááááááá	ááááááááá	ááááááááá
-234	U-234	1.000E+00	1.377E-03	1.377E-03	1.377E-03	1.377E-03	1.377E-03	1.376E-03	1.373E-03	1.369E-03	1.338E-03	1.299E-03
-234	Th-230	1.000E+00	0.000E+00	3.054E-09	3.054E-08	3.054E-07	1.527E-06	3.052E-06	1.522E-05	3.032E-05	1.472E-04	2.836E-04
U-234	Ra-226	1.000E+00	0.000E+00	1.215E-12	1.214E-10	1.213E-08	3.014E-07	1.197E-06	2.821E-05	1.051E-04	1.607E-03	4.057E-03
-234	Pb-210	1.000E+00	0.000E+00	1.459E-17	1.433E-14	1.337E-11	1.269E-09	7.632E-09	2.859E-07	1.136E-06	1.827E-05	4.638E-05
-234	ÔDSR(j)		1.377E-03	1.377E-03	1.377E-03	1.377E-03	1.379E-03	1.381E-03	1.417E-03	1.506E-03	3.110E-03	5.686E-03
-235	U-235	1.000E+00	5.625E-03	5.625E-03	5.625E-03	5.625E-03	5.624E-03	5.624E-03	5.617E-03	5.608E-03	5.542E-03	5.459E-03
-235	Pa-231	1.000E+00	0.000E+00	3.148E-08	3.148E-07	3.148E-06	1.573E-05	3.144E-05	1.563E-04	3.106E-04	1.472E-03	2.754E-03
-235	Ac-227	1.000E+00	0.000E+00	2.739E-10	2.713E-08	2.472E-06	4.297E-05	1.201E-04	8.004E-04	1.643E-03	7.987E-03	1.500E-02
-235	ÔDSR(j)		5.625E-03	5.625E-03	5.626E-03	5.631E-03	5.683E-03	5.775E-03	6.574E-03	7.562E-03	1.500E-02	2.321E-02
-238	U-238	1.000E+00	1.992E-03	1.992E-03	1.992E-03	1.992E-03	1.992E-03	1.992E-03	1.989E-03	1.986E-03	1.963E-03	1.934E-03
-238	U-234	1.000E+00	0.000E+00	3.896E-10	3.896E-09	3.896E-08	1.948E-07	3.894E-07	1.944E-06	3.879E-06	1.906E-05	3.728E-05
-238	Th-230	1.000E+00	0.000E+00	4.320E-16	4.321E-14	4.320E-12	1.080E-10	4.318E-10	1.077E-08	4.295E-08	1.049E-06	4.072E-06
-238	Ra-226	1.000E+00	0.000E+00	0.000E+00	1.131E-16	1.144E-13	1.424E-11	1.133E-10	1.354E-08	1.026E-07	8.772E-06	4.836E-05
-238	Pb-210	1.000E+00	0.000E+00	0.000E+00	7.188E-21	9.605E-17	4.797E-14	6.054E-13	1.294E-10	1.075E-09	9.903E-08	5.509E-07
-238	ÔDSR(j)		1.992E-03	1.992E-03	1.992E-03	1.992E-03	1.992E-03	1.992E-03	1.991E-03	1.990E-03	1.992E-03	2.024E-03
ëëëëëë	ëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life μ 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 15 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E-01	1.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03	5.000E+03	1.000E+04
áááááá	ááááááááá	ááááááááá	ááááááááá	ááááááááá	ááááááááá	ááááááááá	ááááááááá	ááááááááá	ááááááááá	ááááááááá
-234	1.089E+04	1.089E+04	1.089E+04	1.089E+04	1.088E+04	1.087E+04	1.059E+04	9.963E+03	4.823E+03	2.638E+03
-235	2.667E+03	2.667E+03	2.666E+03	2.664E+03	2.639E+03	2.597E+03	2.282E+03	1.984E+03	1.000E+03	6.463E+02
-238	7.529E+03	7.529E+03	7.529E+03	7.529E+03	7.529E+03	7.529E+03	7.532E+03	7.536E+03	7.531E+03	7.412E+03
ëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 1.000E+04 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
áááááá	ááááááááá	ááááááááááááááááá	ááááááááá	ááááááááá	ááááááááá	ááááááááá
-234	4.100E+02	1.000E+04	5.686E-03	2.638E+03	5.686E-03	2.638E+03
-235	1.900E+01	1.000E+04	2.321E-02	6.463E+02	2.321E-02	6.463E+02
-238	3.700E+02	1.000E+04	2.024E-03	7.412E+03	2.024E-03	7.412E+03
ëëëëëë	ëëëëëëëëë	ëëëëëëëëëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë	ëëëëëëëëë

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

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E-01	1.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03	5.000E+03	1.000E+04
U-234	U-234	1.000E+00	5.646E-01	5.646E-01	5.646E-01	5.646E-01	5.644E-01	5.643E-01	5.630E-01	5.613E-01	5.484E-01	5.327E-01
U-234	U-238	1.000E+00	0.000E+00	1.442E-07	1.442E-06	1.441E-05	7.206E-05	1.441E-04	7.192E-04	1.435E-03	7.051E-03	1.379E-02
U-234	ΣDOSE(j):		5.646E-01	5.646E-01	5.646E-01	5.646E-01	5.645E-01	5.644E-01	5.637E-01	5.628E-01	5.555E-01	5.465E-01
Th-230	U-234	1.000E+00	0.000E+00	1.252E-06	1.252E-05	1.252E-04	6.259E-04	1.251E-03	6.238E-03	1.243E-02	6.034E-02	1.163E-01
Th-230	U-238	1.000E+00	0.000E+00	1.598E-13	1.599E-11	1.599E-09	3.995E-08	1.598E-07	3.985E-06	1.589E-05	3.880E-04	1.507E-03
Th-230	ΣDOSE(j):		0.000E+00	1.252E-06	1.252E-05	1.252E-04	6.260E-04	1.252E-03	6.242E-03	1.245E-02	6.073E-02	1.178E-01
Ra-226	U-234	1.000E+00	0.000E+00	4.980E-10	4.979E-08	4.973E-06	1.236E-04	4.906E-04	1.156E-02	4.308E-02	6.590E-01	1.663E+00
Ra-226	U-238	1.000E+00	0.000E+00	0.000E+00	4.186E-14	4.234E-11	5.268E-09	4.191E-08	5.010E-06	3.797E-05	3.246E-03	1.789E-02
Ra-226	ΣDOSE(j):		0.000E+00	4.980E-10	4.979E-08	4.973E-06	1.236E-04	4.907E-04	1.157E-02	4.311E-02	6.622E-01	1.681E+00
Pb-210	U-234	1.000E+00	0.000E+00	5.982E-15	5.876E-12	5.483E-09	5.201E-07	3.129E-06	1.172E-04	4.656E-04	7.493E-03	1.902E-02
Pb-210	U-238	1.000E+00	0.000E+00	0.000E+00	2.659E-18	3.554E-14	1.775E-11	2.240E-10	4.788E-08	3.976E-07	3.664E-05	2.038E-04
Pb-210	ΣDOSE(j):		0.000E+00	5.982E-15	5.876E-12	5.483E-09	5.201E-07	3.129E-06	1.173E-04	4.660E-04	7.529E-03	1.922E-02
U-235	U-235	1.000E+00	1.069E-01	1.069E-01	1.069E-01	1.069E-01	1.069E-01	1.068E-01	1.067E-01	1.066E-01	1.053E-01	1.037E-01
Pa-231	U-235	1.000E+00	0.000E+00	5.981E-07	5.981E-06	5.980E-05	2.989E-04	5.973E-04	2.970E-03	5.901E-03	2.796E-02	5.232E-02
Ac-227	U-235	1.000E+00	0.000E+00	5.204E-09	5.154E-07	4.696E-05	8.165E-04	2.282E-03	1.521E-02	3.122E-02	1.518E-01	2.849E-01
U-238	U-238	1.000E+00	7.372E-01	7.372E-01	7.372E-01	7.372E-01	7.371E-01	7.370E-01	7.361E-01	7.350E-01	7.262E-01	7.154E-01

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

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g									
		t=	0.000E+00	1.000E-01	1.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03	5.000E+03	1.000E+04
U-234	U-234	1.000E+00	4.100E+02	4.100E+02	4.100E+02	4.100E+02	4.099E+02	4.098E+02	4.088E+02	4.076E+02	3.982E+02	3.868E+02
U-234	U-238	1.000E+00	0.000E+00	1.047E-04	1.047E-03	1.047E-02	5.233E-02	1.046E-01	5.222E-01	1.042E+00	5.120E+00	1.002E+01
U-234	δS(j):		4.100E+02	4.100E+02	4.100E+02	4.100E+02	4.099E+02	4.099E+02	4.093E+02	4.087E+02	4.034E+02	3.968E+02
Th-230	U-234	1.000E+00	0.000E+00	3.691E-04	3.691E-03	3.691E-02	1.845E-01	3.688E-01	1.839E+00	3.664E+00	1.778E+01	3.427E+01
Th-230	U-238	1.000E+00	0.000E+00	4.711E-11	4.712E-09	4.711E-07	1.178E-05	4.709E-05	1.174E-03	4.684E-03	1.143E-01	4.440E-01
Th-230	δS(j):		0.000E+00	3.691E-04	3.691E-03	3.691E-02	1.845E-01	3.689E-01	1.840E+00	3.668E+00	1.790E+01	3.472E+01
Ra-226	U-234	1.000E+00	0.000E+00	7.995E-09	7.993E-07	7.983E-05	1.984E-03	7.876E-03	1.857E-01	6.915E-01	1.058E+01	2.670E+01
Ra-226	U-238	1.000E+00	0.000E+00	0.000E+00	6.720E-13	6.796E-10	8.457E-08	6.727E-07	8.043E-05	6.096E-04	5.210E-02	2.872E-01
Ra-226	δS(j):		0.000E+00	7.995E-09	7.993E-07	7.983E-05	1.984E-03	7.877E-03	1.857E-01	6.921E-01	1.063E+01	2.699E+01
Pb-210	U-234	1.000E+00	0.000E+00	8.366E-12	8.218E-09	7.669E-06	7.274E-04	4.376E-03	1.640E-01	6.512E-01	1.048E+01	2.659E+01
Pb-210	U-238	1.000E+00	0.000E+00	0.000E+00	3.719E-15	4.970E-11	2.482E-08	3.133E-07	6.697E-05	5.561E-04	5.124E-02	2.851E-01
Pb-210	δS(j):		0.000E+00	8.366E-12	8.218E-09	7.669E-06	7.274E-04	4.376E-03	1.640E-01	6.517E-01	1.053E+01	2.688E+01
U-235	U-235	1.000E+00	1.900E+01	1.900E+01	1.900E+01	1.900E+01	1.900E+01	1.899E+01	1.897E+01	1.894E+01	1.872E+01	1.844E+01
Pa-231	U-235	1.000E+00	0.000E+00	4.015E-05	4.015E-04	4.015E-03	2.006E-02	4.010E-02	1.994E-01	3.961E-01	1.877E+00	3.512E+00
Ac-227	U-235	1.000E+00	0.000E+00	6.396E-08	6.335E-06	5.773E-04	1.004E-02	2.805E-02	1.869E-01	3.838E-01	1.865E+00	3.502E+00
U-238	U-238	1.000E+00	3.700E+02	3.700E+02	3.700E+02	3.700E+02	3.699E+02	3.699E+02	3.694E+02	3.689E+02	3.645E+02	3.591E+02

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

APPENDIX G COST ESTIMATE DETAILED SUMMARY

VCA	LABOR COST	SUPPLIES	EQUIPMENT	SAMPLE COST	TOTAL ESTIMATED WASTE VOLUMES	DISPOSAL COST	TOTAL
33-010(a)	$ 8 400	$ 100	$ 1 200	NA	10.5 yd^3	$ 1 921	$ 11 621
33-010(b)	$ 8 400	$ 50	$ 8 500	$ 270	40 yd^3	$ 30 500	$ 47 720
33-010(d)	$ 8 400	$ 100	$ 1 200	NA	6.5 yd^3	$ 1 490	$ 11 190
33-010(g)	$ 8 400	$ 100	$ 1 200	NA	6 yd^3	$ 570	$ 10 270
33-011(b)	$ 8 400	$ 100	$ 1 200	NA	6.25 yd^3	$ 875	$ 10 575
TOTAL	$ 42 000	$ 450	$ 13 300	$ 270	69.25 yd^3	$ 35 356	$ 91 376

Voluntary Corrective Action Completion Report for

Solid Waste Management Units at TA-33

33-010(a), Canyon-Side Disposal Area
33-010(d), Surface Disposal Area
33-010(g), Canyon-Side Disposal Area
33-011(b), General Storage Area

Field Unit 3

Environmental Restoration Project

June 1996

A Department of Energy
Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY

LA-UR-96-1839

Environmental Restoration
University of California
Environmental Restoration Project, MS M992
Los Alamos, New Mexico 87545
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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

Date: June 13, 1996
Refer to: EM/ER:96-343

Mr. Benito Garcia
NMED-HRMB
P.O. Box 26110
Santa Fe, NM 87502

SUBJECT: VOLUNTARY CORRECTIVE ACTION (VCA) COMPLETION REPORT FOR ACTIVITIES AT TECHNICAL AREA (TA) 33, POTENTIAL RELEASE SITES (PRSs) 33-010(a), (d), and (g) AND 33-011(b)

Dar Mr. Garcia:

Enclosed please find a copy of the VCA Completion Report for cleanup activities in TA-33, PRSs 33-010(a), (d), and (g) and 33-011(b), completed in Fiscal Year 1996. PRS 33-010(a), (d), and (g) are listed in the Hazardous and Solid Waste Amendments (HSWA) Module of the Los Alamos National Laboratory's Resource Conservation and Recovery Act operating permit and we are, therefore, asking for your concurrence in our recommendation to remove these sites from the HSWA Module. PRS 33-011(b) is not listed in the HSWA Module and, therefore, that portion of the report is being submitted for your information only.

The Department of Energy has reviewed and approved this report and has agreed with our recommendation for no further action to remove these sites from the HSWA Module through a permit modification and to remove them from our total list of PRSs. The approval form is attached to the report. The Certification of Completion has been signed and is also included in the enclosed report.

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

Sincerely,

Jorg Jansen, Program Manager
LANL/ER Project

Sincerely,

Theodore J. Taylor, Program Manager
DOE/LAAO

JJ/TT/rfr

Enclosures: (1) Final VCA Completion Report for TA-33, PRS(s) 33-010(a), (d), and (g) and 33-011(b)
(2) Certification of Completion
(3) DOE Approval Form

Cy (w/ encs.):
R. Michelotti, CST-18, MS E525
J. Mose, LAAO, MS A316
D. Neleigh, EPA, R.6, 6PD-N (2 copies)
D. Griswold, AL-ERD, MS A906
J. Harry, EM/ER, MS M992
B. Hoditschek, NMED-HRMB
R. Kern, NMED-HRMB
N. Naraine, DOE-HQ, EM-453
M. Shaner, CIO, MS A117 (5 copies)
T. Taylor, LAAO, MS A316
N. Weber, NMED-AIP, MS J993
J. White, ESH-19, MS K490
S. Yanicak, NMED-AIP, MS J993
RPF, MS M707

Cy (w/o encs.):
T. Baca, EM, MS J591
D. Bradbury, EM/ER, MS M992
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G. Rael, AL-ERD, MS A906
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Los Alamos National Laboratory

UNIVERSITY OF CALIFORNIA

Environmental Restoration

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

Date: June 10, 1996
Refer to: EM/ER:96-342

Mr. Ted Taylor
Los Alamos Area Office
US Department of Energy, MS A316
Los Alamos, NM 87544

SUBJECT: VOLUNTARY CORRECTIVE ACTION (VCA) COMPLETION REPORT FOR ACTIVITIES AT TECHNICAL AREA (TA) 33, POTENTIAL RELEASE SITES (PRSs) 33-010(a, d, g) AND 33-011(b)

Dear Ted:

Enclosed for your review and approval please find a copy of the VCA Completion Report for cleanup activities in TA-33, PRSs 33-010(a, d, g) and 33-011(b) completed in Fiscal Year 1996. Also enclosed is the Approval/Disapproval Form for your signature indicating your approval or disapproval of the report. If you do not approve this plan, please include a brief description of the reason(s) for disapproval.

Once we have received your approval of this report, we will submit it to the regulators for their review/approval.

Your Field Project Coordinator participated in developing and reviewing this report. The Certification of Completion has been signed and is included in the enclosed report.

If you have any questions, please call Roy Michelotti at (505) 665-7444 or Joe Mose at (505) 667-5808. Thank you for your cooperation in this matter.

Sincerely,

Jorg Jansen
Program Manager

JJ/bp

Enclosures: (1) VCA Completion Report for TA-33, PRSs 33-010(a, d, g) and 33-011(b)
(2) Certification of Completion
(3) VCA Approval/Disapproval Form

Cy (w/o encs.):
T. Baca, EM, MS J591
D. Bradbury, EM/ER, MS M992
T. Glatzmaier, DDEES/ER, MS M992
D. McInroy, EM/ER, MS M992
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CONTENTS

1.0 INTRODUCTION 1

2.0 SITE CHARACTERIZATION PRIOR TO CLEANUP ACTIVITY 2

2.1.1 Field Investigation for PRS 33-010(a) 2

2.1.2 Background Comparison 4

2.1.3 Screening Assessment 5

2.1.4 Nature And Extent Of Contamination 6

2.1.5 Risk Calculations and/or Cleanup Level Derivation 6

2.2.1 Field Investigation for PRS 33-010(d) 6

2.2.2 Background Comparison 7

2.2.3 Screening Assessment 7

2.2.4 Nature and Extent of Contamination 7

2.2.5 Risk Calculations and/or Cleanup Level Derivation 8

2.3.1 Field Investigation for PRS 33-010(g) 8

2.3.2 Background Comparison 10

2.3.3 Screening Assessment 10

2.3.4 Nature and Extent of Contamination 10

2.3.5 Risk Calculations and/or Cleanup Level Derivation 10

2.4.1 Field Investigation for PRS 33-011(b) 10

2.4.2 Background Comparison 12

2.4.3 Screening Assessment 13

2.4.4 Nature and Extent of Contamination 13

2.4.5 Risk Calculations and/or Cleanup Level Derivation 13

3.0 REMEDIAL ACTIVITIES AND RESULTS OF CONFIRMATORY SAMPLING 13

3.1 Risk Calculations and/or Cleanup Level Derivation 13

3.2 Remedial Implementation 13

3.3 Confirmatory Sampling 14

4.0 WASTE MANAGEMENT 15

5.0 REFERENCES 16

APPENDIX A QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) A-1

APPENDIX B RAW RFI CHARACTERIZATION DATA B-1

APPENDIX C BEFORE AND AFTER COST COMPARISON C-1

APPENDIX D CONFIRMATORY SAMPLING RESULTS TABLE D-1

APPENDIX E CERTIFICATION OF COMPLETION E-1

LIST OF TABLES

Table 1.0-1 SWMU Description 1

Table 2.1-1 Summary of Samples Collected for PRS 33-010(a) During RFI Field Investigation 4

Table 2.1-2 Inorganics Detected Above LANL Background UTLs at PRS 33-010(a) 5

Table 2.1-3 MCE for Noncarcinogenic Effects at PRS 33-010(a) 6

Table 2.2-1 Summary of Samples Collected for PRS 33-010(d) 7

Table 2.2-2 Inorganic Detected Above Background UTL at PRS 33-010(d) 7

Table 2.3-1 Summary of Samples Collected for PRS 33-010(g) 8

Table 2.3-2 Radionuclide and Inorganics Detected Above Background UTLs at PRS 33-010(g) 10

Table 2.4-1 Summary of Samples Collected for PRS 33-011(b) 12

Table 2.4-2 Radionuclide Detected Above Background UTLs at PRS 33-011(b) 13

Table 4.0-1 Estimated Actual Compared with Projected Waste Volumes 15

LIST OF FIGURES

Fig. 2.1-1. New boundaries for PRSs 33-010(a and d). 3

Fig. 2.3-1. Location map of PRS 33-010(g) at South Site. 9

Fig. 2.4-1. Location map of PRS 33-011(b) at NRAO Site. 11

1.0 INTRODUCTION

From 1947 to 1972 Technical Area (TA) 33 was used for beryllium-polonium weapons component experiments. High explosives (HE) and uranium were used in some tests. The site contains gun-firing areas and firing sites at East and South Sites, with offices, a laboratory, and shop complex at Main Site. A National Radio Astronomy Observatory (NRAO) antenna is currently operational at TA-33. Additional historical information on TA-33 is in the 1992 Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Work Plan (LANL 1992, 0784).

The solid waste management units (SWMUs) addressed in this voluntary corrective action (VCA) report are listed below in Table 1.0-1 and are located at East Site, South Site, and the NRAO Site. SWMU 33-010(b), which was addressed in the VCA plan, will not be included in this report due to delays in field implementation. A VCA Report for SWMU 33-010(b) will be submitted within 30 days of receiving confirmatory sampling data.

TABLE 1.0-1

SWMU DESCRIPTION

SWMU NUMBER	SECTION	SWMU LOCATION	SWMU DESCRIPTION	WASTE DESCRIPTION
33-010(a)	2.1.1	East Site, rim of White Rock Canyon	Canyon-side disposal area	Debris, metal, wood, plastic foam
33-010(d)	2.2.1	North edge of East Site, South rim of Ancho Canyon	Surface disposal area	Debris, foam, glass, concrete, metal scrap
33-010(g)	2.3.1	South and East edge of South Site, north Chaquehui Canyon	Canyon-side disposal area	Debris, metal scrap
33-011(b)	2.4.1	NRAO Site	Storage area	Debris, metal scrap

The objective of Phase I RFI sampling was to determine if contaminants were present at levels of concern. While the Phase I RFI objective was met, it was not determined whether the debris present within each of the SWMUs was contaminated; therefore, the VCA objective was to screen and remove the debris from the PRSs. The debris removal was an obvious and final remedy requiring less than six months to accomplish.

Although not regulated under RCRA, the Phase I investigation and the VCA addressed radioactive contaminants.

Lead was the contaminant of potential concern (COPC) identified at SWMU 33-010(a) in this VCA Report during 1994 sampling, as described in the TA-33 VCA plan (LANL 1995, 02-112). The nature and extent of contamination was easily identified. No other COPCs were identified at SWMU 33-010(d and g) or 33-011(b).

SWMUs 33-010(a, d, and g) are listed in Table A of the Laboratory's Hazardous and Solid Waste Amendments (HSWA) permit. SWMU 33-011(b) is not on the HSWA permit. Because these sites involved only debris removal, they were pursued as VCAs and not expedited cleanups.

This report serves as a formal recommendation to the Department of Energy (DOE) and New Mexico Environment Department to approve no further action for these SWMUs.

2.0 SITE CHARACTERIZATION PRIOR TO CLEANUP ACTIVITY

RFI sampling was performed between May and August 1994. The field activities implemented at the sites included selection of sampling locations, land, geophysical, and screening surveys, and field sampling activities. These activities are generic to all SWMUs addressed in the 1994 RFI and are located in Section 1.3 of the December 1995 RFI Report (Environmental Restoration Project 1995, 1288).

When the RFI work plan for TA-33 was written, no LANL-wide background soil data existed. The TA-33 sampling and analysis plans were designed to collect sufficient data to calculate site-specific background upper tolerance limits (UTLs). Results of this study are discussed in the January 1995 RFI Report for TA-33, LA-UR-95-882 (LANL 1995, 1212). LANL-wide background UTLs have since become available and are used for comparison purposes in this VCA report. TA-33 UTLs are presented here for information purposes.

2.1.1 Field Investigation for PRS 33-010(a)

PRS 33-010(a) is discussed in the VCA plan and the RFI work plan, Subsections 3.5.2.5 and 4.5.3.1 (LANL 1995, 02-112; LANL 1992, 0784). Much of the debris at this site resulted from 1947 site preparation and consists of dead tree trunks, rocks, and scraped earth. In addition, metal chunks and other debris were thrown over the canyon rim at various times. RFI sampling at PRS 33-010(a) was designed to determine mean contamination using reconnaissance sampling. Field screening did not detect contamination to bias any sample locations. Eight samples were taken on the face of the slope (Fig. 2.1-1). All samples were analyzed for metals, uranium, and cesium-137. Three samples were also analyzed for semivolatile organic compounds (SVOCs) and HE (Table 2.1-1). No debris was sampled. There were no deviations from the approved RFI work plan.

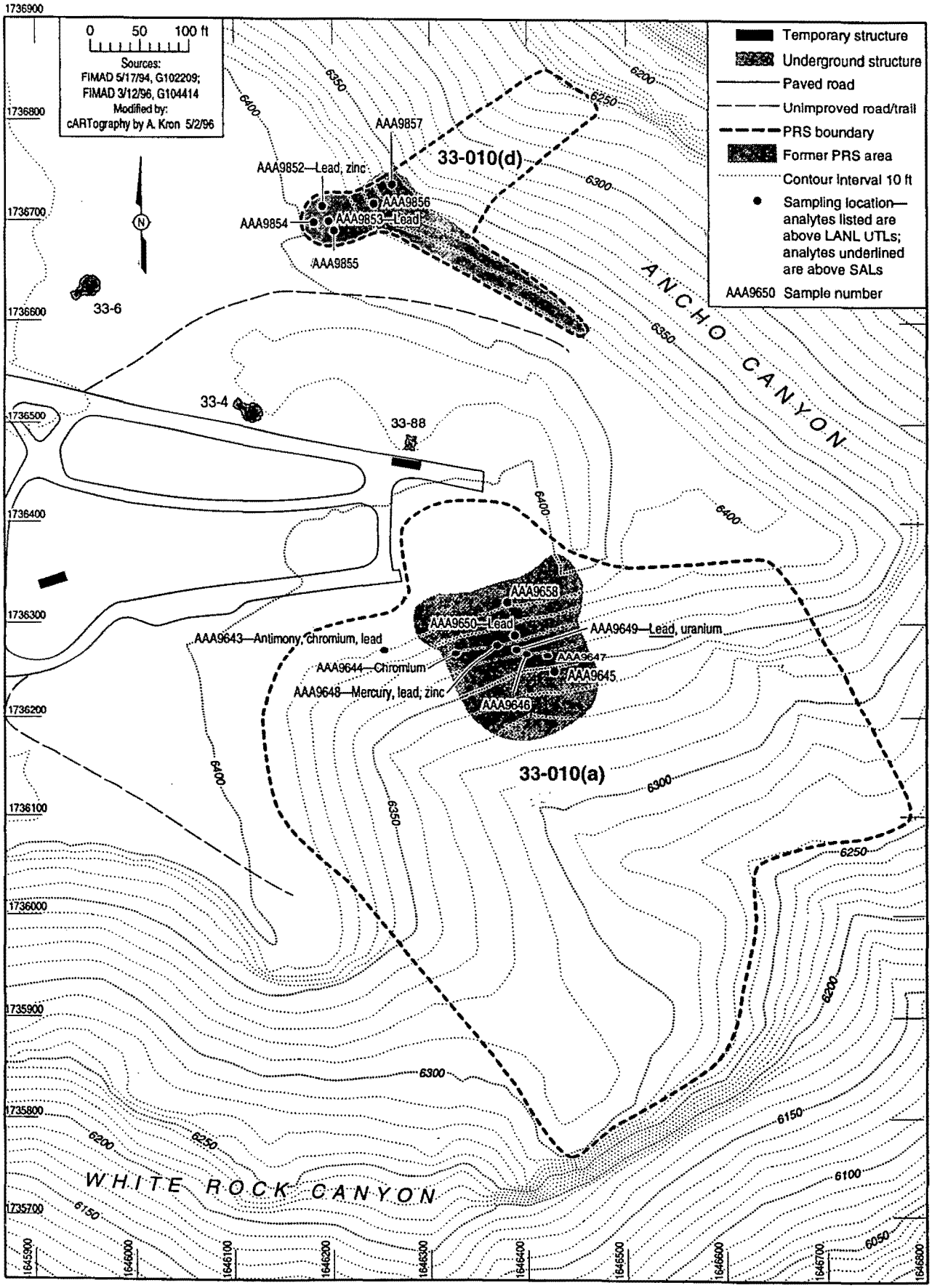

Fig. 2.1-1. New boundaries for PRSs 33-010(a and d).

TABLE 2.1-1

SUMMARY OF SAMPLES COLLECTED FOR PRS 33-010(a)
DURING RFI FIELD INVESTIGATION

SAMPLE ID	SITE ID	DEPTH (in.)	MEDIUM	INOR-GANICS	RADIO-NUCLIDES	SVOCs[a]	HE[b]
AAA9643	33-1392	0-6	Soil	19253[c]	19358	17674	17676
AAA9644	33-1393	0-6	Soil	19253	19358	17674	17676
AAA9645	33-1394	0-6	Soil	19253	19358	17674	17676
AAA9646	33-1414	0-6	Soil	19258	19957	NA[d]	NA
AAA9647	33-1415	0-6	Soil	19258	19957	NA	NA
AAA9648	33-1416	0-6	Soil	19258	19957	NA	NA
AAA9649	33-1417	0-6	Soil	19258	19957	NA	NA
AAA9650	33-1455	0-6	Soil	19258	19957	NA	NA
AAA9658	33-1317	0-6	Soil	19253	NA	17674	NA

[a] SVOCs = Semivolatile organic compounds.
[b] HE = High explosives.
[c] Indicates ER analytical request numbers.
[d] NA = Not analyzed.

2.1.2 Background Comparison

Lead was detected above screening action level (SAL) in one sample. Three samples had uranium above LANL UTLs, but well below SAL. Traces of mercury were found in three samples. Zinc was detected above LANL UTL but below SAL in one sample (Table 2.1-2). No other contaminants were found.

TABLE 2.1-2

INORGANICS DETECTED ABOVE LANL BACKGROUND UTLs AT PRS 33-010(a)

SAMPLE ID	URANIUM (mg/kg)	ANTIMONY (mg/kg)	CHROMIUM (mg/kg)	COPPER (mg/kg)	MERCURY (mg/kg)	LEAD (mg/kg)	ZINC (mg/kg)
SAL[a]	29	31	210	2 800	23	400	23 000
LANL UTL[b]	5.45	2.5	19.3	16.6	0.1	23.3	50.8
TA-33 UTL	4.12	0.27	14.6	N/A[c]	N/A	25.2	57.3
AAA9643	0	6.1[d]	34.0	NA[e]	<0.02	24	32
AAA9643R[d]	NA	<4.4	32.4	NA	<0.02	26	34
AAA9644	0	<4.6	22.7	NA	<0.05	18	44
AAA9646R	NA	<4.3	5.1	3.9	0.03	7	20
AAA9648	5.46	<4.4	12.8	31.8	0.42	35	204
AAA9649	8.34	<4.9	4.1	6.2	0.13	**989**[f]	26
AAA9650	2.8	<4.3	6.1	<4.7	<0.09	84	40

[a] SAL = Screening action level.
[b] UTL = Upper tolerance limit.
[c] N/A = Not available.
[d] R = Replicate sample.
[e] NA = Not analyzed.
[f] Bold = Value above SAL.

2.1.3 Screening Assessment

Lead was detected above SAL in one sample at 989 mg/kg, but is below the industrial cleanup level of 1 000 mg/kg and will therefore not be carried forward through the screening assessment process.

Other identified analytes greater than Los Alamos National Laboratory (LANL) UTLs were submitted for a multiple chemical evaluation (MCE) for noncarcinogenic group. The sum of the maxima for the noncarcinogenic group of analytes is 0.03. This result is well below the target value of 1, which indicates a very low potential for adverse human health effects due to exposure to these analytes. The results of the MCE are summarized in Table 2.1-3. Only one constituent was detected in each of the carcinogenic (chromium) and radionuclide (uranium) groups. As previously mentioned, all detections were below UTLs; therefore, no MCE has been performed for these groupings.

TABLE 2.1-3

MCE FOR NONCARCINOGENIC EFFECTS AT PRS 33-010(a)

ANALYTE	MAXIMUM SOIL CONCENTRATION (mg/kg)	SOIL SAL (mg/kg)	CONCENTRATION NORMALIZED TO SAL
Mercury	0.42	23	0.018
Zinc	204	23 000	0.009
Total			**0.03**

2.1.4 Nature And Extent Of Contamination

Biased sampling was performed at this PRS. RFI results indicate that lead was above the SAL but below the industrial cleanup level. The industrial cleanup level for lead is based on an industrial PRG adopted from EPA Region IX and approved by Region VI (EPA 1995, 1307).

2.1.5 Risk Calculations and/or Cleanup Level Derivation

No risk calculations were required for PRS 33-010(a) because the only constituent found above SAL was lead. The concentration of lead found in the soil was 989 mg/kg, which is below the industrial cleanup level of 1 000 mg/kg.

2.2.1 Field Investigation for PRS 33-010(d)

PRS 33-010(d) is discussed in the VCA plan and in the RFI work plan, Subsections 3.5.2.5 and 4.5.3.1 (LANL 1995, 02-112; LANL 1992, 0784). PRS 33-010(d) is a surface disposal area on the rim of Ancho Canyon at East Site. Debris was dumped in a small drainage leading to the canyon. Much of the debris is concrete blocks. At the top of the drainage are empty glass specimen vials. Garbage, such as foam chunks and metal cans, litters the edge of the canyon just below the rim. Sampling at PRS 33-010(d) was designed to detect maximum contamination using reconnaissance sampling. Six surface soil samples were collected, four samples on the mesa amid the debris and two samples in the drainage near the specimen bottles (Fig. 2.1-1). All samples were analyzed for inorganics, uranium, and gamma emitters (Table 2.2-1). No debris was sampled. There were no sampling deviations from the approved work plan.

TABLE 2.2-1

SUMMARY OF SAMPLES COLLECTED FOR PRS 33-010(d)

SAMPLE ID	SITE ID	DEPTH (in.)	MEDIUM	INOR-GANICS	RADIO-NUCLIDES
AAA9852	33-1422	0-6	Surface soil	17843[a]	19352
AAA9853	33-1423	0-6	Surface soil	17843	19352
AAA9854	33-1424	0-6	Surface soil	17843	19352
AAA9855	33-1425	0-6	Surface soil	17843	19352
AAA9856	33-1426	0-6	Surface soil	17843	19352
AAA9857	33-1427	0-6	Surface soil	17843	19352

[a] ER analytical request number.

2.2.2 Background Comparison

Lead (59 mg/kg) was detected above LANL UTL but far below SAL (Table 2.2-2). No other analyte was detected above UTL.

TABLE 2.2-2

INORGANIC DETECTED ABOVE BACKGROUND UTL AT PRS 33-010(d)

SAMPLE ID	LEAD (mg/kg)
SAL[a]	400
LANL UTL[b]	23.3
TA-33 UTL	25.2
AAA9852	59

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

2.2.3 Screening Assessment

No analyte was detected above SAL at this PRS.

2.2.4 Nature and Extent of Contamination

RFI results indicate that COPCs in soil were detected above background but well below SAL. No contamination was found in the drainage leaving the PRS.

2.2.5 Risk Calculations and/or Cleanup Level Derivation

No risk calculations or cleanup levels were required for PRS 33-010(d).

2.3.1 Field Investigation for PRS 33-010(g)

PRS 33-010(g) is discussed in the VCA plan and in the RFI work plan, Subsections 3.4.2.8 and 4.4.3.1 (LANL 1995, 02-112; LANL 1992, 0784). PRS 33-010(g) is a canyon-side disposal area located on the steep slope at South Site. Much of the debris at this site results from clearing the site and consists of tree trunks, rocks, and scraped earth. In addition, metal chunks, cable, and other debris were thrown over the canyon rim at various times. Sampling at PRS 33-010(g) was designed to determine the mean constituent concentrations using a reconnaissance sampling approach. Five samples were collected on the face of the slope. Three samples were collected on the mesa (Fig. 2.3-1). No debris was sampled. All samples were analyzed for inorganics, uranium, gamma emitters, and HE. One sample was analyzed for herbicides (Table 2.3-1). There were no deviations from the approved work plan.

TABLE 2.3-1

SUMMARY OF SAMPLES COLLECTED FOR PRS 33-010(g)

SAMPLE ID	SITE ID	DEPTH (in.)	MEDIUM	INOR-GANICS	RADIO-NUCLIDES	HIGH EXPLOSIVES	HERBI-CIDES
AAA9804	33-1345	0-6	Soil	19396[a]	19462	17732	NA[b]
AAA9805	33-1346	0-6	Soil	19396	19462	17732	NA
AAA9811	33-1351	0-6	Soil	19283	19471	17831	NA
AAA9812	33-1352	0-6	Soil	19283	19471	17831	NA
AAA9813	33-1353	0-6	Soil	19283	19471	17831	NA
AAA9814	33-1428	0-6	Soil	19283	19471	17831	NA
AAA9815	33-1429	0-6	Soil	19283	19471	17831	NA
AAA9816	33-1431	0-6	Soil	19283	19471	17831	NA
AAA9817	33-1430	0-6	Soil	19283	19471	17831	17798

[a] ER analytical request number.
[b] NA = Not analyzed.

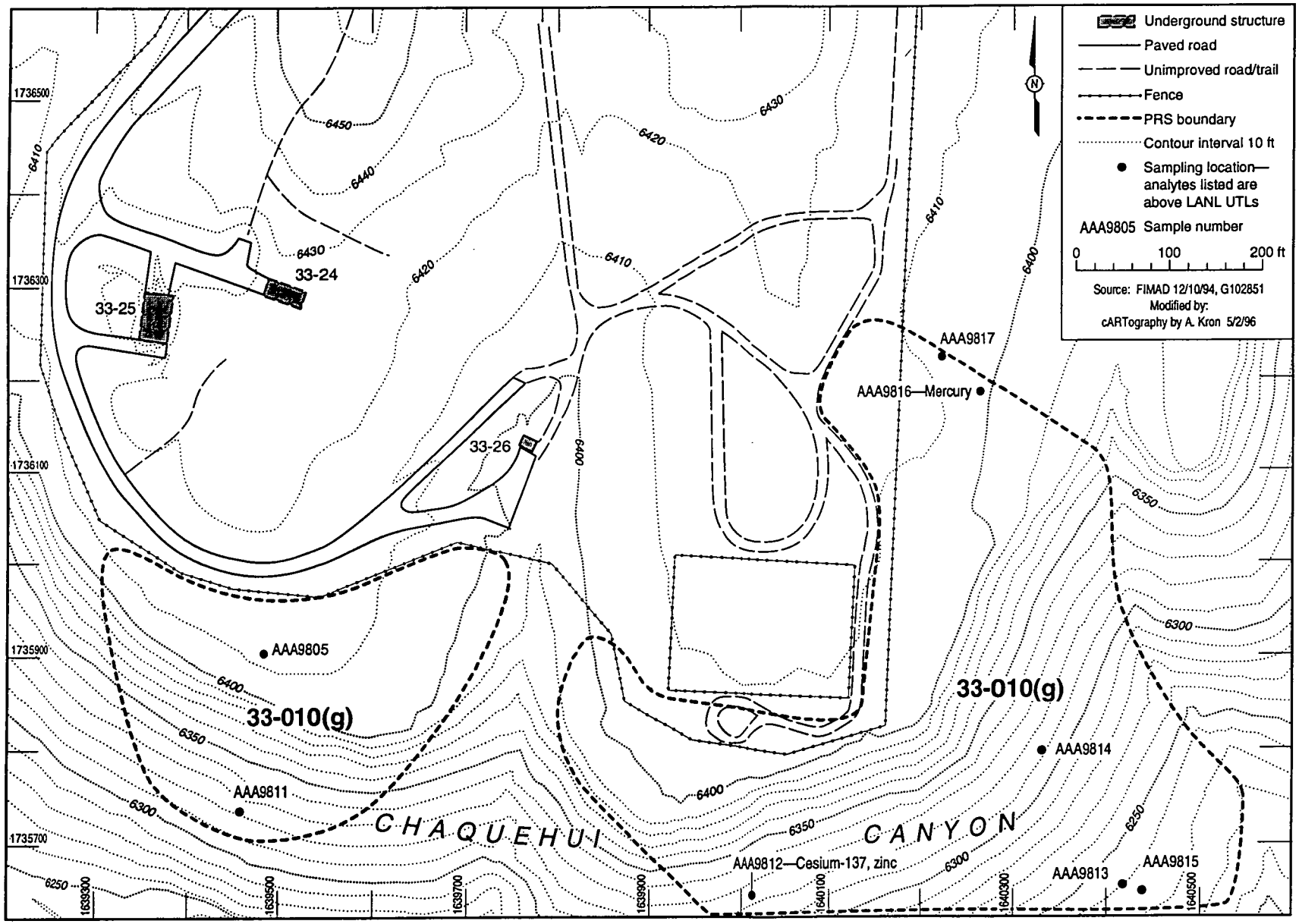

Fig. 2.3-1. Location map of PRS 33-010(g) at South Site.

2.3.2 Background Comparison

Sample AAA9812 contained cesium-137 and zinc above LANL UTLs. Mercury was detected in sample AAA9816 (Table 2.3-2). No other analytes were found above LANL UTLs. No debris was sampled.

TABLE 2.3-2

RADIONUCLIDE AND INORGANICS DETECTED ABOVE BACKGROUND UTLs AT PRS 33-010(g)

SAMPLE ID	CESIUM-137 (pCi/g)	MERCURY (mg/kg)	ZINC (mg/kg)
SAL[a]	4	23	23 004
LANL UTL[b]	1.4	0.1	50.8
TA-33 UTL	2.068	N/A[c]	57.3
AAA9812	2.085	<0.03	54.2
AAA9816	0.59	0.56	32.4

[a] SAL = Screening action level.
[b] UTL = Upper tolerance limit.
[c] N/A = Not available.

2.3.3 Screening Assessment

No analyte was detected above SAL at this PRS.

2.3.4 Nature and Extent of Contamination

RFI results indicate that COPCs in soil were detected above background but well below SAL.

2.3.5 Risk Calculations and/or Cleanup Level Derivation

No risk calculations or cleanup levels were required for PRS 33-010(g).

2.4.1 Field Investigation for PRS 33-011(b)

PRS 33-011(b) is discussed in the VCA plan and the RFI work plan, Subsections 3.6.2.2 and 4.6.3.1 (LANL 1995, 02-112; LANL 1992, 0784). In the 1950s the area became a principal nonradioactive disposal area at TA-33. It was used to store equipment used at the firing sites and as a holding area for strategic materials such as tungsten, uranium, and beryllium until enough material accumulated to be shipped off site. This site was included in a 1984 cleanup at TA-33 (Buhl 1988, 02-038). Sampling at PRS 33-011(b) was designed to detect maximum

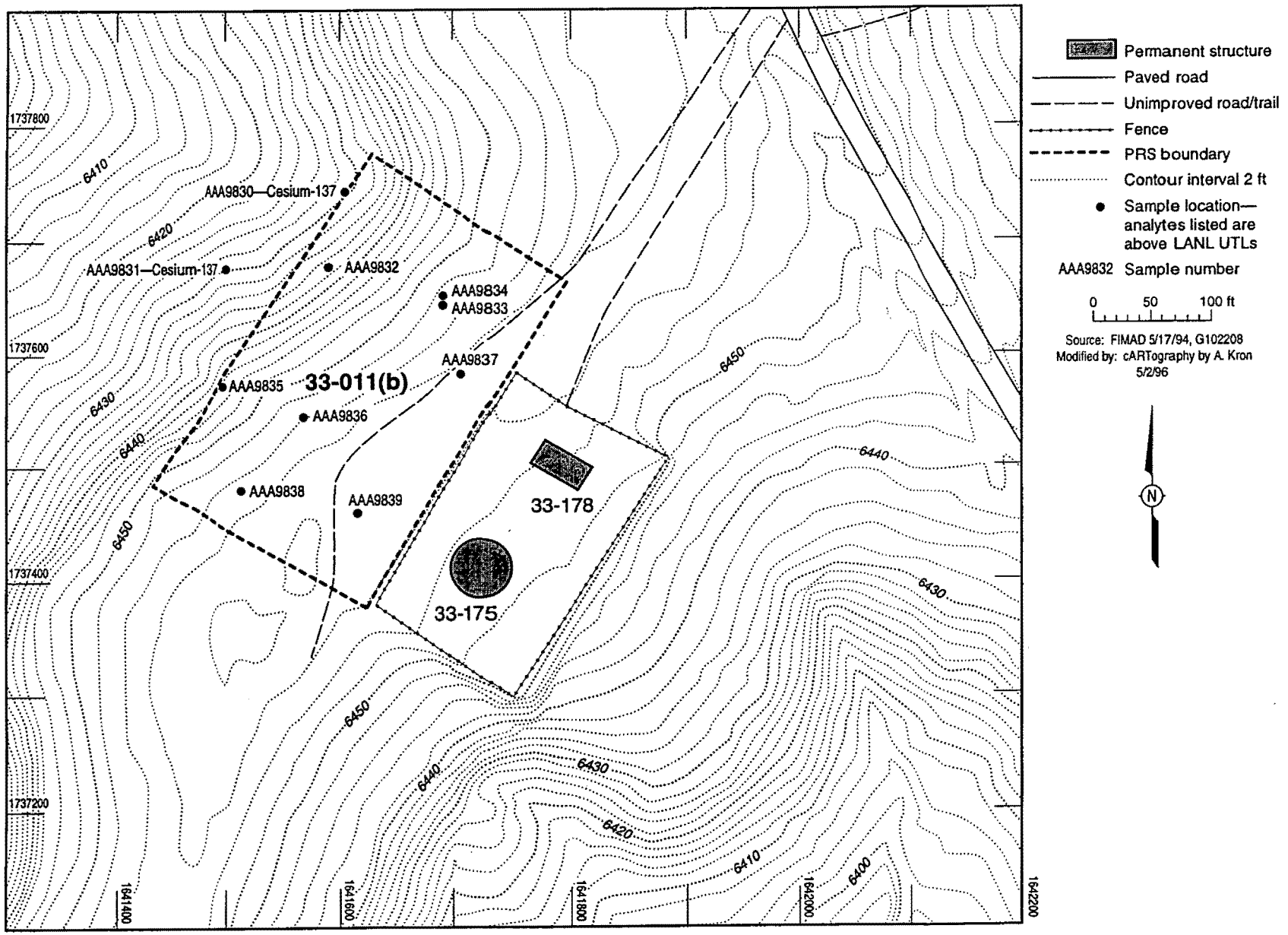

Fig. 2.4-1. Location map of PRS 33-011(b) at NRAO Site.

contamination using reconnaissance sampling. Ten surface soil samples were collected, including four samples in shallow drainages on the slope west of the PRS (Fig. 2.4-1). All samples were analyzed for inorganics, uranium, and gamma emitters. One sample was also analyzed for herbicides (Table 2.4-1). No debris was sampled. During a subsequent site visit, a radioactively contaminated piece of metal debris was found with a Geiger counter. There were no deviations from the approved RFI work plan.

TABLE 2.4-1

SUMMARY OF SAMPLES COLLECTED FOR PRS 33-011(b)

SAMPLE ID	SITE ID	DEPTH (in.)	MEDIUM	INOR-GANICS	RADIO-NUCLIDES	HERBI-CIDES
AAA9830	33-1433	0-6	Soil	19255[a]	19417	NA[b]
AAA9831	33-1434	0-6	Soil	19255	19417	NA
AAA9832	33-1435	0-6	Soil	19255	19417	NA
AAA9833	33-1436	0-6	Soil	19255	19417	NA
AAA9834	33-1471	0-6	Soil	19255	19417	NA
AAA9835	33-1437	0-6	Soil	19255	19417	17897
AAA9836	33-1438	0-6	Soil	19255	19417	NA
AAA9837	33-1439	0-6	Soil	19255	19417	NA
AAA9838	33-1440	0-6	Soil	19255	19417	NA
AAA9839	33-1441	0-6	Soil	19255	19417	NA

[a] ER analytical request number.
[b] NA = Not analyzed.

2.4.2 Background Comparison

Two samples had cesium-137 levels above LANL UTLs but below the TA-33 UTL for cesium-137and well below SAL (Table 2.4-2). No other contaminants were found.

TABLE 2.4-2

RADIONUCLIDE DETECTED ABOVE BACKGROUND UTLs AT PRS 33-011(b)

SAMPLE ID	CESIUM-137 (pCi/g)
SAL[a]	5.1
LANL UTL[b]	1.4
TA-33 UTL	2.068
AAA9830	1.938
AAA9831	1.651

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

2.4.3 Screening Assessment

No analyte was detected above SAL at this PRS.

2.4.4 Nature and Extent of Contamination

RFI results indicate that cesium-137 in soil was detected above background but well below SAL.

2.4.5 Risk Calculations and/or Cleanup Level Derivation

No risk calculations or cleanup levels were required for PRS 33-011(b) because no PCOCs exceeded SALs.

3.0 REMEDIAL ACTIVITIES AND RESULTS OF CONFIRMATORY SAMPLING

3.1 Risk Calculations and/or Cleanup Level Derivation

No cleanup level derivation was necessary for the SWMUs addressed in this report because the lead was the only PCOC greater than SAL but below the industrial cleanup level.

3.2 Remedial Implementation

Debris removal for PRSs 33-010(a, d, and g) and 33-011(b) took place at TA-33 between October 31 and December 9, 1995. The areas remediated are represented in Figures 2.1-1, 2.3-2, and 2.4-1 that show the SWMU boundaries and 1994 RFI sample locations. No confirmatory samples were required during the VCA because no soil removal was performed.

All debris was field screened to detect alpha, beta, and gamma radiation using hand-held ESP instruments in accordance with LANL-ER-SOP-10.07, R0, Field Monitoring for Surface and Volume Radioactivity Levels. All radioactive items were segregated from nonradioactive items at the point of removal from the PRS. Debris was analyzed with x-ray fluorescence (XRF) to verify the presence or absence of hazardous metal constituents in accordance with LANL-ER-SOP-10.08, R0, Operation of the Spectrace 9000™ Field Portable X-Ray Fluorescence Instrument. Debris selected for analysis with the XRF were items that appeared to have been part of an experimental process and were not obvious household waste such as soda cans and food containers, or debris that looked likely to be contaminated (paint, corrosion, ash, etc.). The areas analyzed were selected as areas most likely to contain contaminants (staining, paint, etc.). After screening, the debris was placed in the appropriate waste type group and containerized. Debris that was not removed from the sites included natural materials and objects smaller than three inches in diameter, unless the debris was above radioactive background. Appendix A lists the metal concentrations detected with the XRF and includes the alpha, beta, and gamma radiation readings.

There were three deviations from the VCA plan. The boundaries in which debris was removed at SWMUs 33-010(a and d) were larger than indicated in Fig. 2-2 of the VCA plan. These new boundaries are represented in Fig. 2.1-1 of this report. Waste characterization samples were not collected according to the plan that called for an on-site mobile radiation screening laboratory and mobile chemical screening laboratory. Instead, all debris items were characterized for radioactivity using hand-held alpha, beta, and gamma instruments in accordance with LANL-ER-SOP-10.07, R0. Waste types generated during VCA activities differed from what was projected in the plan and are described below in Section 4.0.

3.3 Confirmatory Sampling

As stated above, no confirmatory sampling was required for SWMUs 33-010(a, d, and g) and 33-011(b) because RFI sampling indicated no risk to human health and the environment from the one constituent found above SAL, i.e., lead.

4.0 WASTE MANAGEMENT

The waste volume estimates given in the VCA plan were greater than the volumes generated during the VCAs; however, in all cases additional waste types were encountered. Unfortunately, the types of wastes generated were combined from all PRSs into the appropriate containers and reported as gross volumes per waste type; therefore, the waste volumes given below in Table 4.0-1 are estimated.

TABLE 4.0-1

ESTIMATED ACTUAL COMPARED WITH PROJECTED WASTE VOLUMES

SWMU NUMBER	WASTE TYPE	PROJECTED BULK VOLUME	ESTIMATED ACTUAL VOLUME
33-010(a)	Nonhaz/Nonrad	10 yd^3	8 yd^3
	Hazardous	0.5 yd^3	0 yd^3 [b]
	Radioactive	0 yd^3 [a]	0.2 ft^3
33-010(d)	Nonhaz/Nonrad	6 yd^3	2 yd^3
	Hazardous	0.5 yd^3	0 yd^3 [b]
	Radioactive	0 yd^3 [a]	0.1 ft^3
33-010(g)	Nonhaz/Nonrad	6 yd^3	4 yd^3
	Radioactive	0 yd^3 [a]	2 ft^3
33-011(b)	Nonhaz/Nonrad	6 yd^3	2 yd^3
	Radioactive	0.25 yd^3	0.5 ft^3

[a] Not expected.
[b] This waste type was not encountered during VCA activity.

Radioactive debris will be disposed at TA-54, Area G by June 31, 1996. The nonradioactive metal will be picked up for recycling by ACE Salvage Company in Albuquerque, New Mexico by May 31, 1996. The remainder of the nonradioactive, nonhazardous materials was taken to the Los Alamos County Landfill on April 8, 1996.

5.0 REFERENCES

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EPA (US Environmental Protection Agency), September 1, 1995. "Region IX Preliminary Remediation Goals (PRGs) Second Half 1995," San Francisco, California. **(EPA 1995, 1307)**

Environmental Restoration Project, December 1995. "RFI Report for TA-33, PRSs 33-004(b, c, j, and m), 33-006(a, b), 33-007(a, b), 33-010(a, b, c, d, g, and h), and 33-011(b,c)," Los Alamos National Laboratory Report LA-UR-95-4439, Los Alamos, New Mexico. **(Environmental Restoration Project 1995, 1288)**

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

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

LANL (Los Alamos National Laboratory), December 1995. "Voluntary Corrective Action Plan for Solid Waste Management Units at TA-33; 33-010(a), 33-010(b), 33-010(d), 33-010(g), and 33-011(b)," Los Alamos, New Mexico. **(LANL 1995, 02-112)**

APPENDIX A QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

1. Screening Data

2. Confirmatory Sampling Data - *N/A*

3. Waste Characterization Data- *N/A*

Because no confirmatory sampling or waste characterization data was necessary for the SWMUs addressed in this VCA report, Appendix A includes only screening data (Table A-1). This table lists radioactive screening and x-ray fluorescence data for SWMUs 33-010(a, d, and g) and 33-011(b).

TABLE A-1

SCREENING DATA

PRS	Sample ID	Rad α/β	Rad γ	Ag	As	Ba	Ca	Cd	Co	Cr	Cu	Fe	Hg	K	Mn	Mo	Ni	Pb	Sr	Th	Ti	U	Zn
33-011(b)																							
	011(b) #13	background	background	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.2
	001(b) #14	54.0 cpm	50 cpm	ND	ND	ND	ND	ND	48	15	15	ND	3.1	ND	2.8	1	3.4	ND	ND	ND	ND	ND	ND
33-011(b) and 33-010(a)																							
	11.14 #1	background	background	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.2	ND	ND	ND	ND	ND	ND	ND	2.34
	11.14 #2	background	background	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.7
33-010(g)																							
	010g-1	121 cpm	background	4.9	2.3	0.59	ND	6	ND	ND	ND	ND	ND	ND	ND	ND	ND	22.1	ND	ND	ND	0.05	ND
	010g-2	1,015 cpm	background	ND	0.35	ND	ND	ND	ND	ND	ND	ND	0.29	ND	ND	ND	ND	0.38	ND	ND	ND	9.64	ND
	010g-3	7,990 cpm	2,500 cpm	0.61	3.17	2.36	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.68	ND	ND	ND	49.7	ND
	010g-4	138 cpm	background	3.1	5.9	0.24	ND	17.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	010g-5	9,780 cpm	600 cpm	1	ND	ND	ND	3.1	ND	ND	ND	ND	3.3	ND	ND	ND	ND	124.2	ND	ND	ND	0.22	ND
	010g-6	147 cpm	background	ND	ND	0.19	ND	2.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	30.06	ND	ND	ND	ND	ND
	010g-7	210 cpm	background	0.89	0.66	25.05	ND	0.85	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.13	ND
	010g-8	3820cpm	800cpm	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.11	ND
	010g-15	654cpm	150cpm	ND	ND	ND	ND	ND	ND	ND	15.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.21	ND
	010g-16	5180cpm	750cpm	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	78.79	ND
	010g-19	16990cpm	2500cpm	ND	ND	ND	ND	ND	ND	ND	1.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.25	ND
	010g-23	949cpm	300 cpm	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.71	ND
	010g-27	3150cpm	500cpm	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.11	ND
	010g-38	14010cpm	8500cpm	ND	ND	ND	ND	ND	ND	ND	2.9	ND	ND	ND	ND	ND	ND	60	ND	ND	ND	ND	29
	010g-42	1917cpm	100cpm	ND	ND	ND	ND	ND	ND	ND	5.8	3.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	58	ND
	010g-48	1424cpm	background	ND	ND	ND	27	ND	35	ND	ND	47.3	ND	16.2	2.5	ND	ND	ND	ND	ND	1.2	58.2	ND
	010g-54	6600cpm	100cpm	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.28	ND	137.8	ND
	010g-58	528cpm	background	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	010g-59	140cpm	background	ND	ND	ND	37	ND	42	ND	1.3	53.12	ND	20	4	ND	ND	ND	ND	ND	17	79	ND
33-010(a)																							
	010a-10	81.0cpm	background	ND	ND	ND	4.6	ND	1.29	ND	ND	28.6	ND	ND	4	ND	ND	ND	ND	ND	ND	ND	ND
	010a-13	76cpm	background	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.12	ND	ND	ND	ND
	010a-14	66cpm	50cpm	ND	1.4	3.6	ND	ND	3	23	ND	ND	ND	ND	ND	ND	ND	87	ND	0.15	83	0.075	ND
	010a-15	59cpm	50cpm	ND	ND	ND	ND	ND	2.4	ND	ND	ND	ND	ND	1.5	ND	ND	ND	ND	ND	ND	ND	ND
	010a-16	81cpm	50cpm	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	010a-17	73cpm	25cpm	ND	ND	ND	ND	ND	ND	ND	11.7	ND	ND	ND	1.8	ND	ND	ND	ND	ND	10	ND	ND
	010a-18	86cpm	25cpm	ND	ND	ND	3.7	ND	ND	ND	ND	ND	ND	5.4	5.3	ND	1.2	ND	ND	ND	ND	ND	ND
	010a-19	68cpm	15cpm	ND	ND	ND	5.3	ND	ND	ND	2.8	0.39	ND	4.4	5	ND	ND	ND	ND	ND	ND	0.01	ND
	010a-20	81cpm	background	ND	ND	ND	3.3	ND	1.5	ND	ND	24.1	ND	3	2.4	ND	ND	22	ND	ND	ND	ND	119
	010a-21	58cpm	background	ND	ND	ND	100	ND	3.4	ND	ND	34.4	ND	ND	12.1	ND	ND	10	ND	ND	ND	ND	ND
	010a-22	80cpm	background	ND	ND	ND	1.2	ND	2.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.2	ND	ND	ND	4.7
	010a-23	98cpm	background	ND	ND	ND	3.4	ND	1.8	ND	ND	65.8	ND	10.6	3.4	ND	ND	ND	ND	ND	ND	ND	ND
	010a-24	103cpm	background	ND	ND	ND	12.4	ND	ND	21	ND	ND	ND	3.3	ND	ND	ND	360	ND	ND	870	ND	550
	010a-25	450cpm	150cpm	ND	ND	ND	1.9	ND	ND	ND	ND	ND	ND	7.5	ND	ND	ND	ND	ND	0.16	1570	1.8	1229
	010a-26	1800cpm	100cpm	ND	ND	0.24	ND	ND	1.5	ND	ND	30.5	ND	ND	2.6	10	ND	ND	ND	ND	ND	1.4	ND
	010a-27	230cpm	50cpm	ND	ND	ND	ND	ND	2.4	ND	2.4	ND	ND	ND	1.4	ND	ND	16	ND	ND	ND	0.71	18
33-010(d)																							
	010d-1	1600cpm	50cpm	ND	ND	ND	12	ND	ND	ND	ND	3.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	111	ND

ND = Not detected.

APPENDIX B RAW RFI CHARACTERIZATION DATA

(reduced data for meeting remediation goal)

Validated data are available in Facility for Information, Management, Analysis and Display (FIMAD) or upon request.

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APPENDIX C BEFORE AND AFTER COST COMPARISON

(for life cycle of remediation, including waste management)

APPENDIX C

COST COMPARISON

ACTIVITY	PROJECTED COSTS	ACTUAL COSTS
Planning (develop plan and field preparation)	–[a]	$25 000
Cleanup	$55 750	$45 000
Post field operations	–[a]	$15 000
Disposal	$4 856	0
Develop VCA Report	–[a]	$22 400
TOTAL	**$43 656**	**$107 400[b]**

[a] Cost not projected in the VCA plan.
[b] $77 000 of $107 400 was for activity not projected in the plan.

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APPENDIX D CONFIRMATORY SAMPLING RESULTS TABLE

Not applicable. No confirmatory samples were required at the SWMUs addressed in this report because no soil removal was performed.

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APPENDIX E CERTIFICATION OF COMPLETION

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CERTIFICATION OF COMPLETION

I certify that all work pertaining to the voluntary corrective action (VCA) 33-010(a) has been completed in accordance with the Department of Energy approved VCA plan entitled **VCA Plan for PRS 33-010(a), Canyon-Side Disposal Area**. Based on my personal involvement or inquiry of the person or persons who managed this clean up, a review of all data gathered and a visit to the site, to the best of my knowledge and belief, all criteria of the plan have been met or exceeded. I believe that the completion of the VCA is both protective to human health and the environment. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Brad Martin

Brad Martin

Field Unit 3 Project leader

Environmental Restoration Program

Los Alamos National Laboratory

3/15/96

Date Signed

CERTIFICATION OF COMPLETION

I certify that all work pertaining to the voluntary corrective action (VCA) 33-010(d) has been completed in accordance with the Department of Energy approved VCA plan entitled **VCA Plan for PRS 33-010(d), Surface Disposal Area.** Based on my personal involvement or inquiry of the person or persons who managed this clean up, a review of all data gathered and a visit to the site, to the best of my knowledge and belief, all criteria of the plan have been met or exceeded. I believe that the completion of the VCA is both protective to human health and the environment. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Brad Martin

Brad Martin
Field Unit 3 Project leader
Environmental Restoration Program
Los Alamos National Laboratory

3/15/96
Date Signed

CERTIFICATION OF COMPLETION

I certify that all work pertaining to the voluntary corrective action (VCA) 33-010(g) has been completed in accordance with the Department of Energy approved VCA plan entitled **VCA Plan for PRS 33-010(g), Canyon-Side Disposal Area.** Based on my personal involvement or inquiry of the person or persons who managed this clean up, a review of all data gathered and a visit to the site, to the best of my knowledge and belief, all criteria of the plan have been met or exceeded. I believe that the completion of the VCA is both protective to human health and the environment. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Brad Martin

Brad Martin
Field Unit 3 Project leader
Environmental Restoration Program
Los Alamos National Laboratory

3/15/96
Date Signed

CERTIFICATION OF COMPLETION

I certify that all work pertaining to the voluntary corrective action (VCA) 33-011(b) has been completed in accordance with the Department of Energy approved VCA plan entitled **VCA Plan for PRS 33-011(b), General Storage Area.** Based on my personal involvement or inquiry of the person or persons who managed this clean up, a review of all data gathered and a visit to the site, to the best of my knowledge and belief, all criteria of the plan have been met or exceeded. I believe that the completion of the VCA is both protective to human health and the environment. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Brad Martin

Brad Martin
Field Unit 3 Project leader
Environmental Restoration Program
Los Alamos National Laboratory

3/15/96
Date Signed

VOLUNTARY CORRECTIVE ACTION (VCA) COMPLETION REPORT APPROVAL/DISAPPROVAL FORM

PRS(s): 33-010(a,d,g) and 33-011(b)

The undersigned have reviewed the VCA Completion Report and believe that the intent and goals of the VCA plan have been met.

FPL _____ Date 6/6/96

FPC _____ Date 6/10/96

.....

I, Theodore J. Taylor, DOE-LAAO, **APPROVE** the accompanying Voluntary Correction Action Report for PRS(s) 33-010(a,d, g) and 33-011(b), TA-33.

I, Theodore J. Taylor, DOE-LAAO, **DO NOT APPROVE** the accompanying Voluntary Correction Action Report for PRS(s) 33-010(a,d, g) and 33-011(b), TA-33.

The following reasons reflect the decision for disapproval:

_____

_____

_____

_____

_____

_____

_____

Signed: _____ Date: 6/12/96