Sandia National Laboratories/New Mexico

PROPOSALS FOR NO FURTHER ACTION ENVIRONMENTAL RESTORATION PROJECT

June 1998

Environmental
Restoration
Project

United States Department of Energy
Albuquerque Operations Office

EXECUTIVE SUMMARY

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a Hazardous and Solid Waste Amendments (HSWA)/Corrective Action (CA) related permit modification based upon No Further Action (NFA) Proposals for Environmental Restoration (ER) Solid Waste Management Units (SWMU). SWMUs 27, 14, 17,103, and 108 are listed in the HSWA Module IV (EPA August 1993) of the SNL/NM Resource Conservation and Recovery Act (RCRA) Hazardous Waste Management Facility Permit (NM5890110518) (EPA August 1992).

OPERABLE UNIT 1332

SNL/NM is proposing a risk-based NFA decision for SWMU 27, Building 9820 (Animal Disposal Pit), OU 1332. SWMU 27 is the former location of an animal disposal pit and other buried debris. Based upon historical and process knowledge, field investigation data, remediation and confirmatory sampling data, and human health and ecological risk screening assessments, an NFA decision is recommended for SWMU 27 for the following reasons.

- All debris was removed from SWMU 27 during the RCRA Facility Investigation (RFI)/Voluntary Corrective Measures (VCM) excavation activities and was confirmed by collection and analysis of confirmatory soil samples.
- No nonradiological or radiological constituents of concern (COC) at concentration or activity levels considered hazardous to human health for a recreational land-use scenario were present in soil remaining at the site.
- No volatile organic compounds (VOC) or radionuclides were detected during the RFI/VCM field-screening programs.
- The risk screening assessment for ecological receptors indicates that the ecological risks associated with SWMU 27 are insignificant.

OPERABLE UNIT 1335

SNL/NM is proposing a risk-based NFA decision for SWMU 14, Burial Site, OU 1335. SWMU 14 is a burial site of glass debris resulting from an explosives above-ground test that involved 6,000 to 8,000 fluorescent light bulbs. Potential COCs are mercury, residual high explosives (HE) and depleted uranium (DU). A confirmatory sampling investigation conducted in the area determined that there was no significant debris or COC present in the area, thereby validating reports that an insignificant amount of material was buried. Based upon field investigation data and the human health risk screening assessment, an NFA is being recommended for SWMU 14 for the following reasons:

- All anomalous material (discolored soil) found in the trenches was sampled and excavated. The material was nonhazardous.

- There was no evidence of mercury from either the field screening or from laboratory analyses, and the total amount of mercury used in the test was insignificant (less than 1 pint).

- There was no evidence of explosives. All samples analyzed for explosives were nondetected.

- Human health and ecological risk screening assessments indicate no impact of the COCs to human health or the environment.

SNL/NM is proposing a risk-based NFA decision for SWMU 17, Scrap Yards, OU 1335. SWMU 17 contains eight inactive scrap yards used to support testing activities at South Thunder Range. Based upon historical and process knowledge, field investigation data, and human and ecological risk screening assessments, an NFA decision is recommended for SWMU 17 for the following reasons:

- All radiological anomalies detected at SWMU 17B were confirmed remediated following the VCM removal activities.

- No nonradiological or radiological COCs were present in soil at concentrations or activity levels considered hazardous to human health for an industrial land-use scenario.

- Risk screening assessment for ecological receptors indicates that the ecological risks associated with SWMU 17 are expected to be insignificant.

SNL/NM is proposing a risk-based NFA decision for SWMU 103, Scrap Yards, OU 1335. SWMU 103 encompasses SWMU 117 (Sodium Pit) and the buildings (including 9939) and structures associated with the Large-Scale Melt Facility. Based upon field investigation data and the human health and ecological risk screening assessment, an NFA is recommended for SWMU 103 for the following reasons:

- All radiological anomalies detected at SWMU 103 were confirmed remediated following the VCM removal activities.

- No nonradiological or radiological COCs were present in soil at concentrations or activity levels considered hazardous to human health for an industrial land-use scenario.

- Risk screening assessment for ecological receptors indicates that the ecological risks associated with SWMU 103 are expected to be low.

SNL/NM is proposing a risk-based NFA decision for SWMU 108, Firing Site (Building 9940), OU 1335. SWMU 108 consists of a bunker and several supporting structures (sheds and office trailers) that were used for explosives testing and reactor safety experiments. Based upon historical and process knowledge, field investigation data, and human health and ecological risk screening assessments, an NFA decision is recommended for SWMU 108 for the following reasons:

- All radiological anomalies detected at SWMU 108 are confirmed to be remediated following the VCM removal activities.
- No nonradiological or radiological COCs were present in soil at concentrations or activity levels considered hazardous to human health for an industrial land-use scenario.
- Risk screening assessment for ecological receptors indicates that the ecological risks associated with SWMU 108 are insignificant.

Based upon the evidence provided above, SWMUs 27, 14, 17, 103, and 108 are proposed for an NFA decision in conformance with Criterion 5 (NMED March 1998), which states that the SWMUs have been fully characterized and remediated in accordance with current and applicable state or federal regulations and that available data indicate that contaminants pose an acceptable level of risk under current and projected future land use.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Concluded)

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF FIGURES (Concluded)

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Concluded)

LIST OF ANNEXES

ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
BLM	Bureau of Land Management
CEARP	Comprehensive Environmental Assessment and Response Program
cm	centimeter(s)
cm^2	square centimeter(s)
COC	constituent of concern
COPEC	constituent of potential ecological concern
cps	counts per second
DCF	dose conversion factor
DOE	U.S. Department of Energy
dpm	disintegration(s) per minute
DQO	Data Quality Objective
DU	depleted uranium
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
FCI	fuel coolant interaction
FITS	Fully Instrumented Test System
FOP	field operating procedure
HASP	health and safety plan
HE	high explosives
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HMX	1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane
HP	health physics
HRMB	Hazardous and Radioactive Materials Bureau
HQ	hazard quotient
ID	identification
IH	industrial hygiene
IRIS	Integrated Risk Information System
KAFB	Kirtland Air Force Base
kg	kilogram(s)
L	liter(s)
LAS	Lockheed Analytical Services
lb	pound(s)
LOAEL	lowest-observed-adverse-effect level
m^3	cubic meter(s)
MDA	minimum detectable activity
MDC	Melt Development Corium
MDL	method detection limit
µg	microgram(s)
µR/hr	microroentgen(s) per hour

ACRONYMS AND ABBREVIATIONS (Concluded)

mg	milligram(s)
mi	mile(s)
mrem	millirem(s)
NOAEL	no-observed-adverse-effect level
NFA	no further action
NMED	New Mexico Environment Department
NRC	U.S. Nuclear Regulatory Commission
OP	operating procedure
OU	operable unit
PCB	polychlorinated biphenyl
pCi/g	picocurie(s) per gram
PID	photoionization detector
PRG	Preliminary Remediation Goals
QA	quality assurance
QC	quality control
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RCT	radiation control technician
RFI	RCRA facility investigation
RME	reasonable maximum exposure
RMMA	Radioactive Materials Management Area
RP	Radiation Protection
RPD	relative percent difference
RPSD	Radiation Protection Sample Diagnostics
SNL/NM	Sandia National Laboratories/New Mexico
SVOC	semivolatile organic compounds
SWHCP	Site-Wide Hydrogeologic Characterization Project
SWMU	solid waste management unit
TA	Technical Area
TAL	target analyte list
TCL	target compound list
TCLP	toxicity characteristic leaching procedure
TEDE	total effective dose equivalent
USFS	U.S. Forest Service
UXO	unexploded ordnance
VCM	voluntary corrective measure
VOC	volatile organic compounds
yr	year

1.0 INTRODUCTION

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a Hazardous and Solid Waste Amendments (HSWA)/Corrective Action (CA) related permit modification based upon No Further Action (NFA) Proposals for Environmental Restoration (ER) Solid Waste Management Units (SWMU). The following SWMUs are listed in the HSWA Module IV (EPA August 1993) of the SNL/NM Resource Conservation and Recovery Act (RCRA) Hazardous Waste Management Facility Permit (NM5890110518) (EPA August 1992). Proposals for each SWMU are located in this document as follows:

Operable Unit 1332

- SWMU 27, Building 9820 (Animal Disposal Pit) (Section 2.0)

Operable Unit 1335

- SWMU 14, Burial Site (Building 9920) (Section 3.0)
- SWMU 17, Scrap Yards/Open Dump (Thunder Range) (Section 4.0)
- SWMU 103, Scrap Yard (Building 9939) (Section 5.0)
- SWMU 108, Firing Site (Building 9940) (Section 6.0)

These proposals each provide a site description, history, summary of investigatory activities, and the rationale for the NFA decision.

3.0 SOLID WASTE MANAGEMENT UNIT 14, BURIAL SITE

3.1 Summary

Solid Waste Management Unit (SWMU) 14 is a burial site of glass debris resulting from an explosives above-ground test that involved 6,000 to 8,000 fluorescent light bulbs. Potential constituents of concern (COC) are mercury, residual high explosives (HE) and depleted uranium (DU). A confirmatory sampling investigation conducted in the area determined that there was no significant debris or COC present in the area, thereby validating reports that an insignificant amount of material was buried. Review and analysis of all relevant data for SWMU 14 indicate that concentrations of COCs at this SWMU are less than applicable risk assessment action levels. Thus, SWMU 14 is being proposed for a no further action (NFA) decision based upon confirmatory sampling data demonstrating that COCs that may have been released from this SWMU into the environment pose an acceptable level of risk under current and projected future land use, per NFA Criterion 5, which states "The SWMU has been fully characterized in accordance with current and applicable state or federal regulations, and that available data indicate that contaminants pose an acceptable level of risk under current and projected future land use" (NMED March 1998).

3.2 Description and Operational History

3.2.1 Site Description

Sandia National Laboratories/New Mexico (SNL/NM) SWMU 14, (Figure 3.2.1-1) is located in the Coyote Test Field Area 1,500 feet east of Technical Area III. The site encompasses an area approximately 140 feet west of Building 9920. SWMU 14 is on land owned by the U.S. Air Force that is permitted to the U.S. Department of Energy (DOE) and SNL/NM. The site, as defined by the SWMU boundaries, covers approximately 2.5 acres. The actual study area is within a 1.4-acre area within the SWMU boundaries. This area was determined from subsequent interviews and investigations to be the approximate area of the burial site. The elevation of the site is 5,454 feet above mean sea level (SNL/NM March 1996a). Current and projected land use for SWMU 14 is industrial.

SWMU 14 lies on the western margin of the Sandia Fault Zone. The geologic materials underlying the site consist of thick alluvial sediments that overlie deep bedrock. An alluvial fan and piedmont colluvium overlies the Santa Fe Group Strata. The Santa Fe deposits are approximately 3,000 feet thick beneath SWMU 14. Descriptions of the regional geology are detailed in the annual Site-Wide Hydrogeologic Characterization Project (SWHCP) 1994 Annual Report (SNL/NM March 1995).

SWHCP soil surveys and surficial mapping provide general soil characteristics for the area around SWMU 14. The dominant soil groups in the area include the Tome very fine sandy

THIS PAGE INTENTIONALLY LEFT BLANK

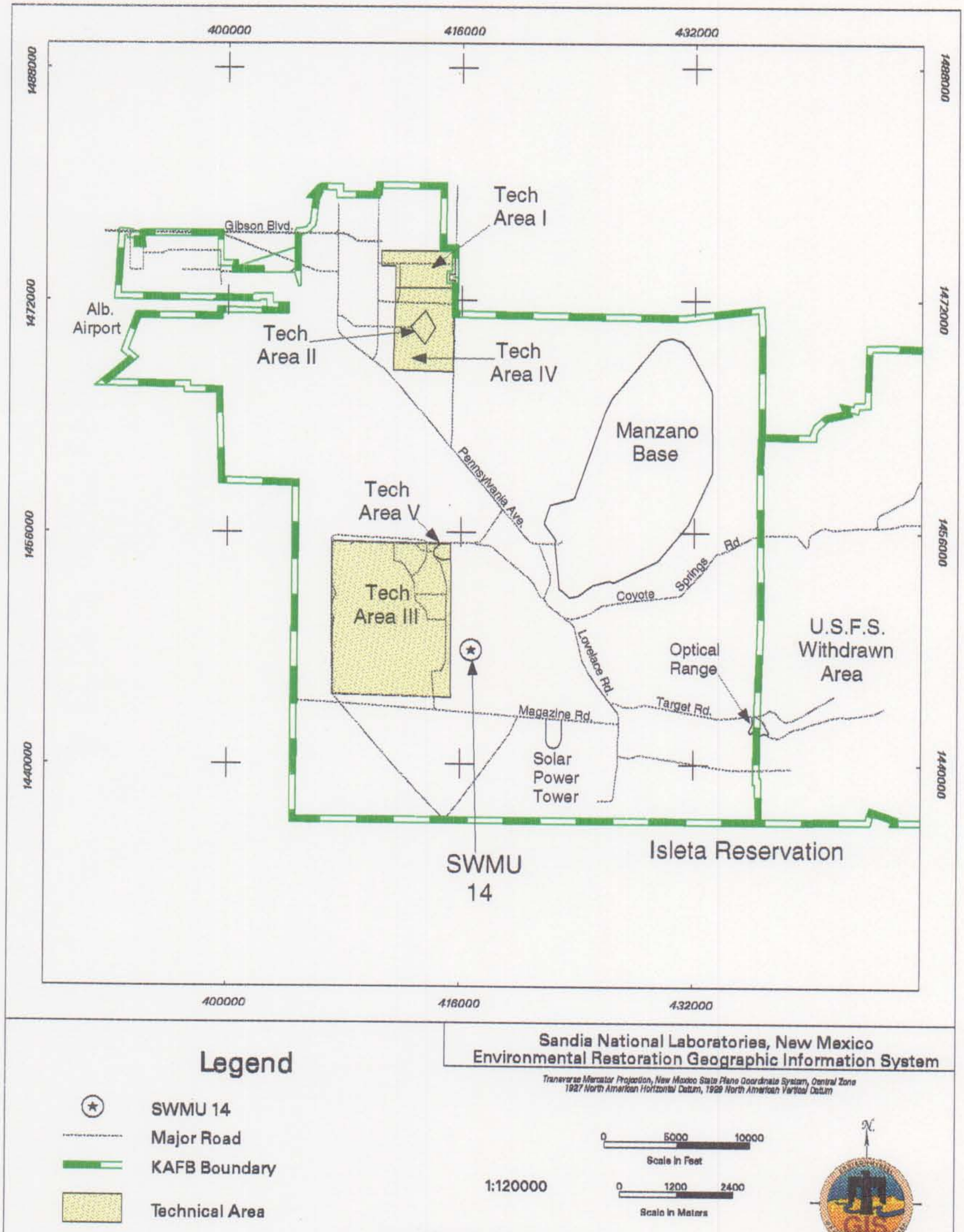


FIGURE 3.2.1-1
Location Map for SWMU 14
Sandia National Laboratories,
New Mexico

scmorri SNL GIS ORG. 6804 06/17/98 MAPID=980656 loam, and the Tijeras gravelly fine, sandy loam. The soils underlying the site are defined as the Tijeras gravelly fine sandy loam. The estimated recharge rate for soils in the area range from between 0.002 and 0.071 centimeters per year (cm/yr), which yields downward seepage velocities ranging from between 0.03 and 11.8 cm/yr (SNL/NM October 1995).

No perennial surface-water bodies are present in the immediate vicinity of SWMU 14. The site is situated between two tributaries forming its nearest surface drainage, an ephemeral watercourse of an unnamed arroyo. The arroyo flows into an internal drainage basin. SWMU 14 lies in the HR-2 geohydrologic region described in the SWHCP Annual Report (SNL/NM March 1995). This region is an intermediate geohydrologic zone between the HR-1 zone to the west and the HR-2 zone to the east. It is comprised of a northeast/southwest-trending fault complex that includes segments of the Sandia, the Tijeras and the Hubbell Springs Faults. The uppermost interval of groundwater saturation in HR-2 is unconfined to semiconfined aquifers in the alluvial facies of the Santa Fe Group and Piedmont alluvium and semiconfined to confined aquifers in the local bedrock units. Examples of these two aquifer models are found in two wells located near the site. Monitoring well STW-1, which is 6,100 feet southeast of Building 9926, is screened in Tertiary conglomerates. Depth to groundwater in this well is 155 feet below ground surface (bgs). Monitoring well LMF-1 is 6,800 feet east of the site. Depth to groundwater in this well is 347 feet bgs. This well is screened in the Abo Sandstone (SNL/NM March 1996b).

For a detailed discussion regarding the local setting at SWMU 14, refer to the "RCRA [Resource Conservation and Recovery Act] Facility Investigation [RFI] Work Plan for OU [Operable Unit] 1335 Southwest Test Area" (SNL/NM March 1996a).

3.2.2 Operational History

Sources associated with activities at SNL/NM in the mid 1970s state that an above-ground explosives test was conducted with 6,000 to 8,000 fluorescent light bulbs (SNL/NM 1996c) in order to determine whether the vacuum in the bulbs, when broken, would suppress the shock wave of the detonation. Mercury was present within the fluorescent bulbs. It is estimated that approximately 0.5 kilograms (kg) of mercury were expended at this test site (SNL/NM June 1997). The light bulbs were first placed in wooden boxes 2 by 2 by 8 feet, then around a 10-pound explosives charge (SNL/NM 1996c). After detonation, the light bulb and box debris were removed from the site and disposed of (SNL/NM 1996c). The remaining debris (scattered fragments of glass) was graded into a low spot in the test area approximately 2 feet deep. There are conflicting reports regarding the specific area of burial at SWMU 14 (SNL/NM 1996c, Wrightson May 1997). The glass debris may have been buried in one of the two locations shown in Figure 3.2.2-1, which are the focal points of the investigation at SWMU 14. No other testing or burial was known to have been associated with this site.

COCs at the site include mercury and HE derived from the testing performed at the site. It is believed that most of the mercury would have been consumed during the test, leaving only trace amounts in the soil. Other potential COCs include DU and metals that may have been mixed from the firing tests at SWMU 85, which is co-located with SWMU 14.

THIS PAGE INTENTIONALLY LEFT BLANK

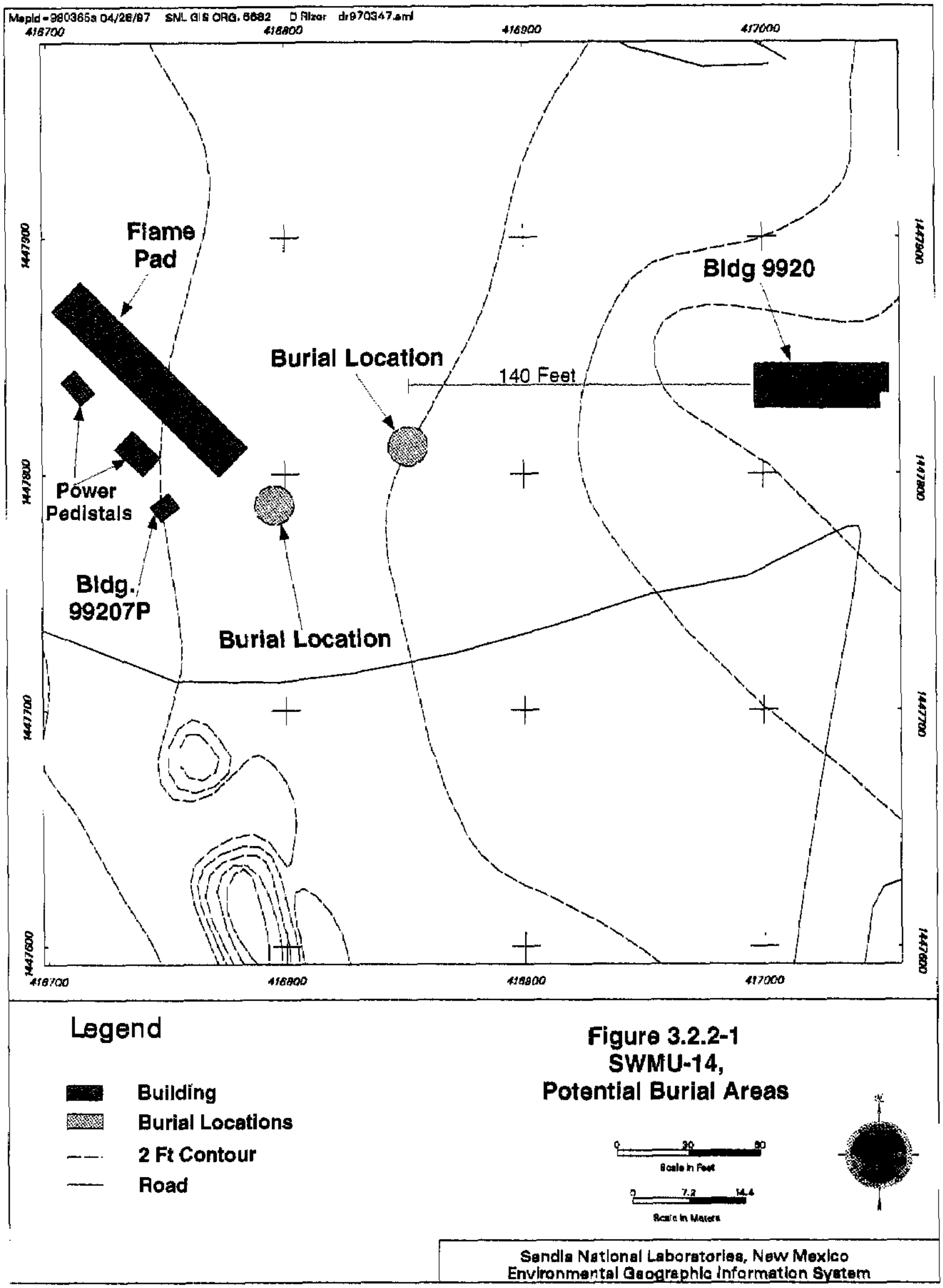


Figure 3.2.2-1
SWMU-14,
Potential Burial Areas

3.3 Land Use

3.3.1 Current

SWMU 14 is on land owned by the U.S. Air Force permitted to the DOE and SNL/NM. SWMU 14 is used as a firing test site by SNL/NM Organization 6314.

3.3.2 Future/Proposed

The projected land use for SWMU 14 is industrial (DOE and USAF March 1996).

3.4 Investigatory Activities

3.4.1 Summary

SWMU 14 was initially investigated under the DOE Comprehensive Environmental Assessment and Response Program (CEARP) in the mid-1980s and included nonsampling data collection and a site inspection (Investigation #1). Beginning in 1994, preliminary investigations were conducted that included unexploded ordnance (UXO)/HE and radiological surveys, a surface geophysical survey of the site (Investigation #2) and an excavation survey with Level III confirmatory sampling (Investigation #3).

3.4.2 Investigation #1—Comprehensive Environmental Assessment and Response Program

3.4.2.1 Nonsampling Data Collection

The site was originally reported in the 1985 CEARP interviews (DOE September 1987). According to this report, the fluorescent tube test debris was buried in a pit about 8 feet deep. However, follow-up interviews with personnel directly involved with the project refuted the 8-foot burial depth. These personnel stated that material was cleaned up and residual was graded over at 2 feet (see Section 3.2.2). Additionally, the report stated that corium thermite (a DU-metal alloy from reactor core coolant interaction tests) was buried in a shallow graded area. This site was given a Hazardous Ranking System Score of 5.1.

Subsequent to the CEARP inspection, the U.S. Environmental Protection Agency (EPA) conducted a RCRA Facility Assessment (EPA April 1987). SWMU 14 was identified as SWMU 45 in the resulting document, which reiterated the findings of the CEARP investigation.

3.4.2.2 Sampling Data Collection

No samples were collected as part of the CEARP investigation.

3.4.2.3 Data Gaps

Data gaps were undefined in the CEARP investigation.

3.4.2.4 Results and Conclusions

Findings were positive for the Federal Facility Site Discovery and Identification Findings Preliminary Assessment and Preliminary Site Investigation.

3.4.3 Investigation #2—SNL/ER Preliminary Investigations

3.4.3.1 Nonsampling Data Collection

3.4.3.1.1 Background Review

A background review was conducted to collect available and relevant information regarding SWMU 14. Sources for this effort included interviews with SNL/NM staff and contractors familiar with site operational history as well as existing historical site records and reports. The study was completely documented and has provided traceable references that sustain the integrity of this NFA proposal. The following, presented in chronological order, lists these information sources that were used to assist in the evaluation of SWMU 14.

- Photographs and field notes from site inspections conducted at the site by SNL/NM ER staff (Wrightson March 1994)
- SNL/NM Facilities Engineering building drawings (SNL/NM [n.d.])
- Two interviews with two facility personnel (current and retired) (Gaither 1991 and SNL/NM 1996c)

3.4.3.1.2 UXO/HE Survey

In February 1994 SNL/NM environmental restoration (ER) personnel and Kirtland Air Force Base Explosive Ordnance Unit performed a 100-percent coverage UXO survey at SWMU 14. The survey was conducted through a visual inspection of the site for ordnance, HE, and ordnance debris. No ordnance material was found at SWMU 14 (SNL/NM September 1994).

3.4.3.1.3 Radiological Survey(s)

The Phase I survey at SWMU 14 (and SWMU 85), which was conducted during March 1994, covered a total of 1.4 acres of flat graded terrain. The area that was surveyed included specific areas of SWMU 85 and suspected burial areas of SWMU 14, based on background interviews. A gamma scan survey was performed at 6-foot centers (100-percent coverage) over the surface of the sites. Only one area source of gamma activity 30 percent or greater than the natural background was identified during this survey. The one area source at SWMU 14 (and SWMU 85) was remediated by RUST Geotech Inc. in September 1995 (SNL/NM September 1997). This was based upon gamma spectroscopy results from the precleanup samples that showed that the elevated radiation was related to anthropogenic material. Cleanup was completed on the source in September 1995, and no additional point or area sources were identified at this site (SNL/NM September 1997). After removal of radiologically contaminated soils, two postcleanup (verification) samples were collected from areas that had exhibited the highest residual gamma readings. Since this radiation anomaly is associated with the VGES tank, which is part of SWMU 85, rather than the burial material from the fluorescent tube firing test, SWMU 14 data and anomaly maps from this voluntary corrective measure (VCM) are presented in the NFA proposal for SWMU 85.

3.4.3.1.4 Cultural-Resources Survey

A Cultural Resources Survey was performed at SWMU 14 in 1994. Findings from this survey indicated that no cultural resources were present on the site (Hoagland and Dello-Russo February 1995).

3.4.3.1.5 Sensitive-Species Survey

A Sensitive Species Survey was performed at SWMU 14 in 1994. Findings from this survey indicated that no sensitive species were present on the site (DOE March 1996).

3.4.3.1.6 Geophysical Survey(s)

On March 5, 1997, MDM/Lamb Inc. conducted a geophysical investigation of SWMU 14 (Hyndman April 1997). The survey was conducted using a Geonics EM-61 high precision locator for metal detection and a Geonics EM-38 ground conductivity meter to delineate changes in the soil characteristics that would indicate disturbed soils (burial pits). The survey focused on the immediate area of the two potential burial locations shown in Figure 3.2.2-1, and investigated the potential subsurface test pits at SWMU 85 adjacent to Building 9920, which are not part of this NFA proposal. Maps of the survey area and significant anomalies are shown in Figures 3.4.3-1 and 3.4.3-2. The geophysical investigation of SWMU 14 did not delineate any trench or pit structures—only buried utilities.

3.4.3.2 Sampling Data Collection

No preliminary screening samples were collected from SWMU 14.

THIS PAGE INTENTIONALLY LEFT BLANK

3.4.3.3 Data Gaps

Information gathered through process knowledge, site files, and personal interviews provided information identifying COCs at SWMU 14. There was, however, conflicting information concerning the exact location of the burial area, and the geophysical data showed no evidence of burial. Additionally, there were no subsurface data to support an NFA decision.

3.4.3.4 Results and Conclusions

The geophysical survey determined there were no anomalies indicating buried material in the reported burial area.

The fact that there were no anomalies in the burial area validates the reports that the volume of debris was insignificant (scattered, residual glass shards) and that the residual material was just graded over (SNL/NM 1996c). Additional sampling would be required to support the NFA proposal.

3.4.4 Investigation #3—SNL/NM ER Project Voluntary Corrective Measure and Confirmatory Sampling

Originally, the RFI Sampling Plan called for collecting 25 random samples from a depth of 10 to 24 inches on a grid established in the area of the reported burial site (see RFI Work Plan [SNL/NM March 1996a]). However, based upon discussion with the New Mexico Environment Department (NMED) Oversight Bureau, it was agreed to excavate exploratory trenches to depths of three feet (one-foot below the reported depth of burial) in the area and sample soils from the bottom of the trenches (SNL/NM June 1997, Wrightson June 1997). The sampling procedures and results are discussed in further detail in the following sections.

3.4.4.1 Nonsampling Data Collection

Other than conducting the geophysical survey (see Section 3.4.3.1.6) no additional nonsampling activities were implemented. A survey, however, was conducted on May 15, 1997, and on June 16, 1997, with SNL/NM facilities in order to confirm the presence and location of underground utilities detected in the geophysical survey.

3.4.4.2 Sampling Data Collection

3.4.4.2.1 Voluntary Corrective Measure Activities

Other than the radiological VCM performed by RUST Geotech Inc., which is associated with SWMU 85 (see Section 3.4.3.1.3) (SNL/NM September 1997), no VCM activities were conducted at SWMU 14.

3.4.4.2.2 Confirmatory Sampling

Seven trenches (Trenches 1 through 7) and two small pits (Trenches 8 and 9) (Figure 3.4.4-1) were excavated in the area of the reported burial site. A total of 175 linear feet of trench was excavated to a depth of 3 feet according to the rationale and procedures described in the "OU 1335, ER Site 14 Confirmatory Sampling Plan" (SNL/NM July 1997), which was reviewed by the NMED. The trench locations and depths were based on direct confirmation interviews with individuals involved in the project and were designed to provide adequate coverage of the reported burial area. The subsurface soil samples were collected from SWMU 14 at 27 trench locations in the trenches. SNL/NM Department 7713 (Radiation Protection Sample Diagnostics) laboratory analyzed all samples on site for gamma-emitting radionuclides using gamma spectroscopy (Annex 3-A). Chemical analyses (HE and RCRA metals plus mercury, beryllium, and nickel) were performed by Lockheed Analytical Services at Level III data quality, which is definitive data (including matrix spikes [MS], matrix spike duplicates [MSD], laboratory control samples, and laboratory control sample duplicates [LCSD]) appropriate for site characterization. Data were validated according to SNL/NM Technical Operating Procedure 94-03 (SNL/NM July 1994). RCRA metals analyzed using EPA Method 6010/7000 included mercury, beryllium, and nickel. HE were analyzed using EPA Method 8300 (EPA November 1986). Figure 3.4.4-1 shows sample locations, and Tables 3.4.4-1, 3.4.4-2, and 3.4.4-3 summarize the data. Semivolatile organic compounds (SVOC) were also analyzed for one sample using EPA Method 8270. These data are presented in Annex 3-A.

During the excavation activities, the trenches were visually inspected for evidence of buried debris, glass fragments, or stained soils and were screened for mercury using a mercury vapor analyzer.

3.4.4.3 Data Gaps

Interviews with site personnel and supporting geophysical survey indicated the amount of material buried was insignificant; however, no data were available to prove or refute unequivocally the presence of contamination at SWMU 14. The sampling plan was designed to determine whether the COCs were present in the reported burial area, and if they were, the extent of the contamination.

3.4.4.4 Results and Conclusions

In Trench 4, discolored soils (gray to black and carbonaceous in appearance) were encountered in one area. This soil occurred as a small lens of disturbed material intermixed with the native soil in Trench 4 (Figures 3.4.4-1, 3.4.4-2a, 3.4.4-2b, 3.4.4–2c, and 3.4.4-2d). This location corresponds to the burial location immediately to the southeast of the flame pad shown in Figure 3.2.2-1. The volume of this lens was approximately 2 cubic feet. These soils were analyzed for metals, gamma radiation, HE, and SVOCs (see Tables 3.4.4-1, 3.4.4-2, and 3.4.4-3 [Sample Number 1335-ER14-CONF-3.0-TR]). These soils were excavated until all discolored soils (about 1 drum of soil) were removed.

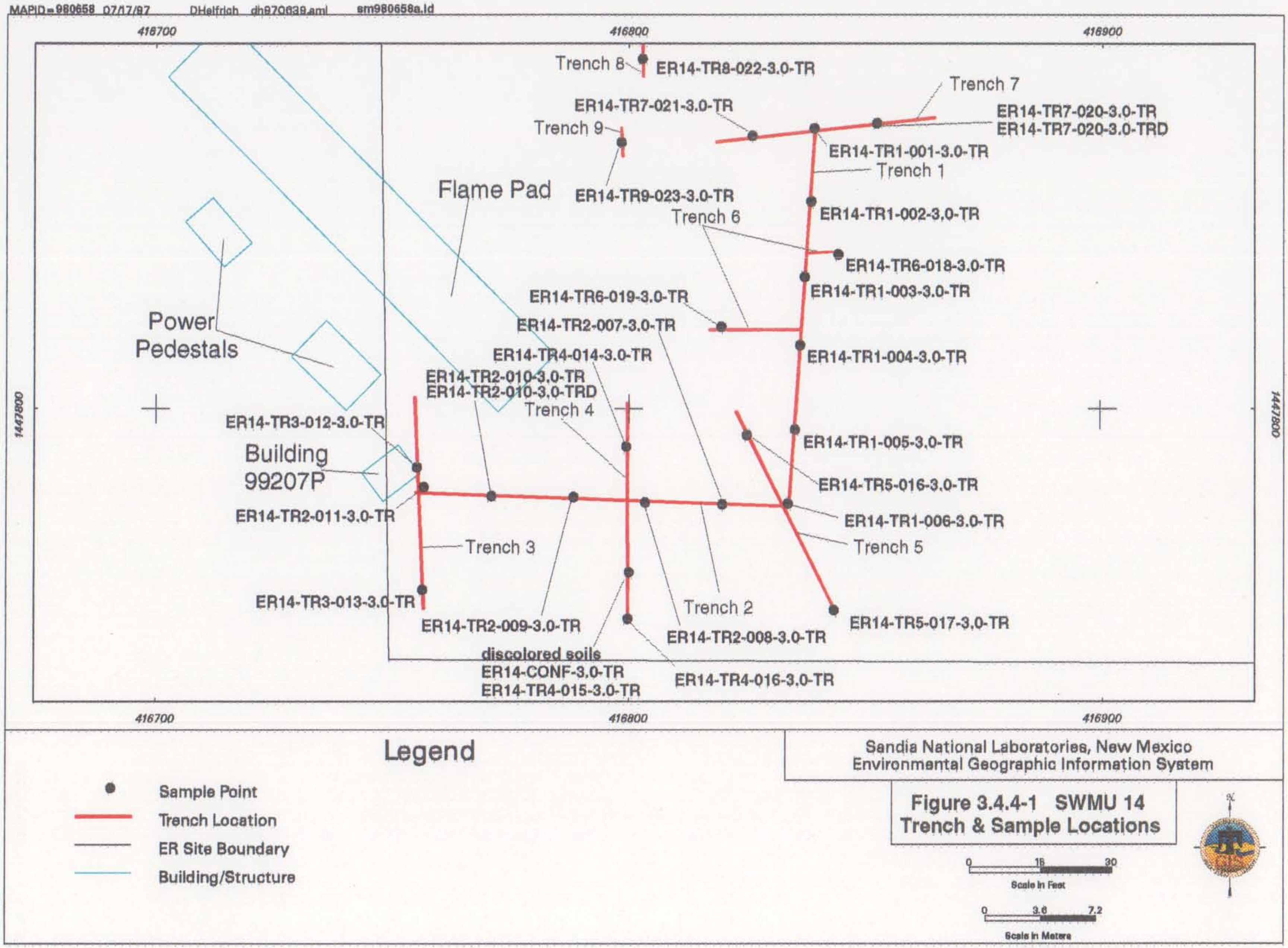


Figure 3.4.4-1 SWMU 14 Trench & Sample Locations

Table 3.4.4-1
Summary of SWMU 14 Confirmatory Soil Sampling Metals Analysis Results, July 1997
(Off-Site Laboratory Only)

Sample Attributes				Metals (EPA 6010/7000)[a] (mg/kg)							
Sample Location	Record Number[b]	ER Sample ID	Sample Depth (ft)	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
TR-1	06814	1335-ER14-TR1-001-3.0-TR	3.0	2.83	81.3	ND (0.103)	7.27	5.22	ND (0.101)	ND (0.309)	ND (0.103)
	06814	1335-ER14-TR1-002-3.0-TR	3.0	3.39	79.5	ND (0.104)	8.35	5.92	ND (0.104)	ND (0.311)	ND (0.104)
	06814	1335-ER14-TR1-003-3.0-TR	3.0	3.25	74.7	ND (0.0948)	8.50	5.46	ND (0.107)	ND (0.284)	ND (0.0948)
	06814	1335-ER14-TR1-004-3.0-TR	3.0	3.35	145.	ND (0.105)	9.21	6.02	ND (0.106)	ND (1.57)	ND (0.105)
	06814	1335-ER14-TR1-005-3.0-TR	3.0	3.49	87.1	ND (0.0941)	8.61	6.42	ND (0.107)	ND (0.282)	ND (0.0941)
	06814	1335-ER14-TR1-006-3.0-TR	3.0	3.39	86.1	ND (0.106)	8.28	6.62	ND (0.103)	ND (0.318)	ND (0.106)
TR-2	06814	1335-ER14-TR2-007-3.0-TR	3.0	3.53	86.1	ND (0.0877)	8.62	5.68	ND (0.108)	ND (1.31)	ND (0.0877)
	06814	1335-ER14-TR2-008-3.0-TR	3.0	3.38	81.8	ND (0.0930)	6.73	5.80	ND (0.102)	ND (0.279)	ND (0.0930)
	06814	1335-ER14-TR2-009-3.0-TR	3.0	2.53	55.7	ND (0.0877)	6.69	5.17	ND (0.111)	ND (0.263)	ND (0.0877)
	06814	1335-ER14-TR2-010-3.0-TR	3.0	3.50	180.	ND (0.0938)	9.85	7.04	ND (0.108)	ND (1.41)	ND (0.0938)
	06814	1335-ER14-TR2-010-3.0-TRD	3.0	3.25	54.9	ND (0.105)	8.50	6.39	ND (0.108)	ND (0.315)	ND (0.105)
	06814	1335-ER14-TR2-011-3.0-TR	3.0	3.34	90.2	ND (0.104)	7.06	5.99	ND (0.108)	ND (0.311)	ND (0.104)
TR-3	06814	1335-ER14-TR3-012-3.0-TR	3.0	3.71	91.8	ND (0.108)	7.73	6.53	ND (0.108)	ND (0.323)	ND (0.108)
	06814	1335-ER14-TR3-013-3.0-TR	3.0	2.13	60.7	ND (0.0875)	6.25	4.91	ND (0.101)	ND (0.262)	ND (0.0875)
TR-4	06814	1335-ER14-TR4-014-3.0-TR	3.0	3.61	96.9	ND (0.104)	8.67	6.22	ND (0.109)	ND (0.313)	ND (0.104)
	06814	1335-ER14-TR4-015-3.0-TR	3.0	2.35	63.6	ND (0.0751)	7.35	4.46	ND (0.106)	ND (0.225)	ND (0.0751)
	06814	1335-ER14-TR4-016-3.0-TR	3.0	1.87	75.7	ND (0.0960)	6.43	4.16	ND (0.0995)	ND (0.288)	ND (0.0960)
	06814	1335-ER14-CONF-3.0-TR	3.0	2.50	59.0	ND (0.0880)	8.00	4.50	ND (0.103)	ND (0.260)	ND (0.0958)
TR-5	06814	1335-ER14-TR5-016-3.0-TR	3.0	2.96	76.1	ND (0.0814)	8.75	6.47	ND (0.107)	ND (0.244)	ND (0.0814)
	06814	1335-ER14-TR5-017-3.0-TR	3.0	2.65	56.7	ND (0.0878)	6.67	4.77	ND (0.106)	ND (1.32)	ND (0.0878)
TR-6	06814	1335-ER14-TR6-018-3.0-TR	3.0	2.50	52.5	0.116 J (0.542)	5.14	3.58	ND (0.109)	ND (0.325)	ND (0.108)
	06814	1335-ER14-TR6-019-3.0-TR	3.0	3.47	109.	ND (0.106)	8.26	5.91	ND U,J (0.103)	ND (0.317)	ND (0.106)
TR-7	06814	1335-ER14-TR7-020-3.0-TR	3.0	6.00	66.8	ND (0.0941)	7.81	5.75	ND U,J (0.0924)	ND (0.282)	ND (0.0941)
	06814	1335-ER14-TR7-020-3.0-TRD	3.0	3.21	76.0	ND (0.0938)	8.22	5.40	ND U,J (0.103)	ND (0.281)	ND (0.0938)
	06814	1335-ER14-TR7-021-3.0-TR	3.0	3.42	107.	ND (0.0911)	8.61	5.92	ND U,J (0.103)	ND (0.273)	ND (0.0911)
TR-8	06814	1335-ER14-TR8-022-3.0-TR	3.0	6.09	89.9	ND (0.0939)	9.63	7.44	ND U,J (0.108)	ND (0.282)	ND (0.0939)
TR-9	06814	1335-ER14-TR9-023-3.0-TR	3.0	2.77	141.	ND (0.104)	6.86	5.10	ND U,J (0.106)	ND (0.313)	ND (0.104)

Refer to footnotes at end of table.

Table 3.4.4-1 (Concluded)
Summary of SWMU 14 Confirmatory Soil Sampling Metals Analysis Results, July 1997
(Off-Site Laboratory Only)

Sample Attributes				Metals (EPA 6010/7000)[a] (mg/kg)							
Sample Location	Record Number[b]	ER Sample ID	Sample Depth (ft)	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
Quality Assurance/Quality Control Samples (all in mg/L)											
NA	06814	1335-ER14-TR1-024-EB	NA	ND (0.00300)	0.00575 J (0.200)	ND (0.00100)	0.00192 J (0.0100)	ND (0.00200)	ND (0.000200)	ND (0.00300)	ND (0.00100)
HRMB Maximum Background Subsurface Soil Concentrations—Southwest Area[c]				4.4	214	0.9	15.9	11.8	<0.1	<1	<1

[a]EPA November 1986.
[b]Chain of custody record.
[c]Dinwiddie September 24, 1997.
EB = Equipment blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
J ( ) = The value reported is less than the contract required detection limit as shown in parenthesis, but greater than or equal to the instrument detection limit.
mg/kg = Milligram(s) per kilogram.
mg/L = Milligram(s) per liter.
NA = Not applicable.
ND ( ) = Not detected at or above the method detection limit, shown in parenthesis.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid waste management unit.
SWTA = Southwest Test Area.
TR- = Trench designation within SWMU 14.
TR, TRD = Trench soil sample, duplicate trench soil sample.
UJ = The analyte was analyzed for, but not detected. The associated value is an estimate and may be inaccurate or imprecise.
UTL = Upper tolerance limit.

Table 3.4.4-2
Summary of SWMU 14 Confirmatory Soil Sampling Gamma Spectroscopy Analysis Results, July 1997
(On-Site Laboratory Only)

Sample Attributes				Gamma Spectroscopy Activity (pCi/g)						
Sample Location	Record Number[a]	ER Sample ID	Sample Depth (ft)	Uranium-238	Thorium-234	Thorium-232	Radium-228	Thorium-228	Uranium-235	Cesium-137
TR-1	06817	1335-ER14-TR1-001-3.0-TR	3.0	ND (1.47E+00)	9.47E-01	5.01E-01	6.63E-01	ND (4.07E-01)	ND (2.04E-01)	ND (3.49E-02)
	06817	1335-ER14-TR1-002-3.0-TR	3.0	ND (1.32E+00)	6.46E-01	5.90E-01	6.08E-01	5.88E-01	ND (1.83E-01)	ND (3.29E-02)
	06817	1335-ER14-TR1-003-3.0-TR	3.0	ND (1.24E+00)	7.90E-01	5.23E-01	5.10E-01	4.27E-01	ND (1.72E-01)	ND (3.00E-02)
	06817	1335-ER14-TR1-004-3.0-TR	3.0	ND (1.29E+00)	7.82E-01	6.00E-01	4.63E-01	7.75E-01	ND (1.81E-01)	ND (3.24E-02)
	06815	1335-ER14-TR1-005-3.0-TR	3.0	ND (6.05E-01)	1.00E+00	5.43E-01	6.09E-01	5.51E-01	8.73E-02	ND (2.61E-02)
	06817	1335-ER14-TR1-006-3.0-TR	3.0	2.03E+00	1.72E+00	6.43E-01	5.40E-01	6.13E-01	ND (1.79E-01)	ND (3.29E-02)
TR-2	06817	1335-ER14-TR2-007-3.0-TR	3.0	ND (1.60E+00)	9.07E-01	6.21E-01	6.47E-01	3.77E-01	ND (1.82E-01)	ND (2.60E-02)
	06817	1335-ER14-TR2-008-3.0-TR	3.0	ND (1.66E+00)	1.12E+00	6.30E-01	6.92E-01	5.97E-01	ND (1.86E-01)	ND (2.72E-02)
	06817	1335-ER14-TR2-009-3.0-TR	3.0	ND (1.55E+00)	7.05E-01	6.01E-01	5.11E-01	5.90E-01	ND (1.77E-01)	ND (2.59E-02)
	06815	1335-ER14-TR2-010-3.0-TR	3.0	ND (1.65E+00)	7.82E-01	6.40E-01	5.81E-01	6.37E-01	1.36E-01	ND (2.65E-02)
	06817	1335-ER14-TR2-010-3.0-TRD	3.0	ND (1.55E+00)	8.66E-01	5.75E-01	6.45E-01	5.51E-01	ND (1.71E-01)	ND (2.39E-02)
	06817	1335-ER14-TR2-011-3.0-TR	3.0	ND (1.46E+00)	5.05E-01	5.99E-01	ND (1.63E-01)	3.70E-01	ND (1.94E-01)	1.22E-02
TR-3	06817	1335-ER14-TR3-012-3.0-TR	3.0	ND (1.42E+00)	ND (5.54E-01)	5.88E-01	5.67E-01	5.82E-01	ND (1.86E-01)	ND (3.58E-02)
	06817	1335-ER14-TR3-013-3.0-TR	3.0	ND (1.40E+00)	1.08E+00	7.48E-01	7.27E-01	4.24E-01	ND (1.99E-01)	ND (3.68E-02)
TR-4	06817	1335-ER14-TR4-014-3.0-TR	3.0	ND (1.49E+00)	1.09E+00	6.91E-01	6.00E-01	6.72E-02	ND (2.02E-01)	ND (3.76E-02)
	06815	1335-ER14-TR4-015-3.0-TR	3.0	ND (1.64E+00)	5.88E-01	5.26E-01	5.75E-01	2.23E-01	ND (1.83E-01)	ND (2.73E-02)
	06817	1335-ER14-TR4-016-3.0-TR	3.0	ND (1.45E+00)	7.28E-01	4.29E-01	5.33E-01	4.73E-01	ND (1.64E-01)	ND (2.48E-02)
	06850	1335-ER14-CONF-3.0-TR	3.0	ND (1.16E+00)	ND (4.57E-01)	6.64E-01	6.61E-01	ND (2.51E-01)	ND (1.65E-01)	ND (3.26E-02)
TR-5	06817	1335-ER14-TR5-016-3.0-TR	3.0	ND (1.31E+00)	7.78E-01	5.61E-01	5.95E-01	4.60E-01	ND (1.81E-01)	ND (3.26E-02)
	06817	1335-ER14-TR5-017-3.0-TR	3.0	ND (1.49E+00)	8.00E-01	5.40E-01	6.52E-01	6.30E-01	ND (1.69E-01)	ND (2.62E-02)
TR-6	06817	1335-ER14-TR6-018-3.0-TR	3.0	ND (1.48E+00)	9.40E-01	5.99E-01	5.23E-01	5.49E-01	ND (1.70E-01)	ND (2.35E-02)
	06817	1335-ER14-TR6-019-3.0-TR	3.0	6.54E-01	8.58E-01	6.00E-01	6.57E-01	6.72E-01	ND (1.69E-01)	ND (2.46E-02)
TR-7	06815	1335-ER14-TR7-020-3.0-TR	3.0	7.87E-01	1.12E+00	6.41E-01	6.64E-01	6.57E-01	ND (1.76E-01)	ND (2.65E-02)
	06817	1335-ER14-TR7-020-3.0-TRD	3.0	ND (1.37E+00)	ND (5.31E-01)	5.78E-01	5.75E-01	3.28E-01	ND (1.87E-01)	ND (3.16E-02)
	06817	1335-ER14-TR7-021-3.0-TR	3.0	8.68E-01	7.99E-01	6.33E-01	6.61E-01	5.96E-01	ND (1.85E-01)	ND (2.60E-02)
TR-8	06815	1335-ER14-TR8-022-3.0-TR	3.0	ND (1.06E+00)	6.65E-01	6.23E-01	6.76E-01	5.89E-01	ND (1.83E-01)	ND (2.65E-02)
TR-9	06817	1335-ER14-TR9-023-3.0-TR	3.0	5.52E-01	8.75E-01	6.54E-01	6.09E-01	6.07E-01	ND (2.19E-01)	ND (3.44E-02)

Refer to footnotes at end of table.

Table 3.4.4-2 (Concluded)
Summary of SWMU 14 Confirmatory Soil Sampling Gamma Spectroscopy Analysis Results, July 1997
(On-Site Laboratory Only)

Sample Attributes				Gamma Spectroscopy Activity (pCi/g)						
Sample Location	Record Number[a]	ER Sample ID	Sample Depth (ft)	Uranium-238	Thorium-234	Thorium-232	Radium-228	Thorium-228	Uranium-235	Cesium-137
Quality Assurance/Quality Control Samples (all in pCi/mL)										
NA	06817	1335-ER14-TR1-024-EB	NA	ND (9.48E-01)	ND (3.12E-01)	ND (1.38E-01)	ND (1.11E-01)	ND (4.66E-01)	ND (1.30E-01)	ND (1.85E-02)
HRMB Maximum Background Subsurface Soil Concentrations—Southwest Area[b]				1.4	1.4	1.01	0.93	0.93[c]	0.16	0.079

[a]Chain of custody record.
[b]Dinwiddie September 24, 1997.
[c]Brown January 24, 1998.

EB = Equipment blank.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
NA = Not applicable.
ND ( ) = Not detected at or above the minimum detectable activity, shown in parenthesis.
pCi/g = Picocurie(s) per gram.
pCi/mL = Picocurie(s) per milliliter.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid waste management unit.
SWTA = Southwest Test Area.
TR- = Trench designation within SWMU 14.
TR, TRD = Trench soil sample, duplicate trench soil sample.
UJ = The analyte was analyzed for, but not detected. The associated value is an estimate and may be inaccurate or imprecise.
UTL = Upper tolerance limit.

Table 3.4.4-3
Summary of SWMU 14 Confirmatory Soil Sampling HE Analysis Results, July 1997
(Off-Site Laboratory Only)

Sample Attributes				High Explosives (EPA 8330)[a] (µg/g)					
Sample Location	Record Number[b]	ER Sample ID	Sample Depth (ft)	2,4,6-trinitrotoluene	2,4-dinitrotoluene	2,6-dinitrotoluene	2 Amino, 4,6-dinitrotoluene	4 Amino, 2,6-dinitrotoluene	HMX
TR-1	06814	1335-ER14-TR1-001-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR1-002-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR1-003-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR1-004-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR1-005-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR1-006-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
TR-2	06814	1335-ER14-TR2-007-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR2-008-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR2-009-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR2-010-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR2-010-3.0-TRD	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR2-011-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
TR-3	06814	1335-ER14-TR3-012-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR3-013-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
TR-4	06814	1335-ER14-TR4-014-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR4-015-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR4-016-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-TR14-CONF-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
TR-5	06814	1335-ER14-TR5-016-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR5-017-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
TR-6	06814	1335-ER14-TR6-018-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR6-019-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
TR-7	06814	1335-ER14-TR7-020-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR7-020-3.0-TRD	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
	06814	1335-ER14-TR7-021-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
TR-8	06814	1335-ER14-TR8-022-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
TR-9	06814	1335-ER14-TR9-023-3.0-TR	3.0	ND (0.11)	ND (0.16)	ND (0.19)	ND (0.13)	ND (0.055)	ND (0.42)
Quality Assurance/Quality Control Samples (all in µg/L)									
NA	06814	1335-ER14-TR1-024-EB	NA	ND (0.030)	ND (0.11)	ND (0.070)	ND (0.040)	ND (0.050)	ND (0.080)

Refer to footnotes at end of table.

Table 3.4.4-3 (Continued)
Summary of SWMU 14 Confirmatory Soil Sampling HE Analysis Results, July 1997
(Off-Site Laboratory Only)

Sample Attributes				High Explosives (EPA 8330)[a] (µg/g)		
Sample Location	Record Number[b]	ER Sample ID	Sample Depth (ft)	Nitrobenzene	RDX	TETRYL
TR-1	06814	1335-ER14-TR1-001-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR1-002-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR1-003-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR1-004-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR1-005-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR1-006-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
TR-2	06814	1335-ER14-TR2-007-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR2-008-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR2-009-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR2-010-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR2-010-3.0-TRD	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR2-011-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
TR-3	06814	1335-ER14-TR3-012-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR3-013-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
TR-4	06814	1335-ER14-TR4-014-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR4-015-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR4-016-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-CONF-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
TR-5	06814	1335-ER14-TR5-016-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR5-017-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
TR-6	06814	1335-ER14-TR6-018-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR6-019-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
TR-7	06814	1335-ER14-TR7-020-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR7-020-3.0-TRD	3.0	ND (0.15)	ND (0.19)	ND (0.34)
	06814	1335-ER14-TR7-021-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
TR-8	06814	1335-ER14-TR8-022-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
TR-9	06814	1335-ER14-TR9-023-3.0-TR	3.0	ND (0.15)	ND (0.19)	ND (0.34)
Quality Assurance/Quality Control Samples (all in µg/L)						
NA	06814	1335-ER14-TR1-024-EB	NA	ND (0.040)	ND (0.020)	ND (0.040)

Refer to footnotes at end of table.

Table 3.4.4-3 (Concluded)
Summary of SWMU 14 Confirmatory Soil Sampling HE Analysis Results, July 1997
(Off-Site Laboratory Only)

Sample Attributes				High Explosives (EPA 8330)[a] (µg/g)				
Sample Location	Record Number[b]	ER Sample ID	Sample Depth (ft)	1,3-Dinitrobenzene	2-Nitrotoluene	3-Nitrotoluene	4-Nitrotoluene	1,3,5-Trinitrobenzene
TR-1	06814	1335-ER14-TR1-001-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR1-002-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR1-003-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR1-004-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR1-005-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR1-006-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
TR-2	06814	1335-ER14-TR2-007-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR2-008-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR2-009-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR2-010-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR2-010-3.0-TRD	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR2-011-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
TR-3	06814	1335-ER14-TR3-012-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR3-013-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
TR-4	06814	1335-ER14-TR4-014-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR4-015-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR4-016-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-CONF-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
TR-5	06814	1335-ER14-TR5-016-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR5-017-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
TR-6	06814	1335-ER14-TR6-018-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR6-019-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
TR-7	06814	1335-ER14-TR7-020-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR7-020-3.0-TRD	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
	06814	1335-ER14-TR7-021-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
TR-8	06814	1335-ER14-TR8-022-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
TR-9	06814	1335-ER14-TR9-023-3.0-TR	3.0	ND (0.10)	ND (0.070)	ND (0.16)	ND (0.17)	ND (0.070)
Quality Assurance/Quality Control Samples (all in µg/L)								
NA	06814	1335-ER14-TR1-024-EB	NA	ND (0.030)	ND (0.030)	ND (0.020)	ND (0.030)	ND (0.040)

[a]EPA November 1986
[b]Chain of custody record.

EB = Equipment Blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
HE = High explosives.
HMX = 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane.
ID = Identification.
NA = Not applicable.
ND ( ) = Not detected at or above the method detection limit, shown in parenthesis.
RDX = 1,3,5-trinitro-1,3,5-triazacyclohexane.
SWMU = Solid waste management unit.
TETRYL = 2,4,6-trinitrophenylmethylnitramine.
TR- = Trench designation within SWMU 14.
TR, TRD = Trench soil sample, duplicate trench soil sample.
µg/L = Microgram(s) per liter.
µg/g = Microgram(s) per gram.

THIS PAGE INTENTIONALLY LEFT BLANK

Figure 3.4.4-2a. Excavation Activities SWMU 14, Trench #2

Figure 3.4.4-2b. Excavation Activities SWMU 14, Trench #3

Figure 3.4.4-2c. Excavation Activities SWMU 14, Trench #9.

Figure 3.4.4-2d. Stained Soils in Trench #4 SWMU 14.

Scattered glass fragments were also observed on the surface at trenches 8 and 9 (Figures 3.4.4-1 and 3.4.4-2a, b, c). The mercury vapor detector did not show any mercury vapors in the soil. The mercury vapor concentrations in the soils ranged from 0.000 milligram (mg) per cubic meter (m^3) to 0.004 mg/m^3. Ambient mercury concentrations in the air ranged from 0.000 to 0.001 mg/m^3 (Wrightson July 1997).

After all the discolored soils were removed, the area was sampled for metals, explosives, and gamma radiation. All results were below approved background levels (Sample Number 1335-ER14-015-3.0-TR).

These findings support the reports that the amount of glass buried was minimal. The volume of mercury associated with the glass is also minimal, since none was detected in the field screening and the soil samples.

Metals

From the samples collected in the trenches at SWMU 14, four metals (barium, cadmium, chromium, and lead) were below the approved SNL/NM maximum background levels established for the subsurface soils in the Southwest Test Area (SWTA) (Dinwiddie September 24, 1997) (Table 3.4.4-1). All barium results were below the approved SNL maximum background levels of 214 mg/kg for subsurface soil in the SWTA (Dinwiddie September 24, 1997). Barium concentrations at SWMU 14 ranged from 52.5 to 180 mg/kg. Cadmium values were all below the detectable limits except for one sample (1335 ER14-TR6-018-3.0-TR) at a concentration of 0.116 J mg/kg. This concentration was below the background level for cadmium (0.9 mg/kg). Chromium samples, with values ranging from 5.14 to 9.85 mg/kg, were below the background level of 15.9 mg/kg. Lead concentrations ranged from 3.58 to 7.44 mg/kg, which were less than the background level of 11.8 mg/kg.

Mercury, silver, and selenium concentrations were all nondetect. The maximum detection limit for mercury was 0.111 mg/kg, whereas the NMED approved background level is nonquantified at less than 0.1 mg/kg. At these detection limits, mercury is considered to have no significant impact on human health and the environment at SWMU 14. Selenium concentrations were all nondetect. The detection limits of the three samples were slightly above the nonquantified background level of less than 1 mg/kg. The maximum detection limit, 1.57 for sample 1335-ER14-TR1-004-3.0-TR, has insignificant impact on human health and the environment at SWMU 14 at a concentration of ½ the detection limit.

All silver concentrations were nondetect. Silver does not have a quantifiable background concentration. However, at ½ the maximum detection limit, silver poses insignificant risk to human health and the environment.

Arsenic had slightly elevated concentrations above background. Of the 27 samples collected at SWMU 14, two samples were above the background levels for arsenic: sample numbers 1335-ER14-TR7-020-3.0-TR at 6.0 mg/kg and 1335-ER14-TR8-022-3.0-TR at 6.09 mg/kg. All others were below the NMED background level of 4.4 mg/kg for subsurface soil in the SWTA.

Metals results from the discolored soils (Sample Number 1335-ER14-CONF-3.0-TR) were all below NMED approved background levels.

Radiological Analyses

Of the gamma activities reported in Table 3.4.4-2, uranium-238 and thorium-234 were reported in one instance at levels slightly above approved background. Twenty-two of the twenty-seven samples analyzed for gamma radiation were below the minimum detectable activities (MDA) for uranium-238. Even though the MDAs for uranium-238 exceed the approved background levels, this does not represent a data quality problem. In most cases, the data were obtained by gamma spectroscopic analysis (multiisotopes reported per analysis). The MDA is a function of sample counting time and/or analytical method used. Uranium values obtained for the radionuclides presented in this NFA have MDAs that are slightly higher than the approved background value, given the routine 6000-second counting times used. The important aspect of the uranium data that must be considered is not how the MDA compares to selected background values for the site, but rather the calculated Preliminary Remediation Goals (PRG), which are based on a 15-millirem per year (mrem/yr) effective dose equivalent maximum dose limit in EPA's OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA August 1997). These PRGs are several orders of magnitude larger than the MDAs reported, which ensures adequate protection of human health and the environment. For the samples that were detectable above the MDA, activities ranged from 0.552 picocuries (pCi)/gram (g) to 2.03 pCi/g. However, MDAs for uranium-238 were variable among the samples and, in some cases, were slightly above the 1.4 pCi/g background activity for the SWTA. The highest MDA for uranium-238 at SWMU 14 was 1.66 pCi/g. Gamma activities for thorium-234 ranged from not detected (ND) (0.457 pCi/g MDA) to 1.72 pCi/g. Three samples were nondetects, with the highest MDA at 0.54 pCi/g. Background activity for thorium-234 in the SWTA was 1.4 pCi/g.

Thorium-232, radium-228 and cesium-137 were all below background levels. Thorium-232 activities ranged from 0.429 pCi/g to 0.748 pCi/g. Background activities for thorium-232 at the SWTA were 1.01 pCi/g. Radium-228 activities ranged from ND (0.163 pCi/g MDA) to 0.727 pCi/g. These activities are below the background levels of 0.93 pCi/g. For cesium-137, gamma activities ranged from ND (0.0246 pCi/g) to 0.012 pCi/g. Background levels for cesium-137 are 0.079 pCi/g. All cesium-137 activities were below background levels.

Activities for thorium-228 ranged from 0.067 pCi/g to 0.775 pCi/g. Two samples were nondetect (from Trench 1 and Trench 4). The highest MDA for these samples was 0.407 pCi/g. No background values are available for thorium-228 but it can be roughly estimated at 0.93 pCi/g, the background value for radium-228, its precursor. Uranium-235 activities ranged from ND (0.164 pCi/g) to 0.136 pCi/g. Background levels for uranium-235 are 0.16 pCi/g. Only two samples had detectable activities of uranium-235. However, MDAs for the nondetectable samples were greater than background, which rendered comparison to background for uranium-235 uncertain. However, as discussed above, the magnitude of the MDA compared to the calculated PRG ensures adequate protection of human health and the environment. Complete results of gamma spectroscopy are contained in Annex 3-A.

For the discolored soils (Sample Number 1335-ER14-CONF-3.0-TR) radiological activities were either below MDAs or less than NMED approved background levels.

SVOCs

From the discolored soil, one sample, 1335-ER14-CONF-3.0-TR, was analyzed for SVOCs. All constituents were nondetect for this sample. Results, including method detection limit, practical quantitation limit, and reporting detection limit, are shown in Annex 3-A.

HE

HE analytes were all below applicable detection limits (Table 3.4.4-3). Because explosives are not naturally occurring, there can be no comparison of detection limits to background. Based upon sample results, explosives do not have an impact on the environment at SWMU 14. For the discolored soils (Sample Number 1335-ER14-CONF-3.0-TR) all explosives were nondetect.

3.4.4.5 Data Validation

Samples were analyzed for metals, HE, and radioactivity. Two duplicate pairs and an equipment blank were submitted with the field samples. Level III data validation were performed on inorganic, organic, and radiometric data. The SVOC analysis was analyzed at Level III data quality but was not validated. The data were determined to be acceptable, and the quality control (QC) data were adequate.

Specific problems, which minimally affect data quality, are presented below:

Metals

The mercury holding times were exceeded by 1 day for six samples (1335-ER14-TR6-019, 1335-ER14-TR6-020, 1335-ER14-TR6-020D, 1335-ER14-TR6-021, 1335-ER14-TR6-022, 1335-ER14-TR6-023). Mercury was not detected in the six samples, but because of the exceeded holding time, the results were "UJ" coded (see footnote "UJ" on Table 3.4.4-1). Also, for the lab control samples, the barium percent recovery did not meet acceptable limits. The relative percent difference for field duplicates was performed for arsenic, barium, chromium, and lead. The arsenic RPD for one sample set (60.8) and the barium RPD for one sample set (106) are outside the EPA acceptable limits of 20 percent (EPA February 1994). However, because these are field duplicates and not laboratory duplicates, the difference may be attributable to inhomegeneity in the soil and not analytical methods. No data were qualified since the LCSD, MS, and MSD met acceptable limits. The data were determined to be acceptable and the QC data were adequate.

3.5 Site Conceptual Model

3.5.1 Nature and Extent of Contamination

From review of the data collected from the trenching activities performed at SWMU 14, there was one area of discolored soils (approximately 2 cubic feet) that appears to have been buried test material. Also, scattered fragments of glass were encountered on the surface at Trenches 8 and 9. The absence of mercury and HE, the primary COCs in the soil at this site prior to the investigation, indicates the soils were not contaminated by the materials released at SWMU 14.

Although there were no COCs (mercury and HE) detected at SWMU 14, arsenic was slightly over the approved maximum background level, and some gamma activities for uranium-238 and thorium-234 were greater than the approved background levels (see Table 3.5.1-1). In addition, mercury and selenium, which were nondetect in all confirmation samples, do not have quantifiable maximum background concentration levels. The MDAs for uranium-235 were slightly higher than background. Only two samples for arsenic were above approved SNL/NM maximum background levels by a maximum difference of 1.69 mg/kg. Because of the low concentration of this constituent and the localized nature of its occurrence, it appears that this is not a contaminant; rather, it is a localized soil anomaly in the immediate area of the sample points.

Although uranium-238 was detected over the approved background level of 1.4 pCi/g in only one sample from the trenches, many of the MDAs for uranium-238 were slightly greater than background. One sample was slightly above the background level for thorium-234 (Table 3.5.1-1). Since surface soil contamination at SWMU 14 would be associated with the firing sites at Building 9920, confirmation samples from the surface soils (from the Rust Geotech Inc. VCM) are considered part of SWMU 85, Firing Sites Building 9920. The fact that each of these constituents is confined to one sample provides evidence that the distribution of these elements is limited to the immediate sample area. In addition, the fact that the samples were collected at a depth of 1-foot below the reported bottom of the burial site, is evidence that the vertical and lateral extent of contamination at SWMU 14 has been defined.

It has been previously estimated that a total of 0.56 kg of mercury was associated with the fluorescent tubes used at SWMU 85 (70 mg/tube x 8000 tubes). This is equivalent to 413 ml of mercury (Weast and Selby 1967), or less than 1 pint of mercury used in the test, most of which would be vaporized in the explosive test.

The absence of geophysical and chemical anomalies, and the fact that the total volume of residual mercury remaining from the test would be inconsequential, indicates that the occurrence of contaminated debris is insignificant at SWMU 14.

3.5.2 Environmental Fate

The primary sources of COCs at SWMU 14 were buried fragments of fluorescent tubes associated with a firing test at Building 9920. The material may have included mercury and

Table 3.5.1-1
Summary of COCs for SWMU 14

COC Type	Number of Samples	COCs Greater than Background	Maximum Background Limit/SWTA[a] (mg/kg except where noted)	Maximum Concentration (mg/kg except where noted)	Average Concentration[b] (mg/kg except where noted)	Sampling Locations Where Background Concentration Limit Exceeded
Inorganic Nonradionuclides	27	Arsenic	4.4	6.09	3.27	TR7-020, TR8-022
		Mercury	<0.1[c]	ND (0.111)	ND (0.105)	None. However, the detection limits of 26 of the 27 samples were greater than background level.
		Selenium	<1[c]	ND (1.57)	ND (.454)	All results were ND, however, some MDLs are greater than background: TR1-004, TR2-007, TR2-010, TR5-017
Radionuclides	27	U-238	1.4	2.03 pCi/g	Not calculated[d]	TR1-006
		Th-234	1.4	1.72 pCi/g	Not calculated[d]	TR1-006
		U-235	0.16	MDA (0.219)	Not calculated[d]	All MDAs were greater than background; however, two samples had detectable results less than background: TR1-005, TR2-010

[a]SWTA = Southwest Test Area (Dinwiddie September 24, 1997)
[b]Average concentration includes all samples and duplicates, and nondetects.
[c]Background levels for these constituents are not quantified.
[d]An average MDA is not calculated because the variability of the counting error and the number of reported nondetectable activities. These nondetectable activities are solely a function of instrument counting duration rather than an indication of the presence or absence of a specific radionuclide in the environment.

COC = Constituents of concern.
MDA = Minimum detectable activities.
mg/kg = Milligram(s) per kilogram.
ND = Radionuclide not present above the MDA given in ( ).
SWMU = Solid waste management unit.

explosives; however, these contaminants were not detected in significant amounts. Mercury, selenium, and silver background levels, however, must be considered in a risk assessment of the SWMU. Also uranium-238 and thorium-234 gamma activities were above background levels, and although these constituents were not known to be associated with the material reportedly buried at SWMU 14, radiological constituents were known to have been used at Building 9920.

Figure 3.5.2-1 diagrams the environmental fate for the constituents at SWMU 14. The current and future land use for SWMU 14 is industrial (DOE and USAF March 1996). The potential human receptor is the industrial worker. Because the SWMU is a burial site, unless excavated, the surface exposure pathways are nonexistent. There is no exposure through dust emissions, nor direct exposure through surface soil or surface runoff. Dashed lines in the conceptual model flow diagram (Figure 3.5.2-1) indicate these exposure pathways.

Subsurface contaminant exposure pathways could be relevant to SWMU 14, particularly percolation to the vadose zone. The exposure to human receptors is minimal unless the SWMU is excavated. There is potential exposure to biota via this pathway because of plant uptake and the ingestion of the plants and soil by fauna.

Several factors preclude a groundwater pathway as a potential exposure route. The infiltration rates have been determined to be on the order of 0.002 to 0.071 cm/yr, and seepage rates from 0.03 to 11.8 cm/yr (see Section 3.2.1). Groundwater has been estimated to be at an approximate depth of 155 feet bgs. High partitioning coefficients and low mobility of these ions in the transporting medium would dilute the low concentrations of the constituents even more. For these reasons, groundwater was not evaluated as a contaminant migration pathway. Additional discussion of the exposure routes and receptors at SWMU 14 is provided in Annex 3-B.

3.6 Site Assessments

3.6.1 Summary

The site assessment concludes that SWMU 14 does not have significant potential to affect human health under an industrial land-use scenario. After consideration of the uncertainties associated with the available data and modeling assumptions, ecological risks associated with SWMU 14 were found to be low. Brief descriptions of the site assessments are provided below and detailed in Annex 3-B.

3.6.2 Risk Screening Assessments

3.6.2.1 Human Health

SWMU 14 has been recommended for industrial land-use (DOE and USAF March 1996). A complete discussion of the risk assessment process, results, and uncertainties is provided in Annex 3-B. Because the presence of COCs was in concentrations or activities greater than

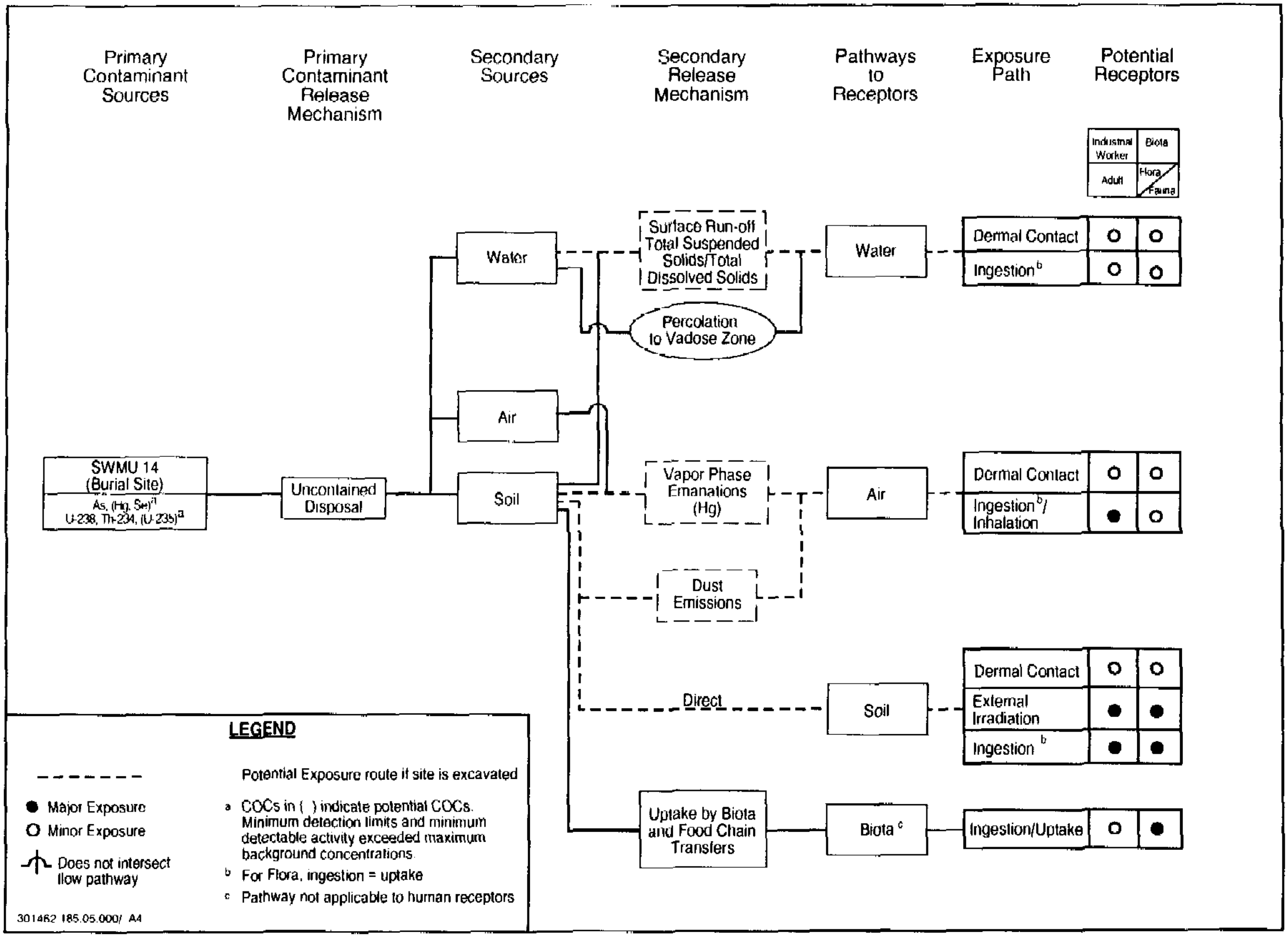


Figure 3.5.2-1

Conceptual Model Flow Diagram for SWMU 14, Burial Site, Building 9920

background levels, it was necessary to perform a health risk assessment analysis for the site. Besides COC metals, any volatile organic compounds or semivolatile organic compounds detected above their reporting limits, and any relevant radionuclide compounds either detected above background levels and/or MDAs were included in this assessment. The risk assessment process provides a quantitative evaluation of the potential adverse human health effects caused by constituents in the soil at the site. The Risk Assessment Report calculated the Hazard Index and excess cancer risk for both an industrial land-use and a residential land-use setting. The excess cancer risk from nonradiological COCs and radiological COCs is not additive (EPA 1989).

In summary, the Hazard Index calculated for SWMU 14 nonradiological COCs is 0.02 for an industrial land-use setting—less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk. The incremental Hazard Index is 0.01. The excess cancer risk for SWMU 14 nonradiological COCs is 3×10^{-6} for an industrial land use setting. Guidance from the NMED indicates that excess lifetime risk of developing cancer by an individual must be less than 10^{-6} for Class A and B carcinogens and less than 10^{-5} for Class C carcinogens (NMED March 1998). The excess cancer risk is driven by arsenic, which is a Class A carcinogen. Thus, the total excess cancer risk for this site is above the suggested acceptable risk value (10^{-6}). However, the incremental excess cancer risk for SWMU 14 is 9×10^{-7}, which is below NMED Guidelines. The incremental total effective dose equivalent for radionuclides for an industrial land-use setting for SWMU 14 is 0.017 mrem/yr, which is well below the recommended dose limit of 15 mrem/yr. found in EPA's OSWER Directive No. 9200.4-18 and reflected in a document entitled "Sandia National Laboratories/New Mexico Environmental Restoration Project—RESRAD Input Parameter Assumptions and Justification" (EPA August 1997, SNL/NM February 1998). The incremental excess cancer risk for radionuclides is 1.9×10^{-7} for industrial land-use scenario, which is much less than risk values calculated from naturally occurring radiation and from intakes considered background concentration values.

The residential land-use scenarios for this site are provided only for comparison in the Risk Assessment Report (Annex 3-B). The report concludes that SWMU 14 does not have significant potential to affect human health under an industrial land-use scenario.

3.6.2.2 *Ecological*

As set forth by the NMED Risk-Based Decision Tree, an ecological screening assessment that corresponds with the screening procedures in the EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997) was performed. An early step in the evaluation is comparison of COC concentrations and identification of potentially bioaccumulative constituents. This is presented in Annex 3-B. This methodology also requires the development of a site conceptual model and food web model, and selection of ecological receptors. Each of these items is presented in the "Predictive Ecological Risk Assessment Methodology for SNL/NM ER Program, Sandia National Laboratories/New Mexico" (IT June 1998) and will not be duplicated here. The screen also includes the estimation of exposure and ecological risk.

The results of the ecological risk assessment screen are presented in Tables 14, 15, 16, and 17 of Annex 3-B. Site-specific information was incorporated into the screening assessment when such data were available. Hazard quotients (HQ) greater than unity were originally predicted; however, closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to exposure concentration (maximum COC concentration was used in the estimation of risk), exposure setting (area use factors of one were assumed), background risk, quality of analytical data, and the use of detection limits as exposure concentrations. Based upon an evaluation of these uncertainties, ecological risks associated with this site are expected to be low.

3.6.3 Baseline Risk Assessment

The Baseline Risk Assessment is summarized below.

3.6.3.1 Human Health

Based upon the screening assessment summarized in Section 3.6.2.1, a baseline human health risk assessment is not required for SWMU 14.

3.6.3.2 Ecological

Based upon the screening assessment summarized in Section 3.6.2.2, a baseline ecological risk assessment is not required for SWMU 14.

3.7 No Further Action Proposal

3.7.1 Rationale

Based upon field investigation data and the human health risk assessment analysis, an NFA is being recommended for SWMU 14 for the following reasons:

- All anomalous material (discolored soil) found in the trenches was sampled and excavated. The material was nonhazardous.
- There was no evidence of mercury from either the field screening or from laboratory analyses, and the total amount of mercury used in the test was insignificant (less than 1 pint).
- There was no evidence of explosives. All explosives were nondetected in the laboratory data.
- Human health and ecological risk evaluations indicate no impact of the COCs to human health or the environment.

3.7.2 Criterion

Based upon the evidence provided above, SWMU 14 is proposed for an NFA decision in conformance with Criterion 5 (NMED March 1998), which states that the SWMU has been fully characterized in accordance with current and applicable state or federal regulations and that available data indicate that contaminants pose an acceptable level of risk under current and projected future land use.

REFERENCES

Brown, C.D. (Sandia National Laboratories/New Mexico), Memorandum to D. Jercinovic (IT Corporation), "Radiological Data Tables and DU Ratios," January 14, 1998.

Dinwiddie, R.S. (New Mexico Environment Department). Letter to M.J. Zamorski, U.S. Department of Energy, "Request for Supplemental Information: Background Concentrations Report, SNL/KAFB," September 24, 1997.

DOE, see U.S. Department of Energy

EPA, see U.S. Environmental Protection Agency

Gaither, K., Memorandum to ERST File, Subject: ER Site 85, Building 9920 Firing Site, Sandia National Laboratories, Albuquerque, New Mexico. October 29, 1991.

Hoagland, S. and R. Dello-Russo, February 1995. "Cultural Resources Investigation for Sandia National Laboratories/New Mexico, Environmental Restoration Program, Kirtland Air Force Base, New Mexico," Butler Service Group, Albuquerque, New Mexico.

Hyndman, D.A., April 1997. "Geophysical Investigation of Environmental Site 117 and 14," Sandia National Laboratories, New Mexico," IT Corporation, Albuquerque, New Mexico.

IT, see IT Corporation.

IT Corporation (IT), June 1998. "Predictive Ecological Risk Assessment Methodology for the SNL/NM ER Program, Sandia National Laboratories, New Mexico," IT Corporation, Albuquerque, New Mexico.

New Mexico Environment Department (NMED), March 1998. "RPMP Document Requirement Guide," New Mexico Environment Department, Hazardous and Radioactive Materials Bureau, RCRA Permits Management Program, Santa Fe, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), July 1994. "Verification and Validation of Chemical and Radiochemical Data," TOP 94-03, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), September 1994. "Unexploded Ordnance/High Explosives (UXO/HE) Visual Survey of SWMUs Final Report," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), March 1995. "Site-Wide Hydrogeologic Characterization Project, Calendar Year 1994 Annual Report," Sandia National Laboratories Environmental Restoration Project, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), [N.D.], Engineering Drawings.

Sandia National Laboratories/New Mexico (SNL/NM), October 1995. "Chemical Waste Landfill Groundwater Assessment Report," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), March 1996a. "RCRA Facility Investigation Work Plan for Operable Unit 1335, Southwest Test Area," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories, New Mexico (SNL/NM), March 1996b. "Sitewide Hydrogeologic Characterization Project, Calendar Year 1995, Annual Report" Sandia National Laboratories, Environmental Restoration Project, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), 1996c, Environmental Safety and Health Record Number ER/7585/1335/14/Int/96-211, Sandia National Laboratories, Albuquerque, New Mexico.*

Sandia National Laboratories, New Mexico (SNL/NM), June 1997. Bullets of understanding between NMED/DOE OB and DOE/SNL ER Project for sampling and analyses plans for ER Sites 14 and 85, OU 1335, Southwest Test Area, Sandia National Laboratories, Environmental Restoration Project, Albuquerque, New Mexico.

Sandia National Laboratories, New Mexico (SNL/NM), July 1997. "OU 1335, ER Site 14 Confirmatory Sampling Plan," Sandia National Laboratories, Environmental Restoration Project, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), September 1997. "Final Report, Survey and Removal of Radioactive Surface Contamination at Environmental Restoration Sites, Sandia National Laboratories/New Mexico," SAND97-2320/1/2-UC-902, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), February 1998. "RESRAD Input Parameter Assumptions and Justification," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

---

*Because many of the tests conducted at SNL/NM are classified, this SNL/NM reference number refers to an SNL/NM Environmental Safety and Health Records Center coding system intended to maintain the confidentiality of former SNL/NM employees.

SNL/NM, see Sandia National Laboratories/New Mexico.

U.S. Department of Energy (DOE), Albuquerque Operations Office, Environmental Safety and Health Division, Environmental Program Branch, September 1987, draft. "Comprehensive Environmental Assessment and Response Program (CEARP) Phase 1: Installation Assessment, Sandia National Laboratories, Albuquerque," Albuquerque Operations Office, U.S. Department of Energy, Albuquerque, New Mexico.

U.S. Department of Energy and U.S. Air Force (DOE and USAF), March 1996. "Workbook: Future Use Management Area 7," prepared by Future Use Logistics and Support Working Group in cooperation with the Department of Energy Affiliates and the U.S. Air Force, Albuquerque, New Mexico.

U.S. Department of Energy (DOE), Kirtland Area Office, March 1996. "Environmental Assessment of the Environmental Restoration Project at Sandia National Laboratories/ New Mexico," Kirtland Area Office, U.S. Department of Energy, Albuquerque, New Mexico.

U.S. Environmental Protection Agency (EPA), November 1986. "Test Methods for Evaluating Solid Waste," 3rd ed., Update III, SW-846, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), April 1987. "Final RCRA Facility Assessment Report of Solid Waste Management Units at Sandia National Laboratories, Albuquerque, New Mexico," Contract No. 68-01-7038, Region 6, U.S. Environmental Protection Agency, Dallas, Texas.

U.S. Environmental Protection Agency (EPA), 1989. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual," EPA/540-1089/002, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), February 1994. "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review," Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1997. "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risks," Interim Final, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), August 1997. "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination," Directive No. 9200.4-18, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

Weast, R.C., and S.M. Selby, eds., 1967. *Handbook of Chemistry and Physics*, Chemical Rubber Co., Cleveland, Ohio.

Wrightson, W., March 24, 1994. Field notes, collected for Environmental Restoration Project Department 6134, Sandia National Laboratories, Field Notes (unpublished), Albuquerque, New Mexico.

Wrightson, W., May 1997. Field notes, Logbook #205 "Site 14 RFI Sampling," Sandia National Laboratories, Albuquerque, New Mexico, p. 14.

Wrightson, W., June 1997. Field notes, Logbook #205 "Site 14 RFI Sampling," Sandia National Laboratories, Albuquerque, New Mexico, p. 27.

Wrightson, W., July 1997. Field notes, Logbook #205 "Site 14 RFI Sampling," Sandia National Laboratories, Albuquerque, New Mexico, p. 30–37.

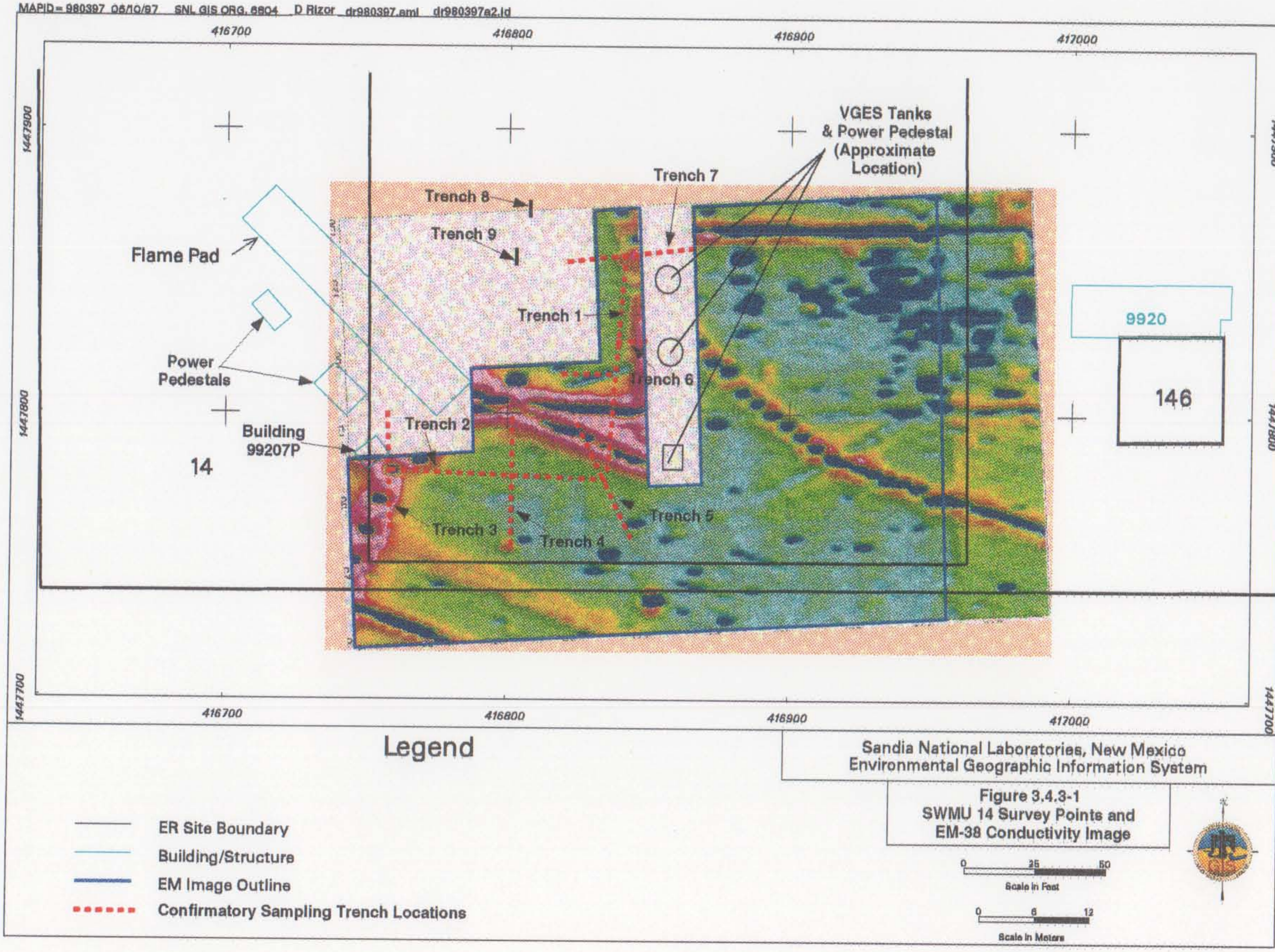
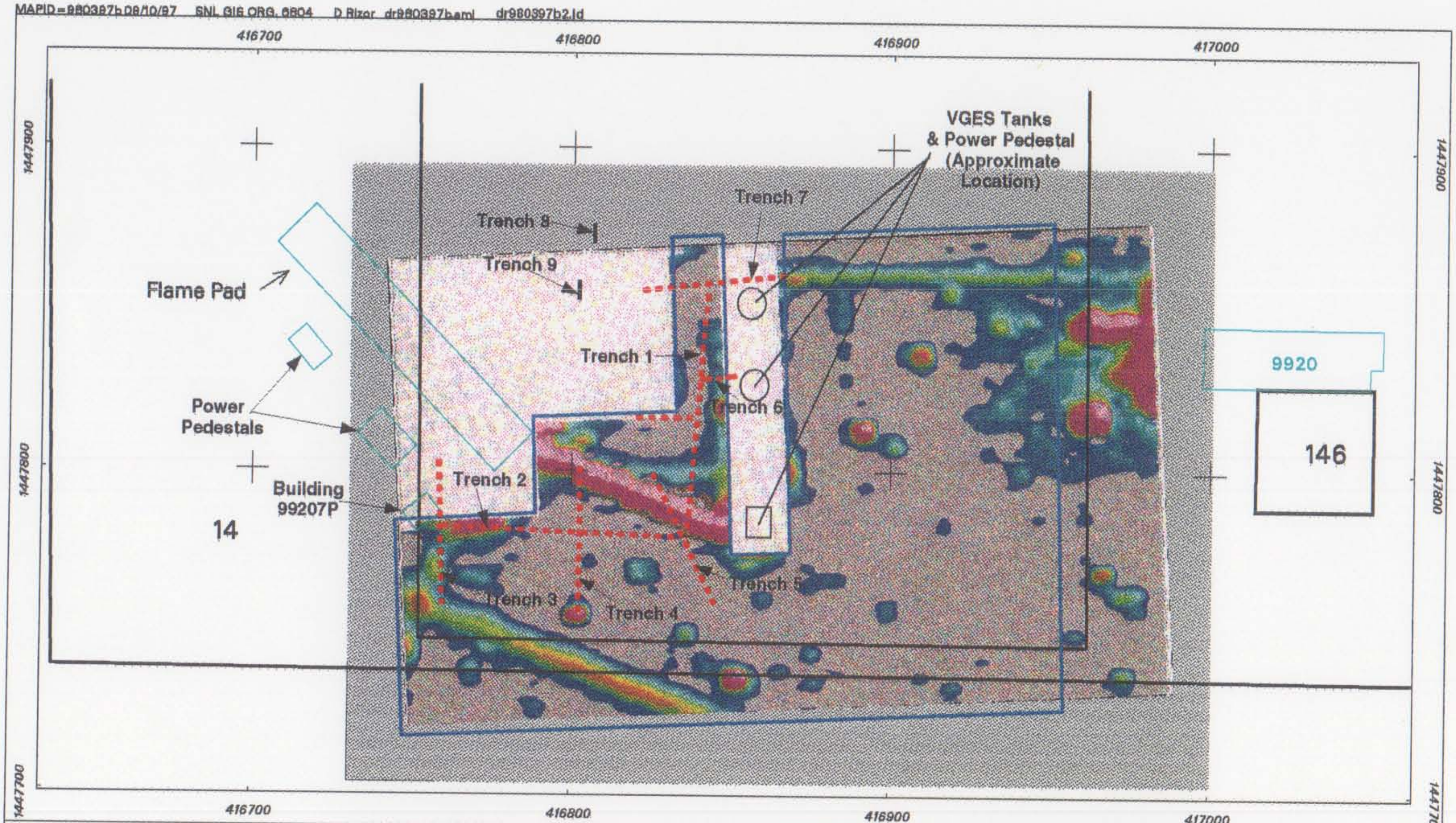


Figure 3.4.3-1
SWMU 14 Survey Points and
EM-38 Conductivity Image



Legend

- ER Site Boundary
- Building/Structure
- EM Image Outline
- Confirmatory Sampling Trench Locations

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Figure 3.4.3-2
SWMU 14 Survey Points and
EM-61 Conductivity Image

0 25 50
Scale in Feet

0 6 12
Scale in Meters

ANNEX 3-B
SWMU 14 Risk Screening Assessment Report

TABLE OF CONTENTS

LIST OF TABLES

SWMU 14: RISK SCREENING ASSESSMENT

I. Site Description and History

Sandia National Laboratories/New Mexico (SNL/NM) Solid Waste Management Unit (SWMU) 14 is a burial site located west of Building 9920 (SWMU 85) on Kirtland Air Force Base (KAFB) approximately 1,500 feet east of SNL/NM Technical Area III. The total size of the actual burial area is believed to be somewhere within a 250- by 250-foot (1.4-acre) area west of Building 9920. This site is on KAFB land permitted to the U.S. Department of Energy (DOE). The terrain is generally flat with a gentle slope to the west. Vegetation surrounding the SWMU is primarily desert grasses, although the SWMU itself is clear of vegetation.

Little information is available on this particular site. The shallow graded area could not be located from old aerial photos or from geophysical surveys. The area encompassing the site is graded, with a gentle slope to the west.

In the mid-1970s, an aboveground explosive test was conducted with 6,000 to 8,000 fluorescent light bulbs to see whether the vacuum in the bulbs, when broken, would suppress the shock wave of the detonation. Mercury was present within the fluorescent bulbs. The light bulbs were placed in 2- by 2- by 8-foot wooden boxes and then placed around a 10-pound explosive charge. After detonation, the light bulb and box debris was collected and sent to a landfill. The remaining debris (a small number of glass shards) was graded to a low spot in the test area approximately 2 feet deep and was covered with a layer of soil.

A voluntary corrective measures (VCM) was conducted in September 1995 to remove a soil source with elevated radiation levels associated with SWMU 85, which is co-located with SWMU 14. Additionally, surface soils were collected in the burial area in 1997 and were analyzed for explosives, metals, and radiological activity. These data were evaluated as part of the SWMU 85 investigation.

Finally, in July 1997, nine shallow exploratory trenches in the burial area were excavated to approximately 3 feet, with a cumulative length of approximately 350 linear feet. Approximately 2 cubic feet of discolored material was excavated from the area. No other significant debris was present in the trenches. Twenty-seven samples were collected from the trenches and analyzed for Resource Conservation and Recovery Act (RCRA) metals, gamma spectroscopy for radiological activity, and high explosives (HE). No significant constituents of concern (COC) were detected. These data have been evaluated as part of this risk assessment.

II. Comparison of Results to Data Quality Objectives

The confirmatory sampling conducted at SWMU 14 was designed to collect adequate samples to:

- Determine whether hazardous waste or hazardous constituents have been released at the site

- Characterize the nature and extent of any releases
- Provide sufficient Level 3 analytical data to support risk screening assessments.

Table 1 summarizes the sample location design for SWMU 14. The source of potential COCs at SWMU 14 may have been due to burial of explosive test debris, particularly fragments of fluorescent light bulbs, intermixed with radiological material.

Table 1
Summary of sampling performed to Meet Data Quality Objectives

SWMU	Potential COC Source	Area of Site (acres)	Number of Sampling Locations	Sample Density (samples/acre)	Sampling Location Rationale
14	Buried explosive test debris (fluorescent tube fragments) Radiological material (depleted uranium)	1.4 Acres	25	18	Location and nature of the burial site could not be confirmed through site background interviews, and geophysical surveys.

Seven trenches (Trenches 1-7) and two smaller pits (Trenches 8 and 9) were excavated in the investigation area. The number and location of the samples collected were dependent upon the length of the trenches, since the samples were collected at equal intervals along the trenches. The number and locations of the samples were also dependent upon the presence of suspect soil contamination determined by the screening process implemented during the investigation.

Table 2 summarizes the analytical methods and data quality requirements necessary to (1) determine whether hazardous waste or hazardous constituents have been released at the site, (2) characterize the nature and extent of any releases, and (3) provide sufficient Level 3 analytical data to support risk screening assessments.

Table 2
Summary of Data Quality Requirements

Analytical Requirement	Data Quality Level	General Engineering Laboratory	Radiation Protection Sample Diagnostics Laboratory Department 713 SNL/NM
RCRA metals and mercury, beryllium, and nickel EPA Method 6010/7000	Level 3	27 Samples including 2 Duplicates	Not Applicable
Explosives EPA Method 8330	Level 3	27 Samples including 2 Duplicates	Not Applicable
Gamma Spectroscopy	Level 2	Not Applicable	27 Samples including 2 Duplicates

EPA = U.S. Environmental Protection Agency
SNL/NM = Sandia National Laboratories/New Mexico

A total of 25 locations were sampled at SWMU 14 and analyzed for RCRA metals plus mercury, nickel, and beryllium and for explosives by Lockheed Analytical Services. Cadmium was nondetect with its respective minimum detection limit (MDL) below the maximum background screening level. Mercury does not have a quantifiable maximum background. However, mercury contributes insignificant risk to human health and the environment at one-half of its detection limit. Selenium and silver do not have quantifiable maximum background concentrations, so the relationship between the MDL and the maximum screening concentration is unknown. All explosives were below detection limits, and radiological gamma activities were detected above background in one sample for U-238 and Th-234.

The SNL/NM Sample Management Office conducted a Level 3 Data Validation review in accordance with Technical Operating Procedure 94-03. Rev. (SNL/NM July 1994). This review has confirmed that the data are acceptable for use in the No Further Action (NFA) proposal for SWMU 14. The data quality objectives (DQO) for SWMU 14 have been met.

III. Determination of Nature, Rate, and Extent of Contamination

III.1 Introduction

The determination of the nature, rate, and extent of contamination at SWMU 14 was based upon an initial conceptual model validated by confirmatory sampling at the site. The initial conceptual model was developed from historical background information including numerous site inspections, personal interviews, historical photographs, and geophysical and radiological surveys. The DQOs are contained in the Operable Unit 1335 RCRA Facility Investigation Work Plan (SNL/NM March 1996), which was modified in the Confirmatory Sampling Plan (SNL/NM July 1997). The Confirmatory Sampling Plan was based upon a meeting between New Mexico Environment Department (NMED) and SNL/NM Dept. 6685 (SNL/NM June 1997). The DQOs contained in the Confirmatory Sampling Plan (SNL/NM July 1997) identified the sample locations, sample density, sample depth, and analytical requirements. The sample data used to characterize SWMU 14 were collected in accordance with the rationale and procedures described in the Confirmatory Sampling Plan (SNL/NM July 1997). The data were subsequently used to develop the final conceptual model for SWMU 14, which is presented in Section 3.5 of the associated NFA proposal. The quality of the data specifically used to determine the nature, rate, and extent of contamination are described below.

III.2 Nature of Contamination

The nature of contamination at SWMU 14 was determined with analytical testing of soil and media and the potential for degradation of relevant COCs (Section V). The analytical requirements include RCRA metals, plus mercury, beryllium, and nickel to characterize inorganic contamination in the soil. Gamma spectroscopy was utilized as a general screening analyses and to determine if radiological contaminated soil from SWMU 85, which is co-located with SWMU 14, was intermixed with the material at SWMU 14. Explosives analyses were performed on the soil samples to determine if explosive residue from the firing testing was present in the soils. These analytes and methods are appropriate to characterize the COCs and potential degradation products associated with historical activities at SWMU 14.

III.3 Rate of Contaminant Migration

The rate of COC migration is dependent predominantly on site meteorological and surface hydrologic processes as described in Section V. Data available from the Site-Wide Hydrogeologic Characterization Project (published annually); numerous SNL/NM air, surface-water, radiological monitoring programs; biological surveys; and other governmental atmospheric monitoring at the Kirtland Air Force base (i.e., National Oceanographic and Atmospheric Administration) are adequate to characterize the rate of COC migration at SWMU 14.

III.4 Extent of Contamination

Soil samples were collected at equal intervals along the trench floor to determine if buried debris and hazardous constituents were present at SWMU 14. In addition, locations with evidence of contamination, such as stained or discolored soils, were sampled. Approximately 2 cubic feet of discolored carbonaceous soil, intermixed with native soil, was excavated from the area. The residual soils at this location were determined to be uncontaminated.

The sample number and distribution were sufficient to determine that COCs were not present in the soil, although there were constituents unrelated to the activities at SWMU 14 (arsenic, U-238, and Th-234) above background. The fact that arsenic is confined to two samples at low concentrations and the radiological constituents are confined to one sample provides evidence that the distribution of these elements was limited to the immediate sample area. The lateral extent of the contamination of the COCs at SWMU 14 therefore appears to be defined.

Reports of a 2-foot burial depth are documented for SWMU 14 (see section 4.2.2 of the SWMU 14 NFA proposal) and the sample depth at SWMU 14 was at 3 feet. Because of the relatively low solubility of most metals and organic compounds, limited precipitation, and high evapotransporation, the vertical rate of ionic migration is expected to be low. Samples collected at 1 foot below the floor of the alleged burial area are representative of the media potentially impacted by site activities and sufficient to determine the vertical extent of COC migration.

In summary, the design of the confirmatory sampling was appropriate to determine the nature and extent of contamination.

IV. Comparison of COCs to Background Screening Levels

Site history and characterization activities are used to identify potential COCs. The identification of COCs and the sampling to determine their concentration levels across the site are described in the SWMU 14 NFA proposal. Generally, COCs evaluated in this risk assessment include all detected organics and relevant radiological contaminants and all inorganic COCs that were analyzed for. If the detection limit of an organic compound was too high (could possibly cause an adverse effect to human health or the environment), the compound was retained. Nondetect organics that were not included in this assessment were determined to have low enough detection limits to ensure protection of human health and the environment. In order to provide conservatism in this risk assessment, the calculation uses only the maximum concentration value of each COC determined for the entire site. The approved SNL/NM maximum background concentration (Dinwiddie September 24, 1997) was selected to provide the background screen in Tables 3 and 4. Human health nonradiological COCs were also compared to SNL/NM proposed Subpart S action levels (Table 3) (IT July 1994).

Nonradiological inorganics that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium are not included in this risk assessment (EPA 1989). Both radiological and nonradiological COCs are evaluated. The nonradiological COCs evaluated in this risk assessment include only inorganics due to the fact that all HE concentrations are nondetect.

Nonradiological COCs for the human health and ecological risk screening assessments at SWMU 14 are listed in Table 3. Radiological COCs are listed in Table 4. All tables show the associated approved SNL/NM maximum background concentration values (Dinwiddie September 24, 1997). Discussion of Tables 3 and 4 is provided in Section VI.4 and Sections VII.2 and VII.3.

V. Fate and Transport

The release of COCs at SWMU 14 was to the surface and subsurface soil (assuming the shallow burial of debris). Wind, water, and biota are natural mechanisms of COC transport from the primary release point. Excavation and removal of soil are potential human-caused mechanisms of transport. Winds can be strong in the open, grassland environment at SWMU 14. Moderate winds can transport surface soil particles with adsorbed COCs (or COCs in particulate form) as suspended dust, capable of dry or wet deposition. Strong winds may move larger (sand-sized) particles by saltation. Wind erosion is reduced by vegetative cover; however, this site does not have a good vegetative cover.

Water at SWMU 14 is received as precipitation (rain or occasionally snow). The average annual precipitation in this area is about 8 inches (NOAA 1990) and the evapotranspiration value is 95 percent of the total rainfall (Thomson and Smith 1985). Precipitation will either infiltrate or form runoff. Infiltration at the site is enhanced by the nearly flat relief and the sandy nature of the soil (the soil in the area of the site is primarily Tijeras gravelly fine sandy loam [USDA 1977]). Runoff from the site to adjacent areas is probably significant only during intense rainfall events and during extended rainfall periods when soils are near saturation. Surface runoff in the area of SWMU 14 is to the west, toward an internal drainage basin, but no major surface drainage features occur on the site. Runoff may carry soil particles with adsorbed COCs. The distance of transport will depend on the size of the particle and the velocity of the water (generally be low because of the flat terrain).

Water that infiltrates into the soil will continue to percolate through the soil until field capacity is reached. COCs desorbed from the soil particles into the soil solution may be leached into the subsurface soil with this percolation. The effective rooting depth of the soil at SWMU 14 is

Table 3
Nonradiological COCs for Human Health and Ecological Risk Assessment at SWMU 14 with Comparison to the Associated SNL/NM Background Screening Value, BCF, Log K_{ow}, and Subpart S Screening Value

COC Name	*Maximum* Concentration (mg/kg)	SNL/NM Background Concentration (mg/kg)[a]	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (maximum aquatic)	Log K_{ow} (for organic COCs)	Bioaccumulator?[h] (BCF>40, log K_{ow}>4)	Subpart S Screening Value[b]	Is Individual COC less than 1/10 of the Action Level?
Arsenic	6.09	4.4	No	44[c]	NA	Yes	0.5	No
Barium	180	214	Yes	170[c]	NA	Yes	6000	Yes
Cadmium	0.116 J	0.9	Yes	64[d]	NA	Yes	80	Yes
Chromium, total[e]	9.85	15.9	Yes	16[c]	NA	No	400	Yes
Lead	7.44	11.8	Yes	49[c]	NA	Yes	--	--
Mercury	0.06[f]	<0.1	Unknown	5500[c]	NA	Yes	20	Yes
Selenium	0.8[f]	<1	Unknown	800[g]	NA	Yes	400	Yes
Silver	0.06[f]	<1	Unknown	0.5[c]	NA	No	400	Yes

[a]Dinwiddie (September 24, 1997) Southwest Test Area.
[b]IT (July 1994).
[c]BCF from Yanicak (March 1997).
[d]BCF from Neumann (1976).
[e]Assumed to be chromium VI for Subpart S screening procedure.
[f]COC not detected, concentration assumed to be one-half of the detection limit.
[g]BCF from Callahan et. al. (1979).
[h]NMED (March 1998).

BCF = Bioconcentration factor.
COC = Constituent of concern.
Log = Logarithm (base 10).
NA = Not applicable.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid waste management unit.
mg/kg = Milligrams per kilogram.
K_{ow} = octanol-water partition coefficient.
-- = Information not available.

Table 4
Radiological COCs for Human Health and Ecological Risk Assessment at SWMU 14 with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log K_{ow}

COC Name	Maximum Gamma Activity (pCi/g)	SNL/NM Background Gamma Activity (pCi/g)[a]	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background[a] Screening Value?	BCF (maximum aquatic)	Bioaccumulator? (BCF>40, log K_{ow}>4)
Cs-137	1.2×10^{-2}	0.079	Yes	3000[c]	Yes
Ra-228	0.73	0.93	Yes	30000[d]	No[e]
Th-234	1.7	1.4	No	3000[d]	No[e]
Th-232	0.75	1.01	Yes	3000[d]	No[e]
U-235[b]	8.7×10^{-2}	0.16	Yes	900[d]	Yes
U-234[b]	.017	1.6	Yes	900[d]	Yes
U-238	2.03	1.4	No	900[d]	Yes

[a]Dinwiddie September 24, 1997, Southwest Test Area.
[b]U-234 and U-235 values were calculated using the U-238 concentration and assuming that the U-238 to U-234 ratio was equal to that detected during waste characterization of depleted uranium-contaminated soils generated during the radiological voluntary corrective measures project, where U-234=U-238/8 and U-235=U-238/73 (Brown January 1998).
[c]Bioconcentration factor from Yanicak (March 1997).
[d]Baker and Soldat 1992.
[e]Not considered a bioaccumulator (Yanicak March 1997).

BCF = Bioconcentration factor.
COC = Constituents of concern.
Log = Logarithm (base 10).
pCi/g = Picocuries per gram.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = *Solid waste management unit.*

about 60 inches (USDA 1977), indicating the depth of the system's transient water cycling zone defined by the dynamic balance between percolation/infiltration and evapotranspiration.

Because groundwater at this site is approximately 155 feet below ground surface, the potential for COCs to reach groundwater through the unsaturated zone above the watertable is very small. As water from the surface evaporates, the direction of COC movement may be reversed with capillary rise of the soil water.

Plant roots can take up COCs that are in the soil solution. This may be a passive process, but active (i.e., requiring energy expenditure on the part of the plant) uptake or exclusion of some constituents in the soil solution may also take place. COCs taken up by the roots may be transported to the aboveground tissues with the xylem stream. Aboveground tissues can take up adsorbed constituents by contact with dust particles. COCs in the tissue may be consumed by herbivores or eventually returned to the soil as litter. Aboveground litter is capable of transport by wind until consumed by decomposer organisms in the soil. Constituents in plant tissues that are consumed by herbivores may pass through the gut and be returned to the soil in feces (at the site or transported from the site in the herbivore), or absorbed to be held in tissues, metabolized, or excreted. The herbivore may be eaten by a primary carnivore or scavenger and the constituent still held in the consumed tissues will repeat the sequence of absorption, metabolization, excretion, and consumption by higher predators, scavengers, and decomposers. The potential for transport of the constituents within the food chain is dependent upon the mobility of the species that comprise the food chain and the potential for the constituent to be transferred across the links in the food chain.

The COCs at SWMU 14 are inorganic and elemental in form and are therefore not considered to be degradable. Radiological COCs, however, undergo decay to stable isotopes or radioactive daughter elements. Transformations of inorganics may include changes in valence (oxidation/reduction reactions) or incorporation into organic forms (e.g., the conversion of selenite or selenate from soil to seleno-amino acids in plants).

Table 5 summarizes the fate and transport processes that may occur at SWMU 14. COCs at this site are inorganics in surface and subsurface soil. Because this site is disturbed, vegetative cover is low. Therefore, transport of COCs by wind is possible at this site. Transport by surface-water runoff is moderated by the low slope and high infiltration of the soil. Significant leaching further into the subsurface soil is unlikely for most inorganics, and leaching to the groundwater at this site is highly unlikely. The potential for uptake into the food chain is low. Degradation of the inorganic COCs and decay of radiological COCs is expected to be insignificant.

Table 5
Summary of Fate and Transport at SWMU 14

Transport and Fate Mechanism	Existence at Site	Significance
Wind	Yes	Moderate
Surface runoff	Yes	Low
Migration to groundwater	No	None
Food chain uptake	Yes	Low
Transformation/degradation	Yes	Low

VI. Human Health Risk Screening Assessment

VI.1 Introduction

Human health risk screening assessment of this site includes a number of steps that culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents located at the site. The steps to be discussed include:

Step 1.	Site data are described that provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site.
Step 2.	Potential pathways are identified by which a representative population might be exposed to the COCs.
Step 3.	The potential intake of these COCs by the representative population is calculated using a tiered approach. The first component of the tiered approach includes two screening procedures. One screening procedure compares the maximum concentration of the COC to an approved SNL/NM maximum background screening value. COCs that are not eliminated during the first screening procedure are subjected to a second screening procedure that compares the maximum concentration of the COC to the SNL/NM proposed Subpart S action level.
Step 4.	Toxicological parameters are identified and referenced for COCs that are not eliminated during the screening steps.
Step 5.	Potential toxicity effects (specified as a Hazard Index [HI]) and excess cancer risks are calculated for nonradiological COCs and background. For radiological COCs, the incremental total effective dose equivalent (TEDE) and incremental estimated cancer risk are calculated by subtracting applicable background concentrations directly from maximum on-site contaminant values. This background subtraction only occurs when a radiological COC occurs as contamination and exists as a natural background radionuclide.
Step 6.	These values are compared with guidelines established by the U.S. Environmental Protection Agency (EPA) and DOE to determine if further evaluation, and potential site clean-up, is required. Nonradiological COC risk values are also compared to background risk so that an incremental risk may be calculated.
Step 7.	Uncertainties in the previous steps are discussed.

VI.2 Step 1. Site Data

The description and history for SWMU 14 is provided in Section I. Comparison of results to DQOs is presented in Section II. The determination of the nature, rate and extent of contamination is described in Section III.

VI.3 Step 2. Pathway Identification

SWMU 14 has been designated with a future land-use scenario of industrial (DOE and USAF March 1996) (see Appendix 1 for default exposure pathways and parameters). Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion for the nonradiological COCs and, for the radiological COCs, direct gamma exposure. The inhalation pathway for both nonradiological and radiological COCs is included because of the potential to inhale dust. Soil ingestion is included for the radiological COCs as well. No contamination at depth was determined, and therefore no water pathways to the groundwater are considered. Depth to groundwater at SWMU 14 is approximately 155 feet below ground surface. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered not to be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the industrial land-use scenario. However, plant uptake is considered for the residential land-use scenario.

Pathway Identification

Nonradiological Constituents	Radiological Constituents
Soil ingestion	Soil ingestion
Inhalation (dust)	Inhalation (dust)
Plant uptake (residential only)	Plant uptake (residential only)
	Direct gamma

VI.4 Step 3. COC Screening Procedures

Step 3 is discussed in this section and includes two screening procedures. The first screening procedure is a comparison of the maximum COC concentration to the approved background screening level. The second screening procedure compares maximum COC concentrations to SNL/NM proposed Subpart S action levels. This second procedure is applied only to COCs that are not eliminated during the first screening procedure.

VI.4.1 Background Screening Procedure

VI.4.1.1 Methodology

Maximum concentrations of COCs are compared to the approved SNL/NM maximum screening level for this area (Dinwiddie September 24, 1997). The approved SNL/NM maximum background concentration is selected to provide the background screen in Table 3 and used to calculate risk attributable to background in Table 9. Only the COCs that are above their respective SNL/NM maximum background screening level or COCs that do not have a quantifiable background screening level are considered in further risk assessment analyses.

For radiological COCs that exceed the SNL/NM background screening levels, background values are subtracted from the individual maximum radionuclide concentrations. Those that do not exceed these background levels are not carried any further in the risk assessment. This approach is consistent with DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (DOE 1993). Radiological COCs that did not have a background value and were detected above the analytical minimum detectable activity were carried through the risk assessment at their maximum levels. The resultant radiological COCs remaining after this step are referred to as background-adjusted radiological COCs.

VI.4.1.2 Results

A Comparison of SWMU 14 maximum COC concentrations to the approved SNL/NM maximum background values (Dinwiddie September 24, 1997) for human health risk assessment is presented in Table 3. For the nonradiological COCs, one constituent has a maximum measured value greater than its respective background screening level. Three nonradiological COCs do not have a quantifiable background concentrations, so it is not known whether those COCs exceeded background.

For the radiological COCs, only two constituents had maximum measured activities slightly greater than their respective background (U-238 and Th-234). Th-234 is the short-lived daughter of U-238.

VI.4.2 Subpart S Screening Procedure

VI.4.2.1 Methodology

The maximum concentrations of nonradiological COCs not eliminated during the background screening process were compared with action levels (IT July 1994) calculated using methods and equations promulgated in the proposed RCRA Subpart S (EPA 1990) and Risk Assessment Guidance for Superfund (RAGS) (EPA 1989). Accordingly, all calculations were based upon the assumption that receptor doses from both toxic and potentially carcinogenic compounds result most significantly from ingestion of contaminated soil. Because the samples were all taken from the surface, this assumption is considered valid. If there were ten or fewer COCs and each had a maximum concentration less than one-tenth of the action level, then the site would be judged to pose no significant health hazard to humans. If there were more than ten COCs, the Subpart S screening procedure was not performed.

VI.4.2.2 Results

Table 3 shows the COCs and the associated proposed Subpart S action level. The table compares the maximum concentration values to one-tenth of the proposed Subpart S action level. This methodology was guidance given to SNL/NM from the EPA Region 6 (EPA 1996a). One COC exceeds one-tenth of the proposed Subpart S action level. Because of this COC, the site fails the Subpart S screening criteria and a hazard quotient (HQ) and excess cancer risk value must be calculated for all the COCs.

Radiological COCs do not have predetermined action levels analogous to proposed Subpart S levels, and therefore this step in the screening process is not performed for radiological COCs.

VI.5 Step 4. Identification of Toxicological Parameters

Tables 6 (nonradiological) and 7 (radiological) show the COCs retained in the risk assessment and the values for the available toxicological information. The toxicological values used for nonradiological COCs in Table 6 are from the Integrated Risk Information System (IRIS) (EPA 1998) and Health Effects Assessment Summary Tables (HEAST) (EPA 1997a). Dose

Table 6
Toxicological Parameter Values for SWMU 14 Nonradiological COCs

COC Name	RfD_o (mg/kg-d)	Confidence[a]	RfD_{inh} (mg/kg-d)	Confidence[a]	SF_o $(mg/kg\text{-}day)^{-1}$	SF_{inh} $(mg/kg\text{-}day)^{-1}$	Cancer Class[b]
Arsenic	3E–4[c]	M	--	--	1.5E+0[c]	1.5E+1[c]	A
Mercury	3E–4[d]	--	8.6E–5[c]	M	--	--	D
Selenium	5E–3[c]	H	--	--	--	--	D
Silver	5E–3[c]	L	--	--	--	--	D

[a]Confidence associated with IRIS (EPA 1998) database values (L = low, M = medium, H = high).
[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989) taken from IRIS (EPA 1998):

A - human carcinogen
D - not classifiable as to human carcinogenicity

[c]Toxicological parameter values from IRIS electronic database (EPA 1998)
[d]Toxicological parameter values from HEAST database (EPA 1997a)
-- Information not available.

COC = Constituents of concern.
EPA = U.S. Environmental Protection Agency.
HEAST = Health Effects Assessment Summary Tables.
IRIS = Integrated Risk Information System.
mg/kg-day = Milligram per kilogram day.
$(mg/kg\text{-}day)^{-1}$ = Per milligram per kilogram day.
RfD_o = Oral chronic reference dose.
RfD_{inh} = Inhalation chronic reference dose.
SF_o = Oral slope factor.
SF_{inh} = Inhalation slope factor.
SWMU = Solid waste management unit.

Table 7
Radiological Toxicological Parameter Values for SWMU 14 COCs Obtained from RESRAD Risk Coefficients[a]

COC Name	SF_o (1/pCi)	SF_{inh} (1/pCi)	SF_{ev} (g/pCi-yr)	Cancer Class[b]
U-238[c]	6.20E−11	1.20E−08	6.60E−08	A

[a]From Yu et al. (1993a).
[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989): A - human carcinogen.
[c]U-238 used to account for Th-234 contribution, since Th-234 is short-lived U-238 progeny.
COC = Constituents of concern.
EPA = U.S. Environmental Protection Agency.
SF_o = Oral (ingestion) slope factor.
SF_{inh} = Inhalation slope factor.
SF_{ev} = External volume exposure slope factor.
1/pCi = One per picocurie.
g/pCi-yr = Gram per picocurie-year.

conversion factors (DCF) used in determining the excess TEDE values for radiological COCs for the individual pathways were the default values provided in the RESRAD computer code (Yu et al. 1993a) as developed in the following documents:

- DCFs for ingestion and inhalation are taken from Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion* (EPA 1988).

- DCFs for surface contamination (contamination on the surface of the site) were taken from DOE/EH-0070, *External Dose-Rate Conversion Factors for Calculation of Dose to the Public* (DOE 1988).

- DCFs for volume contamination (exposure to contamination deeper than the immediate surface of the site) were calculated using the methods discussed in *Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil* (Kocher 1983) and ANL/EAIS-8, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil* (Yu et al. 1993b).

VI.6 Step 5. Exposure Assessment and Risk Characterization

Section VI.6.1 describes the exposure assessment for this risk assessment. Section VI.6.2 provides the risk characterization, including the HI value and the excess cancer risk, for both the potential nonradiological COCs and associated background for industrial and residential land uses. The incremental TEDE and incremental estimated cancer risk are provided for the background-adjusted radiological COCs for both industrial and residential land uses.

VI.6.1 Exposure Assessment

Appendix 1 shows the equations and parameter input values used in calculating intake values and subsequent HI and excess cancer risk values for the individual exposure pathways. The appendix shows parameters for both industrial and residential land-use scenarios. The equations for nonradiological COCs are based upon RAGS (EPA 1989). Parameters are based upon information from RAGS (EPA 1989) and other EPA guidance documents and reflect the reasonable maximum exposure (RME) approach advocated by the RAGS (EPA 1989). For radiological COCs, the coded equations provided in RESRAD computer code are used to estimate the incremental TEDE and cancer risk for individual exposure pathways. Further discussion of this process is provided in the Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0 (Yu et al. 1993a).

Although the designated land-use scenario is industrial for this site, risk and TEDE values for a residential land-use scenario are also presented. These residential risk and TEDE values are presented only to provide perspective of potential risk to human health under the more restrictive land-use scenario.

VI.6.2 Risk Characterization

Table 8 shows that for the SWMU 14 nonradiological COCs, the HI value is 0.02, and the excess cancer risk is 3×10^{-6} for the designated industrial land-use scenario. The numbers presented included exposure from soil ingestion and dust inhalation for the nonradiological COCs. *Table 9 shows that assuming the maximum background concentrations of the* SWMU 14 associated background constituents, the HI is 0.01, and the excess cancer risk is 2×10^{-6} for the designated industrial land-use scenario.

For the radioactive COCs, contribution from the direct gamma exposure pathway is included. For the industrial land-use scenario, a TEDE was calculated for an industrial office worker who spends a majority of his time indoors and for an industrial worker who evenly splits his time indoors and outdoors on the site. After analyzing these two scenarios, the most conservative is the *50/50 time split. This resulted in an incremental TEDE of 0.017 millirem* per year (mrem/yr). In accordance with EPA guidance found in Office of Solid Waste and Emergency Response Directive No.9200.4-18 (EPA 1997b), an incremental TEDE of 15 mrem/yr is used for the probable land-use scenario (industrial in this case); the calculated dose value for SWMU 14 for the industrial land use is well below this guideline. The estimated excess cancer risk is 1.9×10^{-7}.

For the residential land-use scenario nonradiological COCs, the HI value increases to 0.7, and the excess cancer risk is 7×10^{-5} (Table 8). The numbers presented included exposure from soil ingestion, dust inhalation, and plant uptake. Although EPA (1991) generally recommends that inhalation not be included in a residential land-use scenario, this pathway is included because of the potential for soil in Albuquerque, New Mexico, to be eroded and, subsequently, for dust to be present in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Appendix 1). Table 9 shows that for the SWMU 14 associated background constituents, the HI is 0.3, and the excess cancer risk is 5×10^{-5}.

Table 8
Risk Assessment Values for SWMU 14 Nonradiological COCs

COC Name	Maximum Concentration (mg/kg)	Industrial Land-Use Scenario[a]		Residential Land-Use Scenario[a]	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	6.09	0.02	3E–6	0.35	7E–5
Mercury	0.06[b]	0.00	--	0.10	--
Selenium	0.8[b]	0.00	--	0.28	--
Silver	0.06[b]	0.00	--	0.00	--
TOTAL		**0.02**	**3E–6**	**0.7**	**7E–5**

[a]From EPA (1989).
[b]COC not detected, concentration assumed to be one-half of the detection limit.
COC = Constituents of concern.
EPA = U.S. Environmental Protection Agency.
SWMU = Solid waste management unit.
mg/kg = Milligram(s) per kilogram.
-- Information not available.

Table 9
Risk Assessment Values for SWMU 14 Nonradiological Background Constituents

COC Name	Background Concentration[a] (mg/kg)	Industrial Land- Use Scenario[b]		Residential Land- Use Scenario[b]	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	4.4	0.01	2E–6	0.25	5E–5
Mercury	<0.1	--	--	--	--
Selenium	<1	--	--	--	--
Silver	<1	--	--	--	--
TOTAL		**0.01**	**2E–6**	**0.3**	**5E–5**

[a]Dinwiddie (September 24, 1997), Southwest Test Area.
[b]From EPA (1989).
COC = Constituents of concern.
EPA = U.S. Environmental Protection Agency.
SWMU = Solid waste management unit.
mg/kg = Milligram(s) per kilogram
-- Information not available.

For the radiological COCs, the incremental TEDE for the residential land-use scenario is 0.048 mrem/yr. The guideline being utilized is an excess TEDE of 75 mrem/yr (SNL/NM February 1998) for a complete loss of institutional controls (residential land use in this case); the calculated dose value for SWMU 14 for the residential land-use scenario is well below this guideline. Consequently, SWMU 14 is eligible for unrestricted radiological release as the residential land-use scenario resulted in an incremental TEDE to the on-site receptor of less than 75 mrem/yr. The estimated excess cancer risk is 6.1×10^{-7}. The excess cancer risk from the nonradiological COCs and the radiological COCs is not additive, as noted in RAGS (EPA 1989).

VI.7 Step 6. Comparison of Risk Values to Numerical Guidelines.

The human health risk assessment analysis evaluated the potential for adverse health effects for both an industrial land-use scenario (the designated land-use scenario for this site) and a residential land-use scenario.

For the industrial land-use scenario nonradiological COCs, the HI calculated is 0.02 (much less than the numerical guideline of 1 suggested in RAGS [EPA 1989]). The excess cancer risk is estimated at 3×10^{-6}. Guidance from the NMED indicates that excess lifetime risk of developing cancer by an individual must be less than 10^{-6} for Class A and B carcinogens and less than 10^{-5} for Class C carcinogens (NMED March 1998). The excess cancer risk for SWMU 14 is driven by arsenic which is a Class A carcinogen. Thus, the total excess cancer risk for this site is above the suggested acceptable risk value (10^{-6}). This risk assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the industrial and residential land-use scenarios. For nonradiological COCs, assuming the industrial land-use scenario, the HI is 0.01. The excess cancer risk is estimated at 2×10^{-6}. Incremental risk is determined from subtracting risk associated with background from potential COC risk. These numbers are not rounded before the difference is determined and therefore may appear to be inconsistent with numbers presented in tables and within the text. The incremental HI is 0.01, and the incremental cancer risk is 9×10^{-7} for the industrial land-use scenario. These incremental risk calculations indicate acceptable risk to human health from nonradiological COCs considering an industrial land-use scenario.

For radiological COCs of the industrial land-use scenario, the incremental TEDE is 0.017 mrem/yr, which is significantly less than EPA's numerical guideline of 15 mrem/yr. The incremental estimated excess cancer risk is 1.9×10^{-7}.

For the residential land-use scenario nonradiological COCs, the calculated HI is 0.7, which is below the numerical guidance. The excess cancer risk is estimated at 7×10^{-5}. The excess cancer risk is again driven by arsenic, which is a Class A carcinogen. Therefore, the total excess cancer risk for this site is above the suggested acceptable risk value (10^{-6}). The HI for associated background for the residential land-use scenario is 0.3. The excess cancer risk is estimated at 5×10^{-5}. The incremental HI is 0.48, and the incremental cancer risk is 2×10^{-5} for the residential land-use scenario. These incremental risk calculations indicate potentially significant contribution to human health risk from the COCs considering a residential land-use scenario.

The incremental TEDE for a residential land-use scenario from the radiological components is 0.048 mrem/yr, which is significantly less than the numerical guideline of 75 mrem/yr suggested in SNL/NM RESRAD Input Parameter Assumptions and Justification (SNL/NM February 1998). The estimated excess cancer risk is 6.1×10^{-7}.

VI.8 Step 7 Uncertainty Discussion

The determination of the nature, rate and extent of contamination at SWMU 14 was based upon an initial conceptual model validated with confirmatory sampling at the site. The confirmatory sampling was implemented in accordance with the Sampling and Analysis Plan (SNL/NM July 1997), which was reviewed by the NMED Oversight Bureau. The DQOs contained in the Sampling and Analysis Plan (SNL/NM July 1997) are appropriate for use in screening risk assessments. The data collected, based upon sample location, density, and depth, are representative of the site. The analytical requirements and results satisfy the DQOs. Data quality was validated in accordance with SNL/NM procedures (SNL/NM July 1994). Therefore, there is no uncertainty associated with the data quality used to perform the risk screening assessment at SWMU 14.

Because of the location, history of the site, and future land-use (DOE and USAF March 1996), there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in making the risk assessment analysis. Because the COCs are found in near-surface soils and because of the location and physical characteristics of the site, there is little uncertainty in the exposure pathways relevant to the analysis.

An RME approach was used to calculate the risk assessment values. This means that parameter values used in the calculations are conservative and that calculated intakes are probably overestimates. Maximum measured values of the concentrations of the COCs are used to provide conservative results.

Table 6 shows the uncertainties (confidence) in nonradiological toxicological parameter values. There is a mixture of estimated values and values from IRIS (EPA 1998) and HEAST (EPA 1997a) databases. Where values are not provided, information is not available from the HEAST (EPA 1997a), IRIS (EPA 1998), or the EPA regions (EPA 1996b and 1997c). Because of the conservative nature of the RME approach, the uncertainties in toxicological values are not expected to be sufficiently high to change the conclusion from the risk assessment analysis.

Risk assessment values for nonradiological COCs are within the human health acceptable range for the industrial land-use scenario compared to established numerical guidance.

For radiological COCs, the conclusion of the risk assessment is that potential effects on human health, for both industrial and residential land-use scenarios are within guidelines and are a small fraction of the estimated 360 mrem/yr received by the average U.S. population (NCRP 1987).

The overall uncertainty in all of the steps in the risk assessment process is considered not significant with respect to the conclusion reached.

VI.9 Summary

SWMU 14 has identified COCs consisting of some inorganic, volatile organic, and radiological compounds. Because of the location of the site, the designated industrial land-use scenario, and the nature of contamination, potential exposure pathways identified for this site included soil ingestion and dust inhalation for chemical constituents and soil ingestion, dust inhalation, and direct gamma exposure for radiological constituents. Plant uptake was included as an exposure pathway for the residential land-use scenario.

Using conservative assumptions and employing an RME approach to risk assessment, calculations for nonradiological COCs show that for the industrial land-use scenario the HI (0.02) is significantly less than the accepted numerical guidance from the EPA. The total excess cancer risk (3×10^{-6}) is above the acceptable risk value provided by the NMED for an industrial land use (NMED March 1998). However, the incremental HI is 0.01, and the incremental cancer risk is 9×10^{-7} for the industrial land-use scenario. Incremental risk calculations indicate acceptable risk to human health for an industrial land-use scenario.

Incremental TEDE and corresponding estimated cancer risk from radiological COCs are much less than EPA guidance values; the estimated TEDE is 0.017 mrem/yr for the industrial land-use scenario. This value is much less than the numerical guidance of 15 mrem/yr in EPA guidance (EPA 1997b). The corresponding incremental estimated cancer risk value is 1.9×10^{-7} for the industrial land-use scenario. Furthermore, the incremental TEDE for the residential land-use scenario that results from a complete loss of institutional control is only 0.048 mrem/year. The guideline for this scenario is 75 mrem/yr (SNL/NM February 1998). Therefore, SWMU 14 is eligible for unrestricted radiological release.

Uncertainties associated with the calculations are considered small relative to the conservativeness of risk assessment analysis. It is therefore concluded that this site does not have potential to affect human health under an industrial land-use scenario.

VII. Ecological Risk Screening Assessment

VII.1 Introduction

This section addresses the ecological risks associated with exposure to constituents of potential ecological concern (COPEC) in soils at SWMU 14. A component of the NMED Risk-Based Decision Tree is to conduct an ecological screening assessment that corresponds with that presented in the EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997d). The current methodology is tiered and contains an initial scoping assessment followed by a more detailed screening assessment. Initial components of NMED's decision tree (a discussion of DQOs, a data assessment, and evaluations of bioaccumulation and fate-and-transport potential) are addressed in the scoping assessment (Section VII.2), with the exception of DQOs, which are reviewed in Section II of this report. Following the completion of the scoping assessment, a determination is made as to whether a more detailed examination of potential ecological risk is necessary. If deemed necessary, the scoping assessment proceeds to a screening assessment whereby a more quantitative estimate of ecological risk is conducted. Although this assessment incorporates conservatisms in the estimation of ecological risks, ecological relevance and professional judgment are also used as recommended by the EPA (EPA 1996c) to ensure that predicted exposures of selected ecological receptors reflect those reasonably expected to occur at the site.

VII.2 Scoping Assessment

The scoping assessment focuses primarily on the likelihood of exposure of biota at/or adjacent to the site to be exposed to constituents associated with site activities. Included in this section are an evaluation of existing data and a comparison of maximum detected concentrations to background concentrations, examination of bioaccumulation potential, and fate and transport potential. A Scoping Risk Management Decision will involve a summary of the scoping results and a determination as to whether further examination of potential ecological impacts is necessary.

VII.2.1 Data Assessment

As indicated in Section IV (Tables 3 and 4), the only constituents in soil within the 0- to-5-foot-depth interval that exceeded background concentrations were:

- Arsenic
- U-238
- Th-234 and daughters.

In addition, mercury, selenium, and silver were reported as not detected.

VII.2.2 Bioaccumulation

Among the COPECs listed in Section VII.2.1, the following were considered to have bioaccumulation potential in aquatic environments (Section IV, Tables 3 and 4):

- Arsenic
- Mercury
- Selenium
- U-238.

It should be noted, however, that as specified by the NMED, the determination of bioaccumulation potential is exclusively based upon log K_{ow} values and maximum reported bioconcentration factors (BCF) for aquatic species. Because only aquatic BCFs are used to evaluate the bioaccumulation potential for metals, bioaccumulation in terrestrial species is likely to be overpredicted.

VII.2.3 Fate and Transport Potential

The potential for the COPECs to move from the source of contamination to other media or biota is discussed in Section V. As noted in Table 5 (Section V), wind dispersal may be of moderate significance as a transport mechanism for COPECs at the soil surface but will not be significant for COPECs below the surface. Surface-water runoff is expected to be of low significance. Transformation, degradation, and food-chain uptake are also expected to be of low significance. Migration to groundwater is not anticipated.

VII.2.4 Scoping Risk Management Decision

Based on information gathered through the scoping assessment, it was concluded that complete ecological pathways may be associated with this Environmental Restoration (ER) site and that COPECs also exist at the site. As a consequence, a screening assessment was deemed necessary to predict the potential level of ecological risk associated with the site.

VII.3 Screening Assessment

As concluded in Section VII.2.4, complete ecological pathways and COPECs are associated with this ER site. The screening assessment performed for the site involves a quantitative estimate of current ecological risks using exposure models in association with exposure parameters and toxicity information obtained from the literature. The estimation of potential ecological risks is conservative to ensure ecological risks are not under-predicted.

Components within the screening assessment include:

- Problem Formulation–sets the stage for the evaluation of potential exposure and risk
- Exposure Estimation–provides a quantitative estimate of potential exposure
- Ecological Effects Evaluation–presents benchmarks used to gauge the toxicity of COPECs to specific receptors
- Risk Characterization–characterizes the ecological risk associated with exposure of the receptors to environmental media at the site
- Uncertainty Assessment–discusses uncertainties associated with the estimation of exposure and risk
- Risk Interpretation–evaluates ecological risk in terms of HQs and ecological significance
- Screening Assessment Scientific/Management Decision Point–presents the decision to risk managers based on the results of the screening assessment

VII.3.1 Problem Formulation

Problem formulation is the initial stage of the screening assessment that provides the introduction to the risk evaluation process. Components that are addressed in this section include a discussion of ecological pathways and the ecological setting, identification of COPECs, and selection of ecological receptors. The conceptual model, ecological food webs, and ecological endpoints (other components commonly addressed in a screening assessment) are presented in the "Predictive Ecological Risk Assessment Methodology for SNL/NM ER Program" (IT June 1998) and are not duplicated here.

VII.3.1.1 Ecological Pathways and Setting

SWMU 14 is located west of Building 9920, approximately 1,500 feet east of Technical Area III. Although the actual burial site was not exactly located, it is believed to be within a 250- by 250-foot (1.4-acre) area that is considered to be the SWMU. This area is within the larger SWMU 85 (the Building 9920 Firing Site), which underwent a VCM in 1995 to remove soils with elevated radiation levels. The terrain is generally flat with a gentle slope to the west. The original vegetation within this area was desert grassland; however, the site has been graded and cleared of vegetation. Ruderal plant species have since become established in the disturbed soils. This site was surveyed for sensitive species in 1994 (IT February 1995) with no sensitive species being found and none expected to occur due to the lack of suitable habitat. No surface water or wetland habitat occurs on or near this site.

Complete ecological pathways may exist at this site through the exposure of plants and wildlife to COPECs in surface and subsurface soil. Direct uptake of COPECs from soil was assumed to be the major route of exposure for plants, with exposure of plants to wind-blown soil assumed to be minor. Exposure modeling for wildlife receptors was limited to food and soil ingestion pathways. Because of a lack of surface water at this site, exposure to COPECs through the ingestion of surface water was considered insignificant. Inhalation and dermal contact were also considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Groundwater (at approximately 155 feet below ground surface) is not expected to be affected by COCs at this site.

VII.3.1.2 COPECs

The COPECs at this site include inorganics and radionuclides. This assessment is based upon soil concentrations of the nonradioactive and radioactive COPECs as measured in surface and near-surface soil samples. In order to provide conservatism in this ecological risk screening assessment, the exposure models use only the maximum concentration of each COPEC determined for the entire site. The inorganic analytes were screened against background concentrations. Those that exceeded the approved SNL/NM background screening levels (Dinwiddie September 24, 1997) for the area were considered to be COPECs (Section IV, Tables 3 and 4). Nonradiological inorganics that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment per the EPA (1989).

VII.3.1.3 Ecological Receptors

As described in detail in IT (June 1998), a nonspecific perennial plant was selected as the receptor to represent plant species at the site. Vascular plants are the principal primary producers at the site and are key to the diversity and productivity of the wildlife community associate with the site. A deer mouse (*Peromyscus maniculatus*) and burrowing owl (*Speotyto* *cunicularia*) were used to represent wildlife use. Because of its opportunistic food habits, the deer mouse was used to represent a mammalian herbivore, omnivore, and insectivore. The burrowing owl was selected as the top predator. It is present at SNL/NM and is designated as a species of management concern by the U.S. Fish and Wildlife Service in Region 2, which includes the state of New Mexico (USFWS September 1995).

VII.3.2 Exposure Estimation

Direct uptake of COPECs from the soil was considered the only significant route of exposure for terrestrial plants. Exposure modeling for the wildlife receptors was limited to the food and soil ingestion pathways. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Drinking water was also considered an insignificant pathway because of the lack of surface water at this site. The deer mouse was modeled under three dietary regimes: as an herbivore (100 percent of its diet as plant material), as an omnivore (50 percent of its diet as plants and 50 percent as soil invertebrates), and as an insectivore (100 percent of its diet as soil invertebrates). The burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Because the exposure in the burrowing owl from a diet consisting of equal parts of herbivorous, omnivorous, and insectivorous mice would be equivalent to the exposure consisting of only omnivorous mice, the diet of the burrowing owl was modeled with intake of omnivorous mice only. Both species were modeled with soil ingestion comprising 2 percent of the total dietary intake. Table 10 presents the species- specific factors used in modeling exposures in the wildlife receptors. Justification for use of the factors presented in this table is described in the ecological risk assessment methodology document (IT June 1998).

Although home range is also included in this table, exposures for this risk assessment were modeled using an area use factor of 1, implying that all food items and soil ingested are from the site being investigated. The maximum measured COPEC concentrations from surface and near-surface soil samples were used to conservatively estimate potential exposures and risks to plants and wildlife at this site.

Table 11 presents the transfer factors used in modeling the concentrations of nonradiological COPECs through the food chain. Table 12 presents the maximum soil concentrations or one-half of the detection limit for these COPECs and derived tissue concentrations in the various food-chain elements that are used to model dietary exposures for each of the wildlife receptors.

For the radiological dose rate calculations, the deer mouse was modeled as an herbivore (100 percent of its diet as plants), and the burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Both were modeled with soil ingestion comprising 2 percent of the total dietary intake. Receptors are exposed to radiation both internally and externally from U-238 and Th-234. Internal and external dose rates to the deer mouse and burrowing owl are approximated using dose rate models from the *Hanford Site Risk Assessment Methodology* (DOE 1995). Radionuclide-dependent data for the dose rate calculations were obtained from Baker and Soldat (1992). The external dose-rate model examines the total-body dose rate to a receptor residing in soil exposed to radionuclides. The soil surrounding the receptor is assumed to be an infinite medium uniformly contaminated with

Table 10
Exposure Factors for Ecological Receptors at SWMU 14

Receptor Species	Class/Order	Trophic Level	Body Weight (kg)[a]	Food Intake Rate (kg/day)[b]	Dietary Composition[c]	Home Range (acres)
Deer Mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Herbivore	2.39E−2[d]	3.72E−3	Plants: 100% (+ Soil at 2% of intake)	2.7E−1[e]
Deer Mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Omnivore	2.39E−2[d]	3.72E−3	Plants: 50% Invertebrates: 50% (+ Soil at 2% of intake)	2.7E−1[e]
Deer Mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Insectivore	2.39E−2[d]	3.72E−3	Invertebrates: 100% (+ Soil at 2% of intake)	2.7E−1[e]
Burrowing owl (*Speotyto cunicularia*)	Aves/ Strigiformes	Carnivore	1.55E−1[f]	1.73E−2	Rodents: 100% (+ Soil at 2% of intake)	3.5E+1[g]

[a]Body weights are in kilograms wet weight.
[b]Food intake rates are estimated from the allometric equations presented in Nagy (1987). Units are kilograms dry weight per day.
[c]Dietary compositions are generalized for modeling purposes. Default soil intake value of 2% of food intake.
[d]From Silva and Downing (1995).
[e]From EPA (1993), based upon the average home range measured in semiarid shrubland in Idaho.
[f]From Dunning (1993).
[g]From Haug et al. (1993).
kg = Kilogram(s).
kg/day = Kilogram(s) per day.
SWMU = Solid waste management unit.

Table 11
Transfer Factors Used in Exposure Models for Constituents of Potential Ecological Concern at SWMU 14

Constituent of Potential Ecological Concern	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor
Inorganic			
Arsenic	4.0E–2[a]	1.0E+0[b]	2.0E–3[a]
Mercury	1.0E+0[c]	1.0E+0[b]	2.5E–1[a]
Selenium	5.0E–1[c]	1.0E+0[b]	1.0E–1[c]
Silver	1.0E+0[c]	2.5E–1[c]	5.0E–3[c]

[a]From Baes et al. (1984).
[b]Default value.
[c]From NCRP (January 1989).
SWMU = Solid waste management unit.

Table 12
Media Concentrations[a] for Constituents of Potential Ecological Concern at SWMU 14

Constituent of Potential Ecological Concern	Soil (maximum)	Plant Foliage[b]	Soil Invertebrate[b]	Deer Mouse Tissues[c]
Inorganic				
Arsenic	6.1E+0	2.4E–1	6.1E+0	2.1E–2
Mercury	6.0E–2[d]	6.0E–2	6.0E–2	4.8E–2
Selenium	8.0E–1[d]	4.0E–1	8.0E–1	1.9E–1
Silver	6.0E–2[d]	6.0E–2	1.5E–2	6.1E–4

[a]In milligrams per kilogram. All are based upon dry weight of the media.
[b]Product of the soil concentration and the corresponding transfer factor.
[c]Based upon the deer mouse with an omnivorous diet. Product of the average concentration in food times the food-to-muscle transfer factor times the wet weight-dry weight conversion factor of 3.125 (from EPA 1993).
[d]Value is one-half of the detection limit.
SWMU = Solid waste management unit.

gamma-emitting radionuclides. The external dose rate model is the same for both the deer mouse and the burrowing owl. The internal total-body dose rate model assumes that a fraction of the radionuclide concentration ingested by a receptor is absorbed by the body and concentrated at the center of a spherical body shape. This provides for a conservative estimate for absorbed dose. This concentrated radiation source at the center of the body of the receptor is assumed to be a "point" source. Radiation emitted from this point source is absorbed by the body tissues to contribute to the absorbed dose. Alpha and beta emitters are assumed to transfer 100 percent of their energy to the receptor as they pass through tissues. Gamma emitting radionuclides only transfer a fraction of their energy to the tissues because gamma rays interact less with matter than do beta or alpha emitters. The external and internal dose rate results are summed to calculate a total dose rate due to exposure to the radionuclides in soil.

VII.3.3 Ecological Effects Evaluation

Benchmark toxicity values for plant and wildlife receptors are presented in Table 13. For plants, benchmark soil concentrations are based upon the lowest-observed-adverse-effect level (LOAEL). For wildlife, toxicity benchmarks are based upon the no-observed-adverse-effect level (NOAEL) for chronic oral exposure in a taxonomically similar test species. Insufficient toxicity information was found to estimate the LOAELs or NOAELs for some COPECs for terrestrial plant life and wildlife receptors, respectively.

The benchmark used for exposure of terrestrial receptors to radiation was 0.1 rad/day. This value has been recommended by the International Atomic Energy Agency (1992) for the protection of terrestrial populations. Because plants and insects are less sensitive to radiation than vertebrates (Whicker and Schultz 1982), the dose of 0.1 rad/day should also offer sufficient protection to other components within the terrestrial habitat of SWMU 14.

VII.3.4 Risk Characterization

Maximum soil concentrations and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. The results of these comparisons are presented in Table 14. HQs are used to quantify the comparison with the benchmarks for plants and wildlife exposure.

Arsenic was the only COPEC that resulted in an HQ greater than unity. This was for the omnivorous and insectivorous deer mouse. No COPECs resulted in an HQ greater than 1.0 for the burrowing owl, although an HQ for this species could not be determined for silver. As directed by the NMED, HIs were calculated for each receptor. The HI is the sum of chemical-specific HQs for all pathways for a given receptor. All receptors except the owl had HIs greater than unity. In no case, however, did an HI exceed a value of 10.

Tables 15 and 16 summarize the internal and external dose rate model results for the two radionuclides. The total radiation dose rate to the deer mouse was predicted to be 1.8E-3 rad/day. The total dose rate to the burrowing owl was predicted to be 1.7E–3 rad/day. The external dose rate due to exposure to U-238 is the primary contributor to the total dose rate

Table 13
Toxicity Benchmarks for Ecological Receptors at SWMU 14

Constituent of Potential Ecological Concern	Plant Benchmark[a,b]	Mammalian NOAELs			Avian NOAELs		
		Mammalian Test Species[c,d]	Test Species NOAEL[d,e]	Deer Mouse NOAEL[e,f]	Avian Test Species[d]	Test Species NOAEL[d,e]	Burrowing Owl NOAEL[g]
Inorganic							
Arsenic	10	Mouse	0.126	0.13	Mallard	5.14	5.14
Mercury (inorganic)	0.3	Mouse	13.2	14.0	Japanese quail	0.45	0.45
Mercury (organic)	0.3	Rat	0.032	0.06	Mallard	0.0064	0.006
Selenium	1	Rat	0.20	0.39	Screech owl	0.44	0.44
Silver	2	Rat	17.8	34.8	---[h]	---	---

[a]In milligrams per kilogram soil.
[b]From Will and Suter (1995), except where noted.
[c]Body weights (in kilograms) for the no-observed-adverse-effect level (NOAEL) conversion are as follows: lab mouse, 0.030; lab rat, 0.350.
[d]From Sample et al. (1996), except where noted.
[e]In milligrams per kilogram body weight per day.
[f]Based upon NOAEL conversion methodology presented in Sample et al. (1996), using a deer mouse body weight of 0.0239 kilogram and a mammalian scaling factor of 0.25.
[g]Based upon NOAEL conversion methodology presented in Sample et al. (1996). The avian scaling factor of 0.0 was used, making the NOAEL independent of body weight.
[h]--- designates insufficient toxicity data.

Table 14
Hazard Quotients for Ecological Receptors at SWMU 14

Constituent of Potential Ecological Concern	Plant Hazard Quotient[a]	Deer Mouse Hazard Quotient (Herbivorous)	Deer Mouse Hazard Quotient (Omnivorous)[a]	Deer Mouse Hazard Quotient (Insectivorous)[a]	Burrowing Owl Hazard Quotient
Inorganic					
Arsenic	6.1E−1	4.3E−1	**3.8E+0**	**7.3E+0**	3.1E−3
Mercury (inorganic)	2.0E−1	6.8E−4	6.8E−4	6.8E−4	1.2E−2
Mercury (organic)	2.0E−1	1.5E−1	1.5E−1	1.5E−1	8.5E−1
Selenium	8.0E−1	1.7E−1	2.5E−1	3.3E−1	5.3E−2
Silver	3.0E−2	2.7E−4	1.7E−4	7.2E−5	---[b]
Hazard Index[c]	**1.6E+0**	7.5E−1	**4.2E+0**	**7.8E+0**	9.2E−1

[a]**Bold** text indicates HQ or HI exceeds unity.
[b]--- designates insufficient toxicity data available for risk estimation purposes.
[c]The HI is the sum of individual hazard quotients using the value for organic mercury as a conservative estimate of the HI.
HI = Hazard index.
HQ = Hazard quotient.
SWMU = Solid waste management unit.

Table 15
Internal and External Dose Rates for
Deer Mice Exposed to Radionuclides at SWMU 14

Radionuclide	Maximum Gamma Activity (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
U-238	1.3E+1	1.1E–4	1.7E–3	1.8E–3
Th-234+D[a]	1.1E+1	1.4E–8	2.0E–5	2.0E–5
Total		1.1E–4	1.7E–3	1.8E–3

[a]The dose rate calculation for Th-234 includes its radioactive daughter, protactinium-234m.
pCi/g = Picocurie(s) per gram.
SWMU = Solid waste management unit.

Table 16
Internal and External Dose Rates for
Burrowing Owls Exposed to Radionuclides at SWMU 14

Radionuclide	Maximum Gamma Activity (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
U-238	1.3E+1	4.1E–5	1.7E–3	1.7E–3
Th-234+D[a]	1.1E+1	9.3E–9	2.0E–5	2.0E–5
Total		4.1E–5	1.7E–3	1.7E–3

[a]The dose rate calculation for Th-234 includes its radioactive daughter, protactinium-234m.
pCi/g = Picocurie(s) per gram.
SWMU = Solid waste management unit.

for both receptors. The dose rates for the deer mouse and the burrowing owl are considerably less than the benchmark of 0.1 rad/day.

VII.3.5 Uncertainty Assessment

Many uncertainties are associated with the characterization of ecological risks at SWMU 14. These uncertainties result from assumptions used in calculating risk that may overestimate or underestimate true risk presented at a site. For this risk assessment, assumptions are made that are more likely to overestimate exposures and risk rather than to underestimate them. These conservative assumptions are used to be more protective of the ecological resources potentially affected by the site. Conservatisms incorporated into this risk assessment include the use of the maximum measured soil concentrations to evaluate risk, the use of wildlife toxicity benchmarks based upon NOAEL values, the use of earthworm-based transfer factors for modeling COPECs into soil invertebrates in the absence of insect data, the incorporation of strict herbivorous and strict insectivorous diets for predicting the extreme HQ values for the deer mouse, and the use of 1.0 as the area use factor for wildlife receptors regardless of seasonal use or home range size. Furthermore, complete bioavailability of all COPECs was assumed for the entire site. Each of these uncertainties, which are consistent among each of the ER-specific ecological risk assessments, is discussed in detail in the uncertainty of the ecological risk assessment methodology document for the SNL/NM ER Program (IT June 1998).

Uncertainties associated with the estimating risk to ecological receptors following exposure to U-238 and Th-234 are primarily related to those inherent in the radionuclide-specific data. Radionuclide-dependent data are measured values that have their associated errors that are typically negligible. The dose rate models used for these calculations are based upon conservative estimates of receptor shape, radiation absorption by body tissues, and intake parameters. The goal is to provide a realistic but conservative estimate of a receptor's exposure to radionuclides in soil, both internally and externally.

Uncertainty associated with the prediction of ecological risks at this site is introduced by using the maximum measured soil concentrations and detection limits to evaluate risk. (One-half of the detection limit value was used to estimate potential risk associated with exposure to mercury, selenium, and silver.) Both situations result in a conservative exposure scenario and may give a false impression of ecological risks associated with these COPECs. Actual exposures are expected to be much lower than those predicted from these values.

In the estimation of ecological risk, background concentrations are included as a component of maximum on-site concentrations. Table 17 illustrates risk estimates associated with exposure of each of the receptors to background concentrations of the metal COPECs. With respect to the plant, no single HQ was found to be greater than one. HQs greater than unity were obtained for the omnivorous and insectivorous deer mouse exposed to arsenic. Approximately 70 percent of the on-site maximum arsenic soil concentration was associated with background. Because of the uncertainties associated with exposure and toxicity, it is unlikely that arsenic, with an exposure concentration largely attributable to background, presents a significant ecological risk.

Table 17
Hazard Quotients for Ecological Receptors Exposed to Background Concentrations for SWMU 14

Constituent of Potential Ecological Concern	Plant Hazard Quotient[a]	Deer Mouse Hazard Quotient (Herbivorous)	Deer Mouse Hazard Quotient (Omnivorous)[a]	Deer Mouse Hazard Quotient (Insectivorous)[a]	Burrowing Owl Hazard Quotient
Inorganic					
Arsenic	4.4E–1	3.1E–1	**2.8E+0**	**5.2E+0**	2.2E–3
Mercury (inorganic)	1.7E–1	5.7E–4	5.7E–4	5.7E–4	5.9E–4
Mercury (organic)	1.7E–1	1.3E–1	1.3E–1	1.3E–1	1.1E–2
Selenium	5.0E–1	1.0E–1	1.5E–1	2.0E–1	3.3E–2
Silver	2.5E–1	2.3E–3	1.4E–3	6.0E–4	---[b]
Hazard Index	**1.4E+0**	5.4E–1	**3.1E+0**	**5.5E+0**	4.6E–2

[a]**Bold** text indicates hazard quotient or hazard index exceeds unity.
[b]--- designates insufficient toxicity data available for risk estimation purposes.
[c]The hazard index is the sum of individual hazard quotients using the value for organic mercury as a conservative estimate of the hazard index.

As illustrated above, consideration of site-specific exposure conditions results in a more realistic estimation of risk. Based upon the home range size of 35 acres for the burrowing owl and the size of SWMU 14 (1.4 acres), an area use factor of approximately 0.04 could be applied to the HQs for this species. This would result in HQ estimates considerably less than those presented in Table 14 for the burrowing owl, also indicating little potential for adverse risks to the owl from exposure to COPECs at SWMU 14.

Based upon this uncertainty analysis, ecological risks at SWMU 14 are expected to be very low. HQs greater than unity were initially predicted; however, closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to exposure concentration and background risk.

VII.3.6 Risk Interpretation

Ecological risks associated with SWMU 14 were estimated through a screening assessment that incorporates site-specific information when available. Overall, ecological risks to plants are expected to be insignificant. With respect to the mouse, risk is expected to be very low. Predicted risk from exposure to arsenic was attributed to background concentrations. No ecological risk was predicted for the burrowing owl. No ecological risks were predicted from exposure to radiation from U-238 and Th-234. Overall ecological risk associated with this site is expected to be very low.

VII.3.7 Screening Assessment Scientific/Management Decision Point

Once potential ecological risks associated with the site have been assessed, a decision is made as whether the site should be recommended for NFA or additional data collected to more thoroughly assess actual ecological risk at the site. With respect to this site, ecological risks were predicted to be very low. The scientific/management decision is to recommend this site for NFA.

VIII. References

Baes, III, C.F., R.D. Sharp, A.L. Sjoreen, and R.W. Shor, 1984. "A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture," ORNL-5786, Oak Ridge National Laboratory, Oak Ridge, Tennessee, pp. 10–11.

Baker, D.A., and J.K. Soldat, 1992. "Methods for Estimating Doses to Organisms from Radioactive Materials Released into the Aquatic Environment," PNL-8150, Pacific Northwest Laboratory, Richland, Washington, pp. 16–20.

Brown, C.D. (Sandia National Laboratories). Memo to Devon Jercinovic (International Technology Corporation), "Radiological Data Tables and DU Ratios, Sandia National Laboratories," Memo (unpublished), Albuquerque, New Mexico. January 14, 1998.

Callahan, M.A., M.W. Slimak, N.W. Gabel, I.P. May, C.F. Fowler, J.R. Freed, P. Jennings, R.L. Durfee, F.C. Whitmore, B. Maestri, W.R. Mabey, B.R. Holt, and C. Gould, 1979, "Water-Related Environmental Fate of 129 Priority Pollutants," EPA-440/4-79-029, Office of Water Planning and Standards, Office of Water and Waste Management, U.S. Environmental Protection Agency, Washington, D.C.

Dinwiddie, R.S. (New Mexico Environment Department). Letter to M.J. Zamorski (U.S. Department of Energy), "Request for Supplemental Information: Background Concentrations Report, SNL/KAFB," September 24, 1997.

DOE, see U.S. Department of Energy.

Dunning, J.B., 1993. *CRC Handbook of Avian Body Masses*, CRC Press, Boca Raton, Florida.

EPA, see U.S. Environmental Protection Agency.

Haug, E.A, B.A. Millsap, and M.S. Martell, 1993. "*Speotyto cunicularia* Burrowing Owl," In A. Poole and F. Gill (eds.), *The Birds of North America*, No. 61, The Academy of Natural Sciences of Philadelphia.

IAEA, see International Atomic Energy Agency.

International Atomic Energy Agency (IAEA), 1992. "Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards," Technical Report Series No. 332, International Atomic Energy Agency, Vienna, Austria.

IT, see IT Corporation.

IT Corporation (IT), July 1994. "Report of Generic Action Level Assistance for the Sandia National Laboratories/New Mexico Environmental Restoration Program," IT Corporation, Albuquerque, New Mexico.

IT Corporation (IT), February 1995. "Sensitive Species Survey Results, Environmental Restoration Project, Sandia National Laboratories/New Mexico," IT Corporation, Albuquerque, New Mexico.

IT Corporation (IT), June 1998. "Predictive Ecological Risk Assessment Methodology for the SNL/NM ER Program, Sandia National Laboratories, New Mexico," IT Corporation, Albuquerque, New Mexico.

Kocher, D.C. 1983, "Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil," *Health Physics*, Vol. 28, pp. 193–205.

Nagy, K.A., 1987. "Field Metabolic Rate and Food Requirement Scaling in Mammals and Birds," *Ecological Monographs*, Vol. 57, No. 2, pp. 111–128.

National Council on Radiation Protection and Measurements (NCRP), 1987. "Exposure of the Population in the United States and Canada from Natural Background Radiation," NCRP Report No. 94, National Council on Radiation Protection and Measurements, Bethesda, Maryland.

National Council on Radiation Protection and Measurements (NCRP), January 1989. "Screening Techniques for Determining Compliance with Environmental Standards: Releases of Radionuclides to the Atmosphere," NCRP Commentary No. 3, Revision of January 1989, National Council on Radiation Protection and Measurements, Bethesda, Maryland.

National Oceanographic and Atmospheric Administration (NOAA), 1990. Local Climatological Data, Annual Summary with Comparative data, Albuquerque, NM.

NCRP, see National Council on Radiation Protection and Measurements.

Neumann, G., 1976, "Concentration Factors for Stable Metals and Radionuclides in Fish, Mussels and Crustaceans – a Literature Survey," Report 85-04-24, National Swedish Environmental Protection Board.

New Mexico Environment Department (NMED), March 1998. "RPMP Document Requirement Guide," New Mexico Environment Department, Hazardous and Radioactive Materials Bureau, RCRA Permits Management Program, Santa Fe, New Mexico.

NOAA, see National Oceanographic and Atmospheric Administration.

Sample, B.E., and G.W. Suter II, 1994. "Estimating Exposure of Terrestrial Wildlife to Contaminants," ES/ER/TM-125, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Sample, B.E., D.M. Opresko, and G.W. Suter II, 1996. "Toxicological Benchmarks for Wildlife: 1996 Revision," ES/ER/TM-86/R3, Risk Assessment Program, Health Sciences Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Sandia National Laboratories/New Mexico (SNL/NM), July 1994. "Technical Operating Procedure 94-03, Verification and Validation of Chemical and Radiological Data, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), March 1995. "Site-Wide Hydrogeologic Characterization Project, Calendar Year 1994 Annual Report," Sandia National Laboratories Environmental Restoration Project, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), March 1996. "RCRA Facility Investigation Work Plan for Operable Unit 1335, Southwest Test Area," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), June 1997. "Bullets of Understanding between NMED/DOE OB and DOE/SNL ER Project for Sampling and Analysis Plans for ER Sites 14 and 85 OU 1335, Southwest Test Area," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), July 1997. "OU 1335, ER Site 14, Confirmatory Sampling Plan," prepared by Sandia National Laboratories/New Mexico Environmental Restoration Project, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), February 1998. "RESRAD Input Parameter Assumptions and Justification," Sandia National Laboratories/New Mexico Environmental Restoration Project, Albuquerque, NM.

Silva, M., and J.A. Downing, 1995. *CRC Handbook of Mammalian Body Masses*, CRC Press, Boca Raton, Florida.

SNL/NM, See Sandia National Laboratories, New Mexico.

Thomson, B.M., and G. J. Smith, 1985. "Investigation of Groundwater Contamination Potential at Sandia National Laboratories, Albuquerque, New Mexico," in *Proceedings of the Fifth DOE Environmental Protection Information Meeting*, Albuquerque, New Mexico, November 6-8, 1984, CONF-841187, pp. 531-540.

U.S. Department of Agriculture (USDA) Soil Conservation Service, United States Department of the Interior Bureau of Indian Affairs and Bureau of Land Management, and New Mexico Agriculture Experiment Station, 1977, "Soil Survey of Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico," United States Government Printing Office, Washington, D.C.

U.S. Department of Energy (DOE), 1988. "External Dose-Rate Conversion Factors for Calculation of Dose to the Public," DOE/EH-0070, U.S. Department of Energy, Assistant Secretary for Environment, Safety and Health, Washington, D.C.

U.S. Department of Energy (DOE), 1993. DOE Order 5400.5, "Radiation Protection of the Public and the Environment," U.S. Department of Energy, Washington, D.C.

U.S. Department of Energy (DOE), 1995. "Hanford Site Risk Assessment Methodology," DOE/RL-91-45 (Rev. 3), U.S. Department of Energy, Richland, Washington.

U.S. Department of Energy and United States Air Force (DOE and USAF), March 1996. "Workbook: Future Use Management Area 7," prepared by the Future Use Logistics and Support Working Group in cooperation with U.S. Department of Energy Affiliates and the U.S. Air Force.

U.S. Environmental Protection Agency (EPA), 1988. "Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual," EPA/540-1089/002, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1990. "Corrective Action for Solid Waste Management Units (SWMU) at Hazardous Waste Management Facilities, Proposed Rule," Federal Register, Vol. 55, Title 40, Parts 264, 265, 270, and 271.

U.S. Environmental Protection Agency (EPA), 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B)," U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1992. "Framework for Ecological Risk Assessment," EPA/630/R-92/001, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1993. "Wildlife Exposure Factors Handbook, Volume I of II," EPA/600/R-93/187a, U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1996a, Personal communication from Maria Martinez (USEPA Region VI) to Elmer Klavetter (SNL/NM) discussing use of proposed Subpart S action levels.

U.S. Environmental Protection Agency (EPA), 1996b. "Region 9 Preliminary Remediation Goals (PRGs) 1996," electronic database maintained by U.S. Environmental Protection Agency, Region 9, San Francisco, California.

U.S. Environmental Protection Agency (EPA), 1996c. "Proposed Guidelines for Ecological Risk Assessment," EPA/630/R-95/002B, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1997a. "Health Effects Assessment Summary Tables (HEAST), FY 1997 Update," EPA-540-R-97-036, Office of Research and Development and Office of Solid Waste and Emergency Response, Washington, D.C..

U.S. Environmental Protection Agency (EPA), 1997b. "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination," OSWER Directive No. 9200-4-18, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1997c. "Risk-Based Concentration Table," electronic database maintained by U.S. Environmental Protection Agency, Region III, Philadelphia, Pennsylvania.

U.S. Environmental Protection Agency (EPA), 1997d. "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risks," Interim Final, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1998, Integrated Risk Information System (IRIS) electronic database, maintained by the U.S. Environmental Protection Agency.

U.S. Fish and Wildlife Service (USFWS), September 1995. "Migratory Nongame Birds of Management Concern in the United States: The 1995 List," Office of Migratory Bird Management, U.S. Fish and Wildlife Service, Washington, D.C.

Whicker, F.W., and V. Schultz, 1982. *Radioecology: Nuclear Energy and the Environment*, Volume II, CRC Press, Boca Raton, Florida.

Will, M.E., and G.W. Suter II, 1995. "Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1995 Revision." ES/ER/TM-85/R2, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Yanicak, S., 1997, Letter to Mat Johansen, DOE/AIP/POC of Los Alamos National Laboratory, regarding "(Tentative) list of constituents of potential ecological concern (COPECs) which are considered to be bioconcentrators and/or biomagnifiers" dated March 3, 1997, from New Mexico Environment Department's Department of Energy Oversight Bureau.

Yu, C., A.J. Zielen, J.-J. Cheng, Y.C. Yuan, L.G. Jones, D.J. LePoire, Y.Y. Wang, C.O. Loureiro, E. Gnanapragasam, E. Faillace, A. Wallo III, W.A. Williams, and H. Peterson, 1993a. "Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD," Version 5.0. Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois.

Yu, C., C. Loureiro, J.-J. Cheng, L.G. Jones, Y.Y. Wang, Y.P. Chia, and E. Faillace, 1993b. "Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil," ANL/EAIS-8, Argonne National Laboratory, Argonne, Illinois.

APPENDIX 1
EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

Background

Sandia National Laboratories (SNL) proposes that a default set of exposure routes and associated default parameter values be developed for each future land-use designation being considered for SNL/NM Environmental Restoration (ER) project sites. This default set of exposure scenarios and parameter values would be invoked for risk assessments unless site-specific information suggested other parameter values. Because many SNL/NM SWMUs have similar types of contamination and physical settings, SNL believes that the risk assessment analyses at these sites can be similar. A default set of exposure scenarios and parameter values will facilitate the risk assessments and subsequent review.

The default exposure routes and parameter values suggested are those that SNL views as resulting in a Reasonable Maximum Exposure (RME) value. Subject to comments and recommendations by the USEPA Region VI and NMED, SNL proposes that these default exposure routes and parameter values be used in future risk assessments.

At SNL/NM, all Environmental Restoration sites exist within the boundaries of the Kirtland AFB. Approximately 157 potential waste and release sites have been identified where hazardous, radiological, or mixed materials may have been released to the environment. Evaluation and characterization activities have occurred at all of these sites to varying degrees. Among other documents, the SNL/ER draft Environmental Assessment (DOE 1996) presents a summary of the hydrogeology of the sites, the biological resources present and proposed land use scenarios for the SNL/NM SWMUs. At this time, all SNL/NM SWMUs have been tentatively designated for either industrial or recreational future land use. The NMED has also requested that risk calculations be performed based upon a residential land use scenario. All three land use scenarios will be addressed in this document.

The SNL/NM ER project has screened the potential exposure routes and identified default parameter values to be used for calculating potential intake and subsequent hazard index, risk and dose values. EPA (EPA 1989a) provides a summary of exposure routes that could potentially be of significance at a specific waste site. These potential exposure routes consist of:

- Ingestion of contaminated drinking water;
- Ingestion of contaminated soil;
- Ingestion of contaminated fish and shell fish;
- Ingestion of contaminated fruits and vegetables;
- Ingestion of contaminated meat, eggs, and dairy products;
- Ingestion of contaminated surface water while swimming;
- Dermal contact with chemicals in water;
- Dermal contact with chemicals in soil;
- Inhalation of airborne compounds (vapor phase or particulate), and;

- External exposure to penetrating radiation (immersion in contaminated air; immersion in contaminated water and exposure from ground surfaces with photon-emitting radionuclides).

Based upon the location of the SNL SWMUs and the characteristics of the surface and subsurface at the sites, we have evaluated these potential exposure routes for different land use scenarios to determine which should be considered in risk assessment analyses (the last exposure route is pertinent to radionuclides only). At SNL/NM SWMUs, there does not presently occur any consumption of fish, shell fish, fruits, vegetables, meat, eggs, or dairy products that originate on-site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

For the industrial and recreational land use scenarios, SNL/NM ER has therefore excluded the following four potential exposure routes from further risk assessment evaluations at any SNL/NM SWMU:

- Ingestion of contaminated fish and shell fish;
- Ingestion of contaminated fruits and vegetables;
- Ingestion of contaminated meat, eggs, and dairy products; and
- Ingestion of contaminated surface water while swimming.

That part of the exposure pathway for radionuclides related to immersion in contaminated air or water is also eliminated.

For the residential land-use scenario, we will include ingestion of contaminated fruits and vegetables because of the potential for residential gardening.

Based upon this evaluation, for future risk assessments, the exposure routes that will be considered are shown in Table 1. Dermal contact is included as a potential exposure pathway in all land use scenarios. However, the potential for dermal exposure to inorganics is not considered significant and will not be included. In general, the dermal exposure pathway is generally considered to not be significant relative to water ingestion and soil ingestion pathways but will be considered for organic components. Because of the lack of toxicological parameter values for this pathway, the inclusion of this exposure pathway into risk assessment calculations may not be possible and may be part of the uncertainty analysis for a site where dermal contact is potentially applicable.

Equations and Default Parameter Values for Identified Exposure Routes

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land use scenarios. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for

Table 1
Exposure Pathways Considered for Various Land Use Scenarios

Industrial	Recreational	Residential
Ingestion of contaminated drinking water	Ingestion of contaminated drinking water	Ingestion of contaminated drinking water
Ingestion of contaminated soil	Ingestion of contaminated soil	Ingestion of contaminated soil
Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)
Dermal contact	Dermal contact	Dermal contact
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	Ingestion of fruits and vegetables
		External exposure to penetrating radiation from ground surfaces

Superfund (RAGS): Volume 1 (EPA 1989a and 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL 1993). Also shown are the default values SNL/NM ER suggests for use in Reasonable Maximum Exposure (RME) risk assessment calculations for industrial, recreational, and residential scenarios, based upon EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL 1993).

Generic Equation for Calculation of Risk Parameter Values

The equation used to calculate the risk parameter values (i.e., Hazard Quotient/Index, excess cancer risk, or radiation total effective dose equivalent [dose]) is similar for all exposure pathways and is given by:

Risk (or Dose) = Intake x Toxicity Effect (either carcinogenic, noncarcinogenic, or radiological)

$$= C \times (CR \times EFD/BW/AT) \times \text{Toxicity Effect} \quad (1)$$

where

C = contaminant concentration (site specific);
CR = contact rate for the exposure pathway;
EFD= exposure frequency and duration;
BW = body weight of average exposure individual;
AT = time over which exposure is averaged.

The total risk/dose (either cancer risk or hazard index) is the sum of the risks/doses for all of the site-specific exposure pathways and contaminants.

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk range of 10^{-4} to 10^{-6}. The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the Hazard Index) for the toxicity resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of this quantitative estimate with the EPA standard Hazard Index of unity (1). The evaluation of the health hazard due to radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA 1989a) and the RESRAD Manual (ANL 1993). Table 2 shows the default parameter values suggested for used by SNL at SWMUs, based upon the selected land use scenario. References are given at the end of the table indicating the source for the chosen parameter values. The intention of SNL is to use default values that are consistent with regulatory guidance and consistent with the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are suggested for use for the various exposure pathways based upon the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

<u>Summary</u>

SNL proposes the described default exposure routes and parameter values for use in risk assessments at sites that have an industrial, recreational or residential future land-use scenario. There are no current residential land-use designations at SNL SWMUs, but this scenario has been requested to be considered by the NMED. For sites designated as industrial or recreational land-use, SNL will provide risk parameter values based upon a residential land-use scenario to indicate the effects of data uncertainty on risk value calculations or in order to potentially mitigate the need for institutional controls or restrictions on Sandia SWMUs. The parameter values are based upon EPA guidance and supplemented by information from other government sources. The values are generally consistent with those proposed by Los Alamos National Laboratory, with a few minor variations. If these exposure routes and parameters are acceptable, SNL will use them in risk assessments for all sites where the assumptions are consistent with site-specific conditions. All deviations will be documented.

Table 2
Default Parameter Values for Various Land Use Scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure frequency (d/y)	***	***	***
Exposure duration (y)	30[a,b]	30[a,b]	30[a,b]
Body weight (kg)	70[a,b]	56[a,b]	70 adult[a,b] 15 child
Averaging Time (days) for carcinogenic compounds (=70 y x 365 d/y) for noncarcinogenic compounds (=ED x 365 d/y)	 25550[a] 10950	 25550[a] 10950	 25550[a] 10950
Soil Ingestion Pathway			
Ingestion rate	100 mg/d[c]	6.24 g/y[d]	114 mg-y/kg-d[a]
Inhalation Pathway			
Inhalation rate (m^3/yr)	5000[a,b]	146[d]	5475[a,b,d]
Volatilization factor (m^3/kg)	chemical specific	chemical specific	chemical specific
Particulate emission factor (m^3/kg)	1.32E9f[f]	1.32E9[f]	1.32E9[f]
Water Ingestion Pathway			
Ingestion rate (L/d)	2[a,b]	2[a,b]	2[a,b]
Food Ingestion Pathway			
Ingestion rate (kg/yr)	NA	NA	138[b,d]
Fraction ingested	NA	NA	0.25[b,d]
Dermal Pathway			
Surface area in water (m^2)	2[b,e]	2[b,e]	2[b,e]
Surface area in soil (m^2)	0.53[b,e]	0.53[b,e]	0.53[b,e]
Permeability coefficient	chemical specific	chemical specific	chemical specific

*** The exposure frequencies for the land use scenarios are often integrated into the overall contact rate for specific exposure pathways. When not included, the exposure frequency for the industrial land use scenario is 8 h/d for 250 d/y; for the recreational land use, a value of 2 hr/wk for 52 wk/y is used (EPA 1989b); for a residential land use, all contact rates are given per day for 350 d/y.
[a]RAGS, Vol. 1, Part B (EPA 1991).
[b]Exposure Factors Handbook (EPA 1989b)
[c]EPA Region VI guidance.
[d]For radionuclides, RESRAD (ANL 1993) is used for human health risk calculations; default parameters are consistent with RESRAD guidance.
[e] Dermal Exposure Assessment (EPA 1992).
[f]EPA 1996.

References

Argonne National Laboratory (ANL), 1993, Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0, ANL/EAD/LD-2, Argonne National Laboratory, Argonne, IL.

U.S. Department of Energy (DOE), 1996 Environmental Assessment of the Environmental Restoration Project at Sandia National Laboratories/New Mexico, U.S. Department of Energy, Kirtland Area Office.

U.S. Environmental Protection Agency (EPA), 1996, personal communication from Maria Martinez (USEPA Region VI) to Elmer Klavetter (SNL/NM) discussing use of proposed Subpart S action levels.

U.S. Environmental Protection Agency (EPA), 1996b, Soil Screening Guidance: Technical Background Document, EPA/540/R95/128, May 1996.

U.S. Environmental Protection Agency (EPA), 1992, Dermal Exposure Assessment: Principles and Applications, EPA/600/8-91/011B, Office of Research and Development, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1991, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B), EPA/540/R-92/003, US Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989a, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, EPA/540-1089/002, US Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989b, Exposure Factors Handbook, EPA/600/8-89/043, US Environmental Protection Agency, Office of Health and Environmental Assessment, Washington, D.C.

October 13, 2003

ADDITIONAL /SUPPORTING DATA

CAN BE VIEWED AT THE
ENVIRONMENTAL, SAFETY, HEALTH
AND SECURITY (ES&H and Security)
RECORD CENTER

FOR ASSISTANCE CALL
844-4688