

Sandia National Laboratories/New Mexico

**PROPOSALS FOR NO FURTHER ACTION
ENVIRONMENTAL RESTORATION PROJECT**

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Environmental
Restoration
Project



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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.

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- 6-B Gamma Spectroscopy Results
- 6-C SWMU 108 Risk Screening Assessment Report

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.

4.0 SOLID WASTE MANAGEMENT UNIT 17, SCRAP YARDS

4.1 Summary

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a risk-based no further action (NFA) decision for Solid Waste Management Unit (SWMU) 17, Scrap Yards, Operable Unit (OU) 1335. SWMU 17 contains eight inactive scrap yards used to support testing activities at South Thunder Range. Review and analysis of all relevant data for SWMU 17 indicates that concentrations of the constituents of concern (COCs) at the site are less than applicable risk assessment action levels. Thus, SWMU 17 is proposed for an NFA decision based upon confirmatory soil sampling demonstrating that COCs that may have been released from the SWMU into the environment pose an acceptable level of risk under current and projected land use as set forth by Criterion 5, which states, "The SWMU/AOC has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use." (NMED March 1998).

4.2 Description and Operational History

4.2.1 Site Description

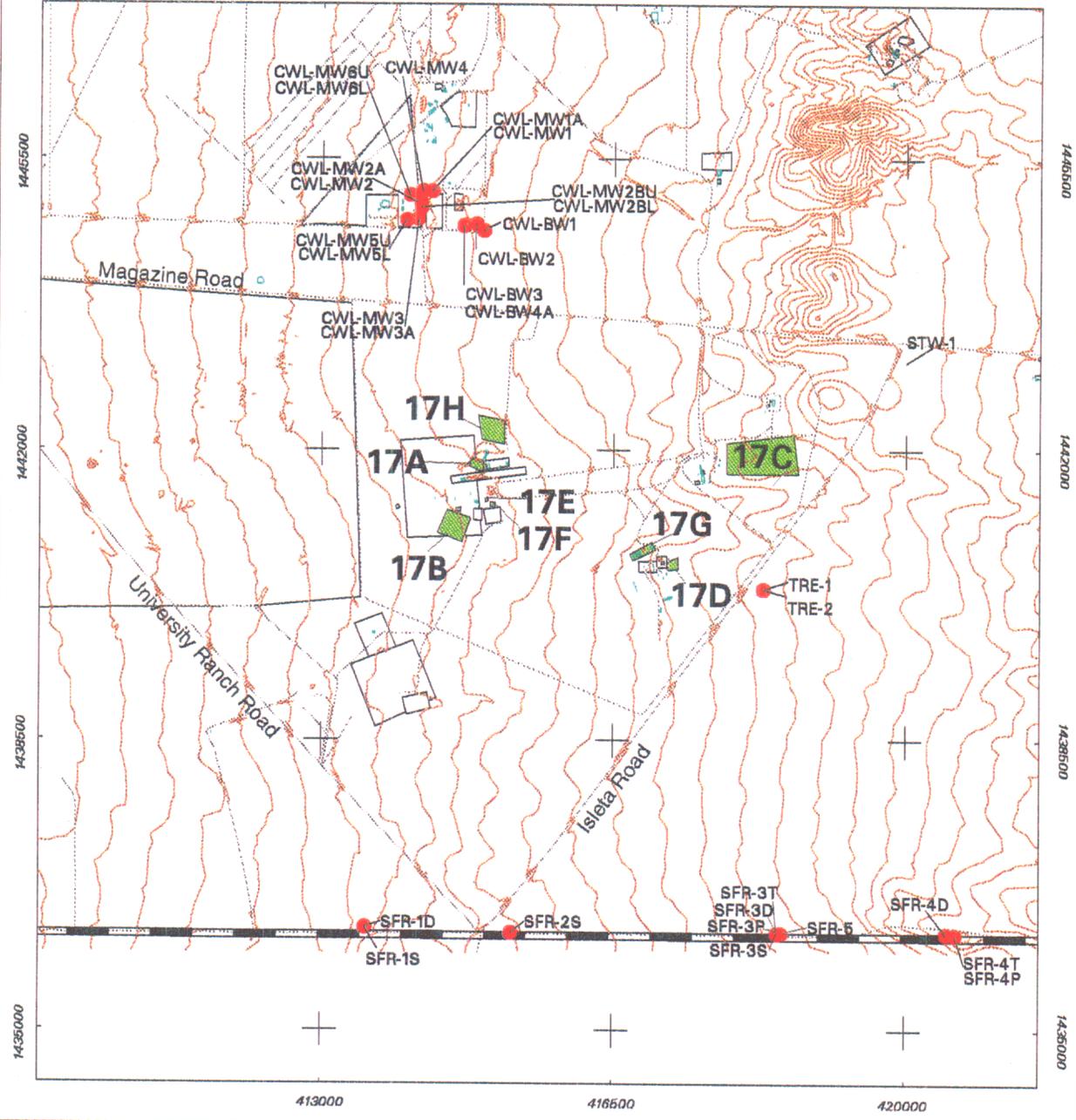
SWMU 17 is located near the southeastern corner of Kirtland Air Force Base (KAFB), within the tract bounded by Magazine Road, Isleta Road, and University Ranch Road in the South Thunder Range (Figure 4.2.1-1). Eight inactive scrap yards comprise SWMU 17: 17A, 17B, 17C, 17D, 17E, 17F, 17G, and 17H.

SWMU 17 lies on the western margin of the Sandia Fault Zone at a mean elevation of 5,415 feet above sea level. The site is underlain by alluvial fan and piedmont colluvium that overlies Santa Fe Group strata. The Santa Fe deposits beneath SWMU 17 are estimated to be approximately 3,000 feet thick. The 1994 Site-Wide Hydrogeologic Characterization Project (SWHCP) Annual Report (SNL/NM March 1995) presents detailed descriptions of the regional geology.

SWHCP soil surveys and surficial mapping provide general soil characteristics for the area around SWMU 17. The dominant soil groups in the area include the Tome very fine, sandy loam and the Tijeras gravelly, fine, sandy loam. The Tijeras gravelly, fine, sandy loam underlies the site. The estimated recharge rate for soils immediately north of SWMU 17 range between 0.002 and 0.071 centimeter (cm) per year (yr), which yields downward seepage velocities ranging between 0.03 and 11.8 cm/yr (SNL/NM October 1995).

No perennial surface-water bodies are present in the vicinity of SWMU 17. All of the SWMU 17 subsites lie within a small unnamed drainage system that crosses the South Thunder Range

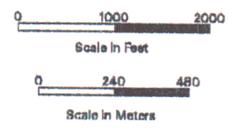
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Legend

- Well Location
- 10 Foot Contour
- Road
- ▬ KAFB Boundary
- SWMU 17
- Other SWMU Boundary
- ▭ Building

**Figure 4.2.1-1
 Location of SWMU 17,
 Scrap Yards**



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and flows westward toward the Rio Grande. This unnamed drainage system is an internal drainage basin with no direct flow to the Rio Grande.

SWMU 17 lies in the HR-2 geohydrologic region described in the 1994 SWHCP Annual Report (SNL/NM March 1995). This region is a transitional geohydrologic zone between the HR-1 zone to the west and the HR-3 zone to the east. It is comprised of a northeast/southwest-trending fault complex that includes segments of the Sandia, Tijeras, and Hubbell Springs faults. It has been determined that 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. The nearest groundwater monitoring wells, TRE-1 and TRE-2, are located approximately 0.5 mile southeast of the site.

Based upon these wells, depth to groundwater is approximately 167 feet below ground surface (bgs) (SNL/NM March 1997). Local groundwater flow is to the west/northwest (SNL/NM March 1997). The nearest production well, KAFB-4, is located approximately 5.5 miles to the northwest of the site.

For a detailed discussion regarding the local setting at SWMU 17, refer to the "RCRA [Resource Conservation and Recovery Act] Facility Investigation Work Plan for OU [Operable Unit] 1335, Southwest Test Area" (SNL/NM March 1996).

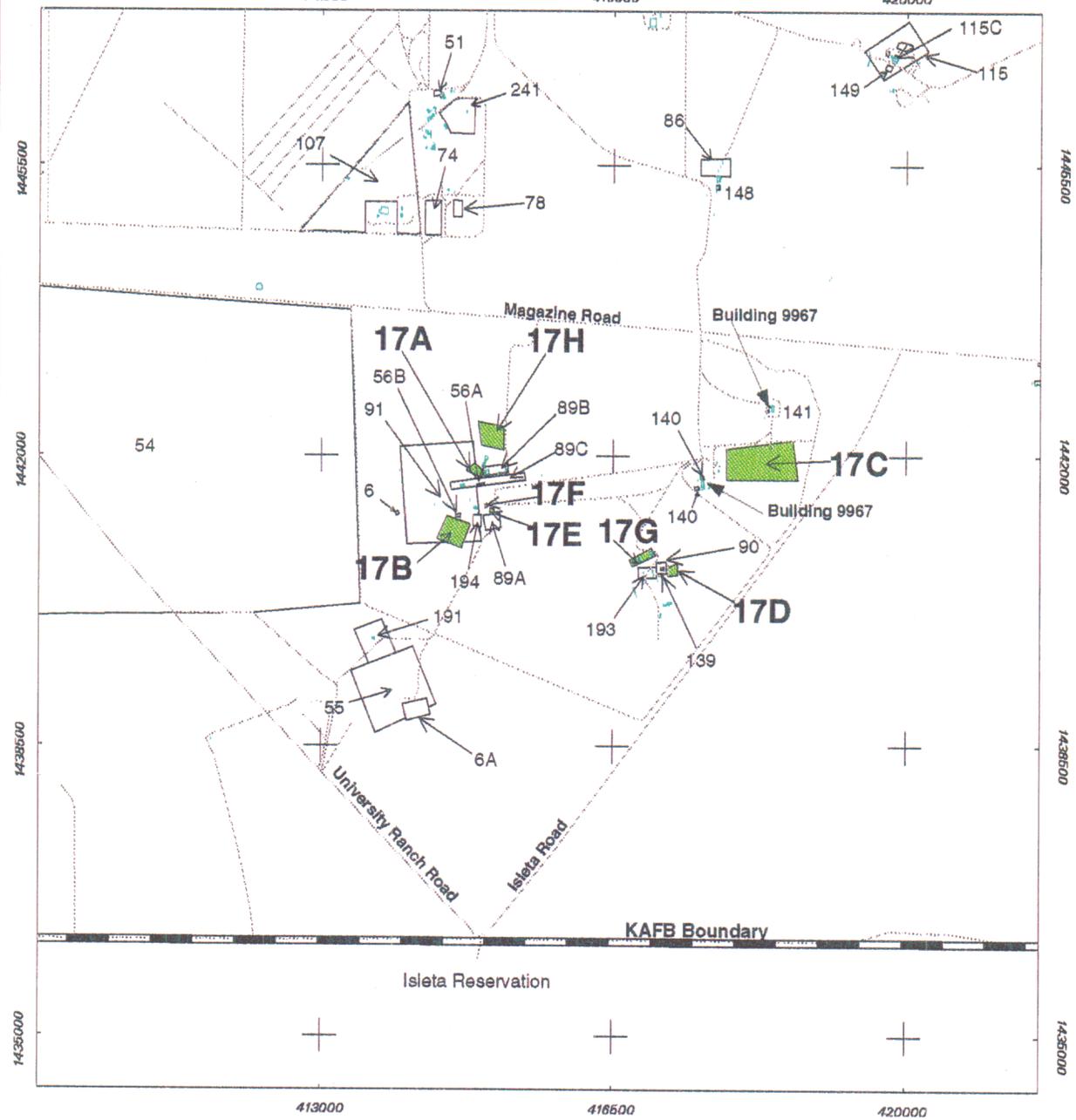
4.2.2 Operational History

The eight scrap yards that comprise SWMU 17 date back to the early 1960s with the development of the shock tubes in the South Thunder Range (Wrightson March 1994). Much of the scrap material is associated with the operations and/or dismantlement of the former shock tubes at SWMU 89. However, based upon confirmatory sampling at SWMU 89, no potential COCs are associated with shock tube structures or components (SNL/NM August 1997). After being active for a period of 20 to 25 years, most of the scrap yards were cleaned up in 1989 and 1990 for a U.S. Department of Energy (DOE) "Tiger Team" audit (Wrightson March 1994, April 1996a). During this cleanup, one former site employee stated that either SNL/NM Industrial Hygiene (IH) personnel or SNL/NM Health Physics (HP) personnel authorized the removal of every load of scrap from the site. After being approved for removal, all scrap was disposed of in an off-site commercial landfill (Wrightson April 1996a). Figure 4.2.2-1 presents the locations of the eight scrap yards.

4.2.2.1 SWMU 17A

SWMU 17A was a scrap yard that covered an area of approximately 0.5 acre. The site contained debris such as sawdust, dirt, wood, and some concrete (Wrightson April 1996b) from the catch pit at the west end of the Large Shock Tube (SWMU 89C) and from tests conducted at the Lead Firing Site (SWMU 91). No photograph is available that shows the scrap and debris formerly stored at the site. In 1989, a contractor moved the debris in the SWMU 17A scrap yard off site to the KAFB landfill. IH and HP personnel reportedly inspected the debris for hazardous materials and radiological materials, respectively, before it was released for off-site disposal. All scrap was sent to the KAFB landfill (Wrightson April 1996a). Currently no scrap or debris remains at the site. The site may contain potential COCs that include depleted uranium (DU)

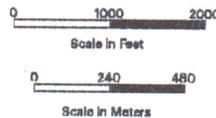
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Legend

-  Road
-  KAFB Boundary
-  SWMU 17
-  Other SWMU Boundary

Figure 4.2.2-1
Site Map of SWMU 17,
Scrap Yards



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and metals associated with the scrap metal stored at the site and debris from the Lead Firing Site (SWMU 91).

4.2.2.2 SWMU 17B

SWMU 17B covers an area of approximately 2 acres and lies predominantly within the boundaries of SWMU 91, Lead Firing Site (Figure 4.2.2-1). SWMU 17B was used as a DU dispersion test site as well as a small scrap yard. The dispersion tests conducted at the site were precursors and similar in nature to the Equus Red test (SWMU 191). The tests consisted of suspending a DU shell with an explosive core between two telephone poles and detonating the shell. The resultant dispersion cloud was monitored by instruments attached to an airplane. The number and size of the charges used in the tests is not known; however, because of the similar nature of these tests to the Equus Red test, it is assumed that similar quantities of explosives and DU were used (Wrightson April 1996b). The Equus Red test used about 104 pounds of plastic-bonded explosive and 9.5 kilograms (kg) of DU. It is unlikely that residual high explosives (HE) remain after the dispersion tests because the tests were high-order, meaning that all of the explosive was consumed in the explosion. The U.S. Environmental Protection Agency (EPA) and the U.S. Department of Defense (DoD) at the Dugway Proving Grounds (DoD January 1992) demonstrated that high-order explosives (under 2,000 pounds) yield combustion by-products and HE well below acceptable risk levels for residential land-use scenarios (worst case). Analytical results from surface soil samples collected at SNL/NM SWMUs 89 and 191, where similar tests were conducted, showed no presence of HE (SNL/NM August 1997, SNL/NM January 1997). Residual DU associated with the dispersion tests is a potential COC at the site.

Scrap material in the SWMU 17B scrap yard consisted of empty *sona* tubes (cardboard tubes used to hold HE and inert gases), cardboard boxes, plywood tables, pallets, dirt, and concrete debris (Figure 4.2.2-2). The scrap reportedly came from the Lead Firing Site (SWMU 91) and the Shock Tube Area (SWMU 89). In 1989, a contractor moved approximately 20 to 40 truckloads of dirt and concrete debris from the SWMU 17B scrap yard off site to the KAFB landfill (Wrightson April 1996a). IH and HP personnel inspected the debris for hazardous materials and radiological materials, respectively, before it was released for off-site disposal. Metals associated with scrap metal stored at the sites and specifically lead, which may have originated from the Lead Firing Site (SWMU 91), may be potential COCs at SWMU 17B.

4.2.2.3 SWMU 17C

SWMU 17C is a storage yard that covers an area of approximately 8 acres and is located 0.5 mile east of the Shock Tube Area (SWMU 89), east of Building 9965 and south of Building 9967 (refer to Figure 4.2.2-1). The majority of the material stored at the site came from outside sources and included nonradioactive scrap metal from the Clinch River Breeder Reactor in Oak Ridge, Tennessee, steel deck plating from a mothballed battleship, and a number of airplane wing tanks (Figure 4.2.2-3) (Wrightson April 1996b). Other scrap materials present at the site included metal, cardboard boxes, plywood tables, wood pallets, dirt, and concrete blocks and debris (Figures 4.2.2-3 and 4.2.2-4). Two 55-gallon drums labeled *contaminated liquids* were stored on a wood pallet at the site (Figure 4.2.2-4). The drums have been removed from the site. Nothing is known of the contents of the two drums or of their disposition. Thirty

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Figure 4.2.2-2. SWMU 17B Scrap Yard.



Figure 4.2.2-3. SWMU 17C Scrap Yard.

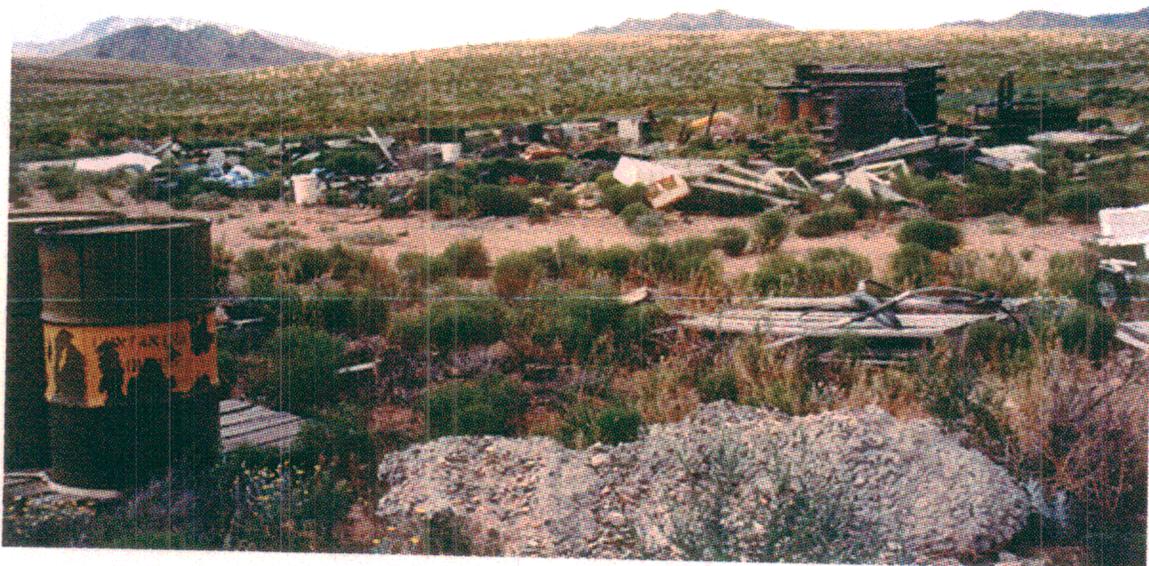


Figure 4.2.2-4. SWMU 17C Scrap Yard Showing Drums Labeled "Contaminated Liquids."

gallons of motor oil were stored at the site, but the precise location where it was stored is not known. Nothing is known of the disposition of the motor oil. No release is known to have occurred (Wrightson April 1996b). Fluorescent tubes were stored at the site before being disposed of in the KAFB landfill ([Author Unknown] April 1993). The precise location of the storage of the tubes at the site is not known.

The majority of the material stored at the site was removed in 1989 and sent off site for disposal in the KAFB landfill (Wrightson April 1996a). IH and HP personnel inspected the material for hazardous materials and radioactive materials, respectively, before it was released for off-site disposal. Material remaining at the site includes some large pieces of scrap metal, a number of wood pallets, steel pipe, three open-ended corrugated metal cylinders, scrap shock tube components, a cable spool with one-inch steel cable, battleship anchor chains, two large concrete blocks (one open-sided), and a very large metal beam. SWMU 17C potential COCs may include metals associated with the scrap metal stored at the site, mercury associated with the fluorescent bulbs, and volatile organic compounds (VOC) from potential releases from the two drums labeled *contaminated liquids* and the 30-gallons of motor oil.

4.2.2.4 SWMU 17D

SWMU 17D was a small scrap yard (approximately 1/3 acre) located just east of the Beryllium Firing Site (SWMU 90) and the Sabotage Test Area (SWMU 193) (refer to Figure 4.2.2-1). The site contained debris from explosives penetration studies that were conducted at the Sabotage Test Area. The penetration studies were conducted to determine how effective different types of attacks might be on storage structures similar to those used to store nuclear weapons (Wrightson April 1996b). Scrap metal, wooden structures, ductwork, and concrete debris were stored at the site (Figure 4.2.2-5). In 1989, all debris and scrap were sent off site for disposal in the KAFB landfill after being screened by IH and HP personnel (Martz June 1985, Wrightson April 1996b). Currently nothing remains at the site. SWMU 17D potential COCs may include DU associated with debris from the penetration studies and metals associated with the scrap metal stored at the site.

4.2.2.5 SWMUs 17E and 17F

SWMUs 17E and 17F (two small scrap yards that occupy 2,500 square feet and 960 square feet, respectively) are located approximately 300 feet south of the Large Shock Tube (SWMU 89C) and approximately 100 feet east of the General Purpose Heat Source Test Area (SWMU 194) (refer to Figure 4.2.2-1). The scrap stored at the two sites reportedly came from the Shock Tube Area (SWMU 89) (Wrightson March 1994, April 1996b). Scrap at the sites included metal, cardboard boxes, wood pallets, wood structures, plywood, metal pipe, and concrete blocks and debris (Figures 4.2.2-6 and 4.2.2-7). Some wood scrap and concrete debris remain at this site. SWMU 17E and 17F potential COCs may include metals.

4.2.2.6 SWMU 17G

SWMU 17G covers an area of approximately 2/3 acre and is located northwest of the Beryllium Firing Site (SWMU 90). It is the remnants of a 2-foot-diameter by 200-foot-long shock tube (Wrightson April 1996b). Scrap remaining at the site includes metal, disassembled sections of the 2-foot-diameter shock tube (one remnant section is approximately 50 feet long), and concrete debris (Figure 4.2.2-8). SWMU 17G potential COCs may include metals.

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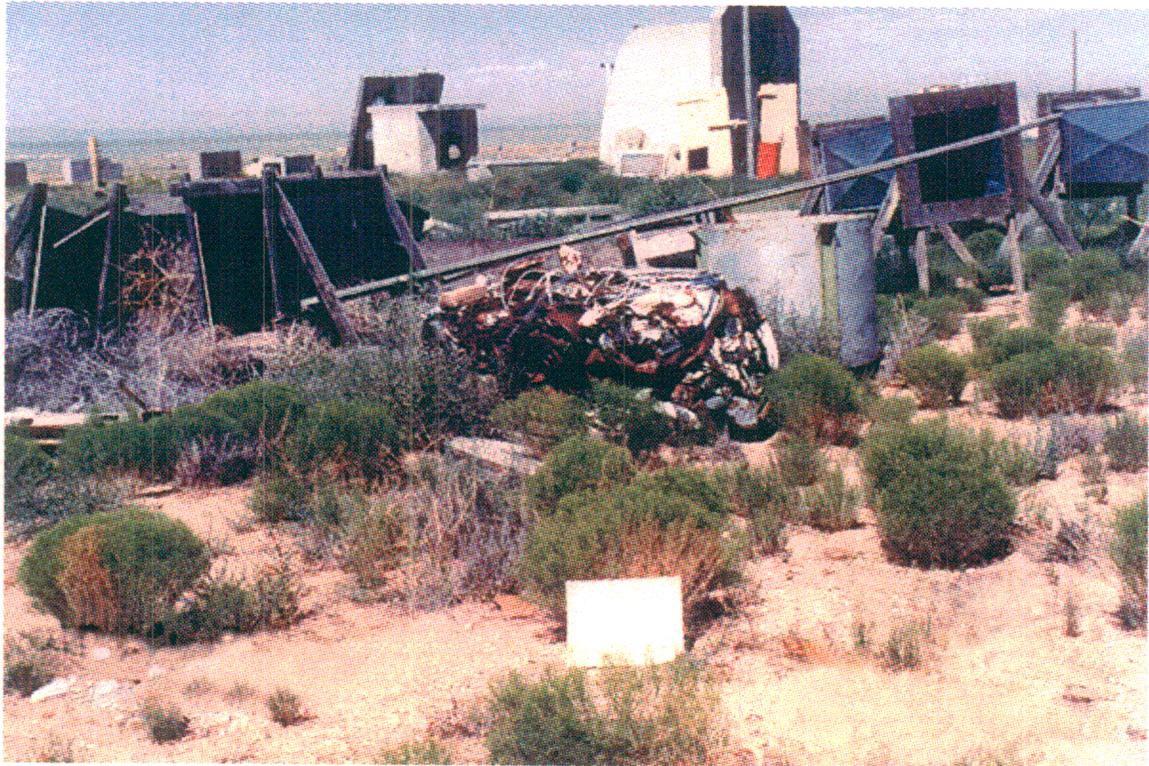


Figure 4.2.2-5. SWMU 17D Scrap Yard.



Figure 4.2.2-6. SWMU 17E Scrap Yard.



Figure 4.2.2-7. SWMU 17F Scrap Yard.



Figure 4.2.2-8. SWMU 17G Scrap Yard Showing Shock Tube Components.

4.2.2.7 SWMU 17H

SWMU 17H, a scrap yard located north of the Large Shock Tube (SWMU 89C) and Building 9965, covers an area of approximately 2 acres. According to sources, the scrap at the site came from Shock Tube tests (SWMU 89) and possibly from Lead Firing Site tests (SWMU 91) (Wrightson April 1996b, March 1994). No photograph is available showing the scrap previously stored at the site. Some documentation suggested that hazardous materials may have been stored at the site. Currently no scrap or debris remains at the site. SWMU 17H potential COCs may include metals associated with the scrap metal stored at the site, mercury associated with the fluorescent bulbs, and VOCs.

The potential COCs listed above for each SWMU 17 subunit were identified based upon historical and process knowledge, the types of tests that were performed at each of the subunits, if any, and the scrap and/or debris that was either known or reported to have been stored at each of the subunits. Because the majority of the scrap stored was metal, the potential COC list included the Resource Conservation and Recovery Act (RCRA) metals, beryllium, and nickel. Because the potential exists for radionuclides other than DU to have been released, gamma spectroscopy analysis was performed to identify additional radionuclides.

4.3 Land Use

4.3.1 Current

SWMU 17 consists of eight inactive scrap yards located on land owned by the U.S. Air Force and permitted to the DOE and SNL/NM (Figure 4.3.1-1). The site has no containment or treatment facilities. Background information indicates that no hazardous materials were knowingly stored at any of the sites. Access to the site is limited through a locked gate at the entrance to South Thunder Range.

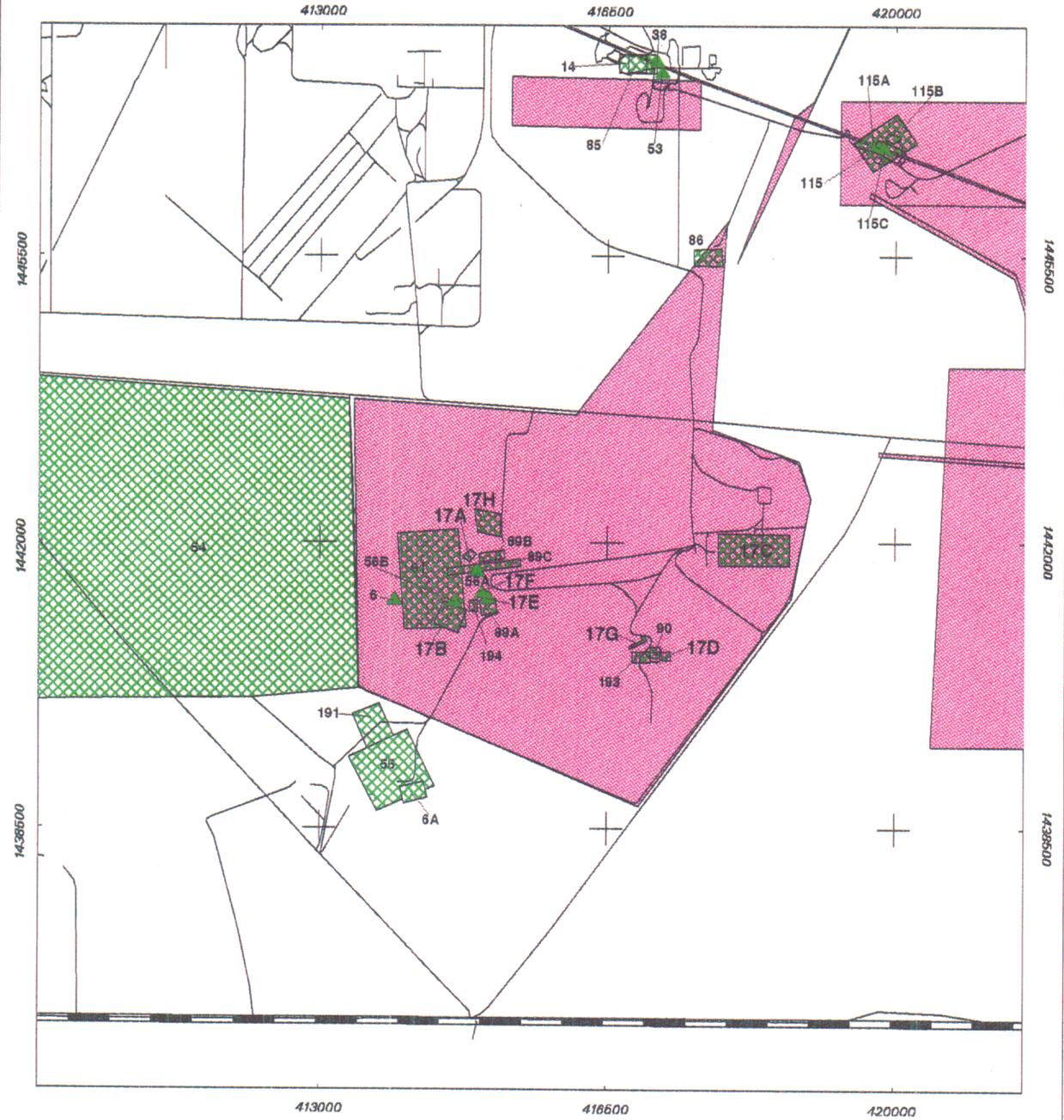
4.3.2 Future/Proposed

4.4 Investigatory Activities

4.4.1 Summary

SWMU 17 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 1993, preliminary investigations were

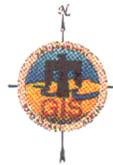
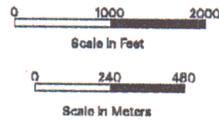
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Legend

-  KAFB Boundary
-  SWMU less than one acre
-  USAF Permitted to DOE/SNL
-  OU1335 SWMU Sites
-  USAF Various Structures Within this Area Permitted to DOE/SNL/TSD/CTA Support Agreement Between USAF and DOE for Various Facilities
-  Roads

**Figure 4.3.1-1
Current Land Use
for SWMU 17**



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conducted that included unexploded ordnance (UXO)/HE and radiological surveys, a voluntary corrective measure (VCM), post-VCM sampling, and confirmatory sampling (Investigation #2).

4.4.2 Investigation #1: DOE Comprehensive Environmental Assessment and Response Program

4.4.2.1 *Nonsampling Data Collection*

The DOE CEARP Phase I report (DOE September 1987) and the RCRA Facility Assessment report (EPA April 1987) first identified SWMU 17 as a potential release site and listed the site as "four scrap yards/open dumps in the Thunder Range Area for storing excess equipment and disposing of waste material." The CEARP report described a scrap yard "located east of Building 9967" that contained several old 55-gallon drums labeled *contaminated liquids*, large insulated metallic pipes and vessels, various electrical transmission components, fluorescent light bulbs, surplus materials and equipment, and general scrap materials. The CEARP report noted that a scrap yard located "west of Pickax and north of the shock tubes" contained excess equipment, demolished vehicles, and fluorescent light bulbs scattered around on the ground and that a scrap yard "south of the shock tubes" contained scrap equipment, large pieces of shrapnel (possibly including lead, beryllium, and DU), and general trash. In addition the CEARP report identified "some old equipment and several old storage tanks (covered with asbestos insulation) stored on the south part of Thunder Range. In addition, there are two pits . . . one with concrete and a pipe structure, the other with a corrugated metal liner. Use of these pits is unknown."

4.4.2.2 *Sampling Data Collection*

No samples were collected during the CEARP.

4.4.2.3 *Data Gaps*

No data were available to confirm whether hazardous materials or wastes were stored or released to the surrounding environment.

4.4.2.4 *Results and Conclusions*

The Comprehensive Environmental Response, Compensation, and Liability Act findings were positive for Federal Facility Site Discovery and Identification Findings, Preliminary Assessment, and Preliminary Site Inspection. The EPA Hazard Ranking migration mode score was 5.8. The site was recommended for further investigation.

4.4.3 Investigation #2: SNL/NM Environmental Restoration Preliminary Investigations

4.4.3.1 *Nonsampling Data Collection*

4.4.3.1.1 *Background Review*

A background review was conducted to collect available and relevant information. Background information sources included interviews with SNL/NM staff and contractors familiar with site operational history and existing historical site records and reports. The study was completely documented and has provided traceable references that sustain the integrity of this proposal. The following lists these information sources that were used to assist in the evaluation of SWMU 17:

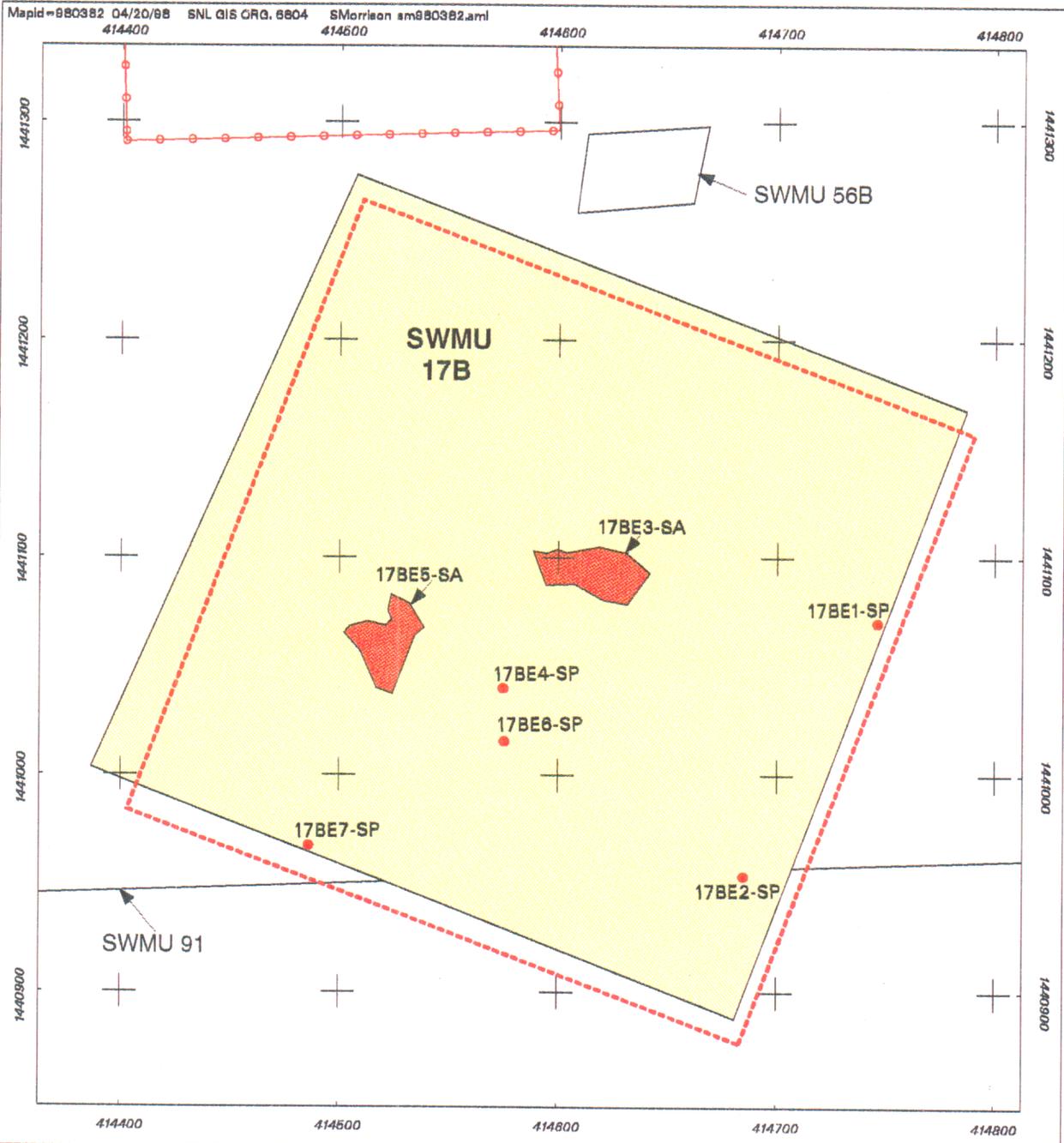
- Photographs and field notes from site inspections conducted by SNL/NM Environmental Restoration (ER) Project staff (Gaither January 1992, Gaither April 1993, Martz June 1985, Bohannon November 1985, [Author Unknown] April 1993, Gaither April 1993, Wrightson March 1994)
- Four interviews with two facility personnel (current and retired) (Martz November 1985, Martz September 1985, Wrightson April 1996a, Wrightson April 1996b).

4.4.3.1.2 *UXO/HE Survey*

In November 1993, KAFB Explosive Ordnance Disposal personnel conducted a visual surface survey for UXO/HE on the ground surface of SWMU 17. No UXO/HE or ordnance debris was identified at or in the vicinity of any of the eight scrap yards that comprise SWMU 17 (SNL/NM September 1994).

4.4.3.1.3 *Radiological Survey(s)*

In January 1994, RUST Geotech specifically conducted surface radiological surveys at SWMUs 17A, 17B, and 17D because of historical operations that indicated DU as a potential COC (RUST Geotech Inc. December 1994). The surveys covered a total of 2.8 acres of flat alluvial terrain. A gamma scan survey was performed on 10-foot centers (over 70-percent coverage) over the surface of the three sites. No areas of gamma activity greater than 30 percent above natural background levels were detected at SWMUs 17A or 17D. Five point source and two area source anomalies of gamma activity 30 percent or greater than natural background levels were identified at SWMU 17B. Natural background gamma exposure rates ranged from 10 to 13 microrentgens (μR) /hour (hr). Figure 4.4.3-1 shows SWMU 17B, the radiological survey boundaries, and the anomalies identified during the Phase 1 survey. The five soil point source anomalies ranged from 16 to 39 $\mu\text{R/hr}$ and two soil area source anomalies ranged in activity from 13 to 31 $\mu\text{R/hr}$. The point source anomalies had an average diameter of 2 feet based upon instrument response. The two soil area source anomalies each contained multiple hot spots.



Legend

- Point Source Gamma Radiation Anomaly (Elevated relative to site specific background, SP = Soil Point)
- Fence
- SWMU Boundary
- Red Survey Boundary
- SWMU 17B Scrap Yard
- Area Source Gamma Radiation Anomaly (Elevated relative to site specific background, SA = Soil Area)

Figure 4.4.3-1
Phase I Survey Radiation Anomalies at SWMU 17B

0 37.5 75

Scale in Feet

0 9 18

Scale in Meters

1:900
 1 in = 75'



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4.4.3.1.4 *Cultural-Resources Survey*

A cultural-resources survey of SWMU 17 was conducted in 1994 in support of the Environmental Assessment of the ER Project at SNL/NM (DOE March 1996). No cultural resources were identified at or in the vicinity of any of the eight scrap yards that comprise SWMU 17 (Hoagland and Dello-Russo February 1995).

4.4.3.1.5 *Sensitive-Species Survey*

A sensitive-species survey was conducted at SWMU 17 during the spring and summer of 1992 and 1993 (Sullivan and Knight May 1994). Tracts of SWMU 17 in the eastern half of the South Thunder Range that are placed in the Sensitivity Zone 3 habitat indicate that no sensitive species were found in this area, although suitable habitat exists. Western tracts of SWMU 17 that are within the Sensitivity Zone 2 habitat indicate that scattered gamma grass cacti occur in the area. Nevertheless the past disturbance of these sites make the occurrence of this species within the boundaries of SWMU 17 highly unlikely (IT February 1995).

4.4.3.2 *Sampling Data Collection*

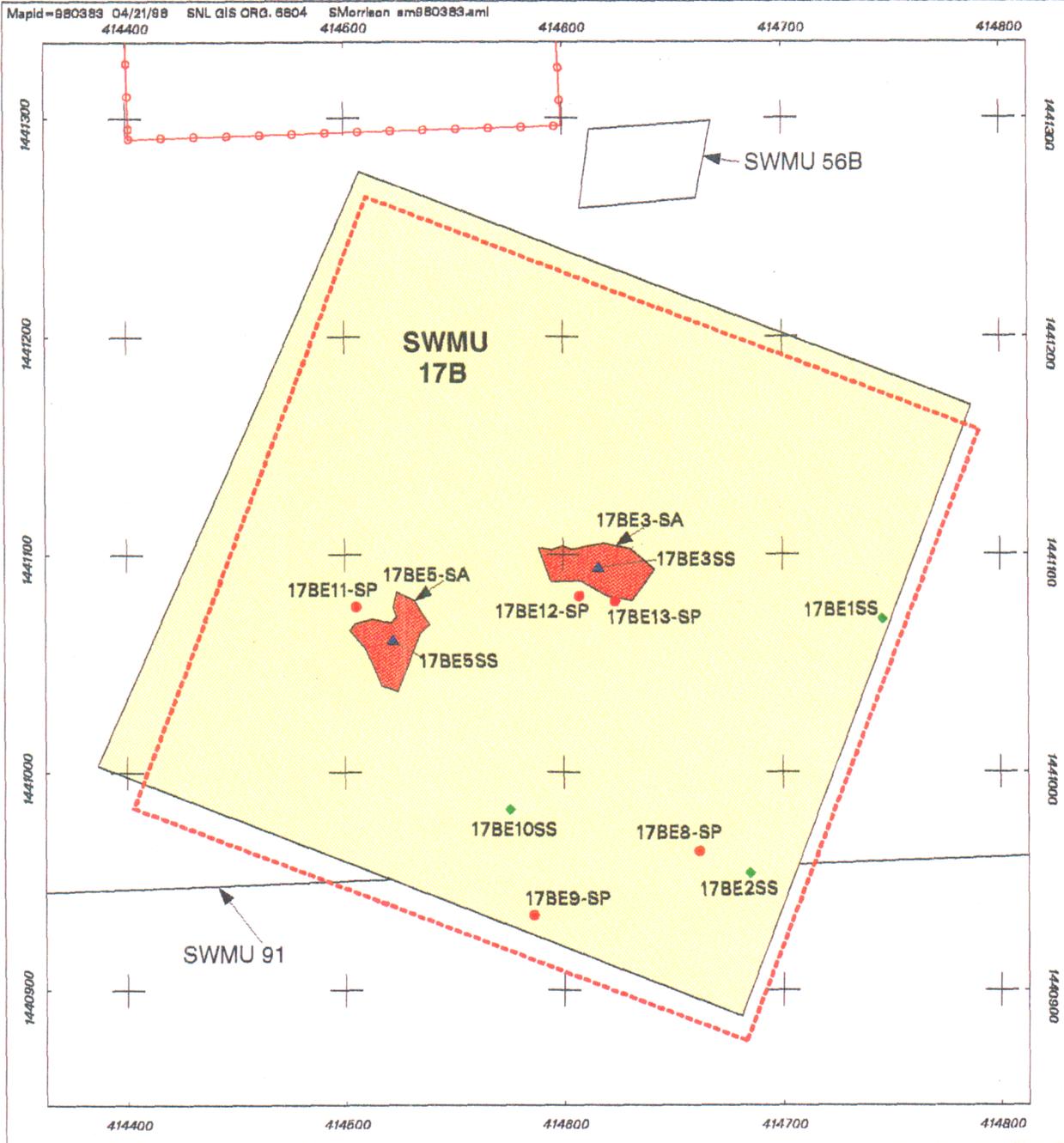
4.4.3.2.1 *Voluntary Corrective Measure Activities*

VCM activities were conducted at SWMU 17B during February and August 1995. The five point source anomalies were removed in February 1995. Prior to remediation of the two area source anomalies, SWMUs 17A, 17B, and 17D were resurveyed on 6-foot centers (over 100-percent coverage). No elevated gamma activity above natural background levels were identified at SWMUs 17A or 17D. Six new point source anomalies were identified at SWMU 17B during the resurveying (Figure 4.4.3-2). The two area sources identified at SWMU 17B during the initial survey and the six new point source anomalies identified at SWMU 17B during the resurveying activities were remediated in August 1995 (SNL/NM September 1997). Twenty-three drums of radiologically contaminated soils and one drum of radiological fragments were removed from the site.

Postcleanup (Verification) Sample Results

After the removal of the point sources and area sources from SWMU 17B during VCM activities, six postcleanup (verification) surface soil samples, including one duplicate, were collected from point and area source locations. Four samples were collected from point source locations (17BE1SS, 17BE1SD, 17BE2SS, and 17BE10SS) and two samples were collected from soil source areas (17BE3SS and 17BE5SS). Samples of soils from the highest activity point sources were collected from the immediate location where the fragment was identified. For soil source areas, soil samples were collected from locations exhibiting the highest residual gamma radiation readings for each source area. Figure 4.4.3-2 shows the six soil sample locations. Gamma spectroscopy analysis was performed on the soil samples to verify that the residual radionuclide activities met risk-based action levels. The radiological COC at SWMU 17B

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Legend

<ul style="list-style-type: none"> ● Point Source Gamma Radiation Anomaly (Elevated relative to site specific background, SP = Soil Point) ▲ Post-cleanup (Verification) Soil Sample Location (SS = Soil Sample) ◆ Point Source Gamma Radiation Anomaly & Post-cleanup (Verification) Soil Sample Location (SS = Soil Sample) ○—○ Fence SWMU Boundary Rad Survey Boundary 	<ul style="list-style-type: none"> SWMU 17B Scrap Yard Area Source Gamma Radiation Anomaly (Elevated relative to site specific background, SA = Soil Area)
---	---

Figure 4.4.3-2
VCM Radiation Anomalies and Post-Cleanup (Verification) Surface Soil Sample Locations at SWMU 17B

0 37.5 75
 Scale in Feet

0 9 18
 Scale in Meters

1:900
 1 in = 75'

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was DU from the dispersion tests conducted at the site. Table 4.4.3-1 shows the maximum residual radionuclide levels for SWMU 17B soils.

Table 4.4.3-1
Maximum Residual Radionuclide Levels for SWMU 17B Soils^a

Radionuclide	Maximum Activity (pCi/g)	Background Activity (pCi/g) ^b
Uranium-238	19.1	1.4
Uranium-235	0.26 ^c	0.16
Uranium-234	2.4 ^c	1.6

^aSNL/NM September 1997.

^bDinwiddie September 24, 1997.

^cMaximum activity calculated for Uranium-235 = Uranium-238/73; maximum activity calculated for Uranium-234 = Uranium-238/8 (Brown January 1998).

pCi/g = Picocurie(s) per gram.

SWMU= Solid waste management unit.

4.4.3.2.2 Confirmatory Sampling

SNL/NM conducted confirmatory soil sampling in August 1995 to determine whether potential COCs were present at levels exceeding background levels at the site. The confirmatory soil sampling program was performed in accordance with the rationale and procedures described in the "Sampling and Analysis Plan for SWMU 17" (SNL/NM July 1995).

Surface soil samples were collected from SWMU 17 at 85 locations. SNL/NM chain-of-custody and sample documentation procedures were followed for all samples collected. Of the 85 samples collected, 100 percent were analyzed on site for gamma-emitting radionuclides and metals. In addition, 50 samples from SWMUs 17C and 17H were analyzed on site for VOCs. SNL/NM Department 7713, Radiation Protection Sample Diagnostics Laboratory (RPSD), analyzed the samples on site for radionuclides using gamma spectroscopy; and SNL/NM Department 6133, ER Chemistry Laboratory, analyzed the samples on site for Target Analyte List (TAL) metals (using EPA Method 6010/7000 modified) and for VOCs (using EPA Method 8240). Twenty percent of the samples collected were analyzed by an off-site laboratory for TAL metals and VOCs. Lockheed Analytical Services (LAS) of Las Vegas, Nevada, analyzed the samples for metals (using EPA Method 6010/7000) and for VOCs (using EPA Methods 8240/8260). This NFA proposal discusses the eight RCRA metals plus nickel.

Selection of the chemical and radiological analyses performed on individual confirmatory samples was based upon historical and process knowledge; the types of tests that were performed at each of the sites, if any; and the scrap and/or debris that was either known or reported to have been stored at each of the sites. TAL metals analysis was selected because the majority of the material stored at the eight scrap yards was metal. Analysis for VOCs was performed on samples collected from SWMUs 17C and 17H because documentation suggested that hazardous materials may have been stored there. Gamma spectroscopy was performed on all soil samples collected from the eight sites.

No HE analyses were performed on any of the samples. SNL/NM operating procedures involving the handling of HE suggest that the release of any HE to the environment is unlikely and that any residual HE remaining after the shock tube tests is unlikely because the tests were high order. The EPA and the DoD at the Dugway Proving Grounds demonstrated that in the worst case, high-order explosives (under 2,000 pounds) yield combustion by-products and HE well below acceptable risk levels for residential land-use scenarios (DoD January 1992). Additionally, analytical results from surface soil samples collected at SNL/NM ER sites where the scrap originated and where similar tests were conducted showed no presence of HE (SNL/NM August 1997, SNL/NM January 1997).

Because most of the scrap at each of the eight sites had been removed several years before confirmatory surface soil sampling was performed, locations for confirmatory sampling were selected based upon the following factors:

- Topographic features. Samples were collected in low-lying areas such as surface drainages, depressions where surface runoff may have concentrated contaminated soils, areas devoid of vegetation, and disturbed soils where materials may have been stored.
- Interviews with personnel familiar with each of the sites combined with photographic evidence. At those sites where all scrap had been removed and disposed of off site, samples were collected from approximate locations where the scrap was stored.

4.4.3.3 *Data Gaps*

Information gathered through process knowledge, review of historical site files, and personal interviews aided in identifying the most likely COCs at SWMU 17 and in the selection of the types of analyses performed on soil samples. Although the history of past releases at the site is incomplete, analytical data from VCM verification sampling, confirmatory sampling, and radiological screening are sufficient to determine whether significant releases of COCs occurred at the site.

4.4.3.4 *Results and Conclusions*

In August 1995, representative surface soil samples were collected from 85 locations at the eight scrap yards that comprise SWMU 17. Tables 4.4.3-2, 4.4.3-3, and 4.4.3-4 summarize the metals, gamma spectroscopy, and VOC analytical results, respectively, for all of the confirmatory surface soil samples. An example soil sample identification (ID) contained in the ER Sample ID is 17A-GR-001-0-SS-02. This ID refers to SWMU Subunit 17A, grab sample type GR, sample location 001, sample depth beginning at 0 feet (surface), soil sample media SS, fraction 02. Complete results of gamma spectroscopy and volatile organic analyses are contained in Annexes 4-A and 4-B, respectively. This section briefly describes those results.

The minimum detection limits (MDL) for all on-site analyses of metals exceeded the background concentration limits for arsenic, cadmium, selenium, and silver. The off-site laboratory provided a lower MDL for metals analyses of split samples; however, the MDL for cadmium, selenium,

Table 4.4.3-2
Summary of SWMU 17 Confirmatory Surface Soil Samples Metals Analytical Results, August 1995

ER Site	Record Number ^b	Sample Attributes		Metals (EPA Method 6010/7000) ^a (mg/kg)													
		ER Sample ID (Figure 4.4.3-3)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Nickel	Selenium	Silver				
17A	509499	17A-GR-001-0-SS-02	0-0.5	ND (50) ^c	89	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (10)	ND (4.0)	ND (50)	ND (10)
	509499	17A-GR-002-0-SS-02	0-0.5	ND (50)	110	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (10)	ND (4.0)	ND (50)	ND (10)
	509499	17A-GR-003-0-SS-02	0-0.5	ND (50)	79	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (10)	ND (4.0)	ND (50)	ND (10)
	509499	17A-GR-004-0-SS-02	0-0.5	ND (50)	130	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (10)	ND (4.0)	ND (50)	ND (10)
	509499	17A-GR-005-0-SS-02	0-0.5	ND (50)	98	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (10)	ND (4.0)	ND (50)	ND (10)
	04212	17A-GR-005-0-SS-02 ^A	0-0.5	2.9	110	ND (1.1)	ND (1.1)	ND (1.1)	ND (0.11) N [*]	11	ND (1.1)	ND (1.1)	ND (1.1)	ND (0.11) N [*]	11	ND (1.1)	ND (2.2)
	509499	17A-GR-006-0-SS-02	0-0.5	ND (50)	140	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (10)	ND (4.0)	ND (50)	ND (10)
	509499	17A-GR-007-0-SS-02	0-0.5	ND (50)	150	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (10)	ND (4.0)	ND (50)	ND (10)
	509499	17A-GR-008-0-SS-02	0-0.5	ND (50)	170	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (10)	ND (4.0)	ND (50)	ND (10)
	509499	17A-GR-009-0-SS-02	0-0.5	ND (50)	140	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (10)	ND (4.0)	ND (50)	ND (10)
	509499	17A-GR-010-0-SS-02	0-0.5	ND (50)	140	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (10)	ND (4.0)	ND (50)	ND (10)
	509499	17A-GR-010-0-SSD-03	0-0.5	ND (50)	110	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (10)	ND (4.0)	ND (50)	ND (10)
	04212	17A-GR-010-0-SS-02 ^A	0-0.5	5.0	180	ND (1.1)	ND (1.1)	ND (1.1)	ND (0.11) N [*]	16	ND (1.1)	ND (1.1)	ND (1.1)	ND (0.11) N [*]	16	ND (1.1)	ND (2.2)
	17B	509500	17B-GR-001-0-SS-02	0-0.5	ND (50)	100	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
509500		17B-GR-002-0-SS-02	0-0.5	ND (50)	120	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (10)
509500		17B-GR-003-0-SS-02	0-0.5	ND (50)	130	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (10)
509500		17B-GR-004-0-SS-02	0-0.5	ND (50)	220	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (10)
509500		17B-GR-005-0-SS-02	0-0.5	ND (50)	130	ND (0.11)	ND (10)	ND (10)	0.07 J (0.24)	ND (4.0)	ND (50)	ND (10)	ND (0.24)	ND (4.0)	ND (50)	ND (10)	ND (10)
04212		17B-GR-005-0-SS-02 ^A	0-0.5	3.3	160	ND (1.1)	ND (1.1)	ND (1.1)	ND (0.11) N [*]	14	ND (1.1)	ND (1.1)	ND (1.1)	ND (0.11) N [*]	14	ND (1.1)	ND (2.2)
17C	01582	17C-GR-001-0-SS-02	0-0.5	ND (50)	63	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (10)
	01582	17C-GR-002-0-SS-02	0-0.5	ND (50)	55	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (10)
	01582	17C-GR-003-0-SS-02	0-0.5	ND (50)	65	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (10)
	01582	17C-GR-004-0-SS-02	0-0.5	ND (50)	48	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (10)
	01582	17C-GR-005-0-SS-02	0-0.5	ND (50)	83	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (10)
	01582	17C-GR-005-0-SSD-03	0-0.5	ND (50)	78	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (10)
	04268	17C-GR-005-0-SSO ^A	0-0.5	3.8	99	ND (1.0)	ND (1.0)	ND (1.0)	ND (0.10)	ND (4.0)	ND (50)	ND (10)	ND (0.10)	ND (4.0)	ND (50)	ND (10)	ND (2.1)
	01582	17C-GR-006-0-SS-02	0-0.5	ND (50)	72	ND (0.11)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	ND (10)

Refer to footnotes at end of table.

Table 4.4.3-2 (Continued)
 Summary of SWMU 17 Confirmatory Surface Soil Samples Metals Analytical Results, August 1995

Sample Attributes		Metals (EPA Method 6010/7000)* (mg/kg)											
ER Site	Record Number ^b	ER Sample ID	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Nickel	Selenium	Silver
17C	01582	17C-GR-007-0-SS-02	0-0.5	ND (50)	66	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-008-0-SS-02	0-0.5	ND (50)	69	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-009-0-SS-02	0-0.5	ND (50)	88	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-010-0-SS-02	0-0.5	ND (50)	86	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	04268	17C-GR-010-0-0-SS0A	0-0.5	3.7	82	ND (1.1)	ND (1.1)	9.4	8.2	ND (0.10)	ND (8.5)	ND (1.0)	ND (2.1)
	01582	17C-GR-011-0-SS-02	0-0.5	ND (50)	99	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-012-0-SS-02	0-0.5	ND (50)	100	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-013-0-SS-02	0-0.5	ND (50)	80	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-014-0-SS-02	0-0.5	ND (50)	69	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-015-0-SS-02	0-0.5	ND (50)	63	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-015-0-SSD-03	0-0.5	ND (50)	95	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	04268	17C-GR-015-0-0-SS0A	0-0.5	16.5	100	ND (1.1)	ND (1.1)	17	11	ND (0.10)	17	ND (1.0)	ND (2.3)
	01582	17C-GR-016-0-SS-02	0-0.5	ND (50)	82	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-017-0-SS-02	0-0.5	ND (50)	76	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-018-0-SS-02	0-0.5	ND (50)	49	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-019-0-SS-02	0-0.5	ND (50)	50	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-020-0-SS-02	0-0.5	ND (50)	61	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	04268	17C-GR-020-0-0-SS0A	0-0.5	7.9	96	ND (1.1)	ND (1.1)	17	12	ND (0.10)	15	ND (1.0)	ND (2.2)
	01582	17C-GR-021-0-SS-02	0-0.5	ND (50)	110	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-022-0-SS-02	0-0.5	ND (50)	91	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-023-0-SS-02	0-0.5	ND (50)	70	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-024-0-SS-02	0-0.5	ND (50)	62	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-025-0-SS-02	0-0.5	ND (50)	110	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-025-0-SSD-03	0-0.5	ND (50)	120	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	04268	17C-GR-025-0-0-SS0A	0-0.5	3.6	140	ND (1.1)	ND (1.1)	10	6.6	ND (0.10)	12	ND (1.0)	ND (2.1)
	01582	17C-GR-026-0-SS-02	0-0.5	ND (50)	68	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-027-0-SS-02	0-0.5	ND (50)	89	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-028-0-SS-02	0-0.5	ND (50)	51	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01582	17C-GR-029-0-SS-02	0-0.5	ND (50)	75	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
17C	01582	17C-GR-030-0-SS-02	0-0.5	ND (50)	59	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	04268	17C-GR-030-0-0-SS0A	0-0.5	3.1	130	ND (1.0)	ND (1.0)	8.4	6.5	ND (0.10)	8.6	ND (1.0)	ND (2.1)
17D	508959	17D-GR-001-0-SS-02	0-0.5	ND (50)	70	ND (0.11)	ND (10)	ND (10)	ND (10)	0.12 J (0.24)	ND (4.0)	ND (50)	ND (10)
	508959	17D-GR-002-0-SS-02	0-0.5	ND (50)	110	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	508959	17D-GR-003-0-SS-02	0-0.5	ND (50)	160	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)

Refer to footnotes at end of table.

Table 4.4.3-2 (Continued)
 Summary of SWMU 17 Confirmatory Surface Soil Samples Analytical Results, August 1995

Sample Attributes			Metals (EPA Method 6010/7000) ^a (mg/kg)												
ER Site	Record Number ^b	ER Sample ID	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Nickel	Selenium	Silver		
17E	508959	17D-GR-004-0-SS-02	0-0.5	ND (50)	64	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
	508959	17D-GR-005-0-SS-02	0-0.5	ND (50)	62	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
	04235	17D-GR-005-0-SSD-02 [^]	0-0.5	3.0	110	ND (1.0)	ND (1.0)	13	11	ND (0.10) N [*]	12	ND (1.0)	ND (2.1)		
	04235	17D-GR-005-SSD [^]	0-0.5	3.1	120	ND (1.1)	ND (1.1)	11	11	ND (0.11) N [*]	10	ND (1.1)	ND (2.1)		
17F	509409	(Figure 4.4.3-7) 17E-GR-001-0-SS-02	0-0.5	ND (50)	57	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
	509409	17E-GR-002-0-SS-02	0-0.5	ND (50)	110	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
	509409	17E-GR-003-0-SS-02	0-0.5	ND (50)	89	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
	509409	17E-GR-004-0-SS-02	0-0.5	ND (50)	51	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
	509409	17E-GR-005-0-SS-02	0-0.5	ND (50)	59	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
	04212	17E-GR-005-0-SS-02 [^]	0-0.5	ND (2.1)	67	ND (1.0)	ND (1.0)	12	9.3	ND (0.11) N [*]	12	ND (1.0)	ND (2.1)		
	509410	(Figure 4.4.3-7) 17F-GR-001-0-SS-02	0-0.5	ND (50)	49	ND (0.11)	ND (10)	ND (10)	ND (10)	0.08 J (0.24)	ND (4.0)	ND (50)	ND (10)		
	509410	17F-GR-002-0-SS-02	0-0.5	ND (50)	86	ND (0.11)	ND (10)	ND (10)	ND (10)	0.05 J (0.24)	ND (4.0)	ND (50)	ND (10)		
17G	509410	17F-GR-003-0-SS-02	0-0.5	ND (50)	72	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
	509410	17F-GR-004-0-SS-02	0-0.5	ND (50)	110	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
	509410	17F-GR-005-0-SS-02	0-0.5	ND (50)	55	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
	509410	17F-GR-005-0-SSD-03	0-0.5	ND (50)	100	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
	04212	17F-GR-005-0-SS-02 [^]	0-0.5	3.6	130	ND (1.1)	ND (1.1)	13	19	ND (0.11) N [*]	10	ND (1.1)	ND (2.2)		
	01507	(Figure 4.4.3-6) 17G-GR-001-0-SS-02	0-0.5	ND (50)	120	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
	01507	17G-GR-002-0-SS-02	0-0.5	ND (50)	120	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
	01507	17G-GR-003-0-SS-02	0-0.5	ND (50)	120	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
17H	01507	17G-GR-004-0-SS-02	0-0.5	ND (50)	69	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
	01507	17G-GR-005-0-SS-02	0-0.5	ND (50)	67	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
	04235	17G-GR-005-SSD-02 [^]	0-0.5	ND (2.1)	93	ND (1.0)	ND (1.0)	7.5	7.0	ND (0.10) N [*]	ND (8.3)	ND (1.0)	ND (2.1)		
	01509	(Figure 4.4.3-8) 17H-GR-001-0-SS-02	0-0.5	ND (50)	130	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)		
01509	17H-GR-002-0-SS-02	0-0.5	ND (50)	110	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)			
01509	17H-GR-003-0-SS-02	0-0.5	ND (50)	90	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)			
01509	17H-GR-004-0-SS-02	0-0.5	ND (50)	100	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)			
01509	17H-GR-005-0-SS-02	0-0.5	ND (50)	100	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)			
01509	17H-GR-005-0-SSD-03	0-0.5	ND (50)	100	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)			
04269	17H-GR-005-0-SS-05 [^]	0-0.5	5.1	140	ND (1.1)	ND (1.1)	13	15	ND (0.10)	14	ND (1.0)	ND (2.3)			
01509	17H-GR-006-0-SS-02	0-0.5	ND (50)	140	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)			
01509	17H-GR-007-0-SS-02	0-0.5	ND (50)	110	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)			

Refer to footnotes at end of table.

Table 4.4.3-2 (Continued)
 Summary of SWMU 17 Confirmatory Surface Soil Samples Metals Analytical Results, August 1995

Sample Attributes			Metals (EPA Method 6010/7000) ^a (mg/kg)										
ER Site	Record Number ^b	ER Sample ID	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Nickel	Selenium	Silver
	01509	17H-GR-008-0-SS-02	0-0.5	ND (50)	99	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01509	17H-GR-009-0-SS-02	0-0.5	57	120	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01509	17H-GR-010-0-SS-02	0-0.5	ND (50)	100	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	04269	17H-GR-010-0-SS-05 [^]	0-0.5	5.0	150	ND (1.1)	ND (1.1)	15	14	ND (0.10)	14	ND (1.0)	ND (2.2)
	01509	17H-GR-011-0-SS-02	0-0.5	ND (50)	110	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01509	17H-GR-012-0-SS-02	0-0.5	ND (50)	130	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01509	17H-GR-013-0-SS-02	0-0.5	ND (50)	99	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01509	17H-GR-014-0-SS-02	0-0.5	ND (50)	110	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01509	17H-GR-015-0-SS-02	0-0.5	ND (50)	100	ND (0.11)	ND (10)	ND (10)	ND (10)	0.24	ND (4.0)	ND (50)	ND (10)
	01509	17H-GR-015-0-SSD-03	0-0.5	ND (50)	96	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	04269	17H-GR-015-0-SS-05 [^]	0-0.5	4.0	140	ND (1.1)	ND (1.1)	14	12	ND (0.10)	12	ND (1.0)	ND (2.2)
	01509	17H-GR-016-0-SS-02	0-0.5	ND (50)	110	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01509	17H-GR-017-0-SS-02	0-0.5	ND (50)	120	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01509	17H-GR-018-0-SS-02	0-0.5	ND (50)	57	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01509	17H-GR-019-0-SS-02	0-0.5	ND (50)	100	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01509	17H-GR-020-0-SS-02	0-0.5	ND (50)	100	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	01509	17H-GR-020-0-SSD-03	0-0.5	ND (50)	110	ND (0.11)	ND (10)	ND (10)	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)
	04269	17H-GR-020-0-SS-05 [^]	0-0.5	4.7	140	ND (1.1)	ND (1.1)	13	11	ND (0.10)	11	ND (1.0)	ND (2.1)
17H	04269	17H-GR-020-0-SSD-05 [^]	0-0.5	4.1	160	ND (1.1)	ND (1.1)	13	11	ND (0.10)	13	ND (1.0)	ND (2.2)
HRMB Maximum Background Surface Soil Concentrations— Southwest Area				5.6	130	0.65	<1	17.3	21.4	<0.25	11.5	<1	<1
Quality Assurance/Quality Control Samples (all in mg/L)													
17	04268	17C-GR-016-0-0-FBA	NA	0.010	ND (0.20)	ND (0.0050)	ND (0.0050)	ND (0.010)	ND (0.0030)	ND (0.00020)	ND (0.040)	ND (0.0050)	ND (0.010)
	04268	17C-GR-016-0-0-EBA	NA	0.010	ND (0.20)	ND (0.0050)	ND (0.0050)	ND (0.010)	0.0032	ND (0.00020)	ND (0.040)	ND (0.0050)	ND (0.010)
	04212	17F-GR-005-0-EB-06 [^]	NA	ND (0.010)	ND (0.20)	ND (0.0050)	ND (0.0050)	ND (0.010)	ND (0.0030)	ND (0.00020)	ND (0.040)	ND (0.0050)	ND (0.010)
	04212	17F-GR-005-0-FB-07 [^]	NA	ND (0.010)	ND (0.20)	ND (0.0050)	ND (0.0050)	ND (0.010)	ND (0.0030)	ND (0.00020)	ND (0.040)	ND (0.0050)	ND (0.010)
	04235	17G-GR-005-EB-15 [^]	NA	ND (0.010)	ND (0.20)	ND (0.0050)	ND (0.0050)	ND (0.010)	ND (0.0030)	ND (0.00020)	ND (0.040)	ND (0.0050)	ND (0.010)
	04235	17G-GR-005-FB-16 [^]	NA	ND (0.010)	ND (0.20)	ND (0.0050)	ND (0.0050)	ND (0.010)	ND (0.0030)	ND (0.00020)	ND (0.040)	ND (0.0050)	ND (0.010)

Refer to footnotes at end of table.

Table 4.4.3-2 (Concluded)
 Summary of SWMU 17 Confirmatory Surface Soil Samples Metals Analytical Results, August 1995

Sample Attributes			Metals (EPA 60107000) ^a (mg/kg)										
ER Site	Record Number ^b	ER Sample ID	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Nickel	Selenium	Silver
	04269	17H-GR-020-0-EB-06 [^]	NA	0.010	ND (0.20)	ND (0.0050)	ND (0.0050)	ND (0.010)	ND (0.0030)	ND (0.00020)	ND (0.040)	ND (0.0050)	ND (0.010)
	04269	17H-GR-020-0-FB-07 [^]	NA	0.010	ND (0.20)	ND (0.0050)	ND (0.0050)	ND (0.010)	0.0032	ND (0.00020)	ND (0.040)	ND (0.0050)	ND (0.010)

^aEPA November 1986.

^bAnalysis request/chain of custody.

^cValue in parenthesis represents the method detection limit (MDL) for on-site laboratory analyses or project reporting limit (PRL) for off-site laboratory analyses.

^dDinwiddie September 24, 1997.

EB = Equipment blank.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

FB = Field blank.

Ft = Foot (feet).

GR = Grab sample.

HRMB = Hazardous and Radioactive Materials Bureau.

ID = Identification.

J () = The estimated value reported is either above the highest calibration standard or less than the practical quantification limit, shown in parenthesis.

mg/kg = Milligram(s) per kilogram.

mg/L = Milligram(s) per liter.

N* = Matrix spike recovery exceeded acceptance limits and the relative percent difference for duplicate analysis exceeded acceptance limits.

NA = Not applicable.

ND = Not detected above the MDL for on-site laboratory analyses or PRL for off-site laboratory analyses.

S = Reported value was determined from the method of standard addition.

SS = Surface soil sample.

SSD = Duplicate surface soil sample.

SSO = Surface soil sample for off-site analysis.

SWMU = Solid waste management unit.

UTL = Upper tolerance limit.

^ = Off-site lab sample.

Table 4.4.3-3
 Summary of SWMU 17 Confirmatory Surface Soil Samples Gamma Spectroscopy Analysis Results, August 1995
 (On-Site Laboratory Only)

SWMU	Sample Attributes		Gamma Spectroscopy Activity (pCi/g)									
	Record Number ^a	ER Sample ID (Figure 4.4.3-3)	Sample Depth (ft)	Uranium-238	Thorium-234	Thorium-232	Radium-228	Thorium-228	Uranium-235	Cesium-137		
17A	509501	17A-GR-001-0-SS-01	0-0.5	ND (2.08) ^b	ND (5.48E-01)	5.53E-01	5.16E-01	ND (1.58)	ND (3.66E-01)	ND (6.43E-02)		
	509501	17A-GR-002-0-SS-01	0-0.5	ND (2.18)	ND (9.76E-01)	7.74E-01	7.98E-01	6.78E-01	ND (3.84E-01)	ND (6.38E-02)		
	509501	17A-GR-003-0-SS-01	0-0.5	ND (2.12)	ND (9.31E-01)	5.43E-01	5.78E-01	4.73E-01	ND (3.83E-01)	ND (6.59E-02)		
	509501	17A-GR-004-0-SS-01	0-0.5	ND (2.39)	ND (7.08E-01)	6.28E-01	3.72E-01	ND (1.77)	ND (4.06E-01)	ND (7.31E-02)		
	04210	17A-GR-005-0-SS-01	0-0.5	ND (5.44)	ND (1.25)	8.03E-01	7.51E-01	ND (1.34)	ND (3.98E-01)	ND (5.59E-02)		
	509501	17A-GR-005-0-SSD-04	0-0.5	ND (1.98)	ND (9.95E-01)	5.80E-01	7.95E-01	ND (1.49)	ND (3.72E-01)	ND (5.60E-02)		
	509501	17A-GR-006-0-SS-01	0-0.5	ND (2.17)	ND (1.00)	6.92E-01	8.04E-01	1.12	ND (3.78E-01)	ND (6.45E-02)		
	509501	17A-GR-007-0-SS-01	0-0.5	ND (2.10)	ND (9.77E-01)	5.05E-01	3.80E-01	4.80E-01	ND (3.70E-01)	ND (5.89E-02)		
	509501	17A-GR-008-0-SS-01	0-0.5	ND (2.14)	ND (1.11)	5.73E-01	6.12E-01	6.13E-01	ND (3.83E-01)	ND (6.37E-02)		
	509501	17A-GR-009-0-SS-01	0-0.5	ND (2.00)	ND (7.20E-01)	7.55E-01	6.56E-01	ND (1.54)	ND (3.62E-01)	ND (5.77E-02)		
	04210	17A-GR-010-0-SS-01	0-0.5	ND (6.50)	1.20	9.29E-01	8.37E-01	7.84E-01	ND (4.61E-01)	4.68E-02		
	509501	17A-GR-010-0-SSD-04	0-0.5	ND (2.29)	ND (6.76E-01)	6.08E-01	7.75E-01	ND (1.85)	ND (4.34E-01)	ND (7.66E-02)		
	17B RAD VCM	509411	(Figure 4.4.3-4) 17B-GR-001-0-SS-01	0-0.5	ND (5.67)	ND (1.30)	8.47E-01	6.57E-01	7.38E-01	ND (4.06E-01)	7.95E-02	
		509411	17B-GR-002-0-SS-01	0-0.5	ND (6.41)	ND (1.58)	8.52E-01	7.15E-01	ND (1.51)	ND (4.55E-01)	ND (7.34E-02)	
		509411	17B-GR-003-0-SS-01	0-0.5	ND (6.25)	ND (1.41)	5.47E-01	7.53E-01	9.24E-01	ND (4.20E-01)	ND (6.48E-02)	
		509411	17B-GR-004-0-SS-01	0-0.5	ND (6.32)	ND (1.41)	7.69E-01	6.39E-01	1.07	ND (4.46E-01)	8.62E-02	
		04210	17B-GR-005-0-SS-01	0-0.5	ND (6.43)	ND (1.55)	6.95E-01	7.59E-01	8.35E-01	ND (4.76E-01)	2.97E-01	
509411		17B-GR-005-0-SSD-04	0-0.5	ND (6.60)	ND (1.59)	9.73E-01	8.30E-01	ND (1.69)	ND (4.72E-01)	2.88E-01		
02505		(Figure 4.4.3-2) 17BE1-SS	0-0.17	4.09	4.02	5.97E-01	7.13E-01	5.74E-01	ND (2.84E-01)	1.15E-01		
02505		17BE1-SD	0-0.17	4.82	4.35	5.65E-01	8.04E-01	5.19E-01	ND (2.60E-01)	9.60E-02		
02505		17BE2-SS	0-0.33	4.62	4.74	5.03E-01	6.69E-01	6.44E-01	ND (2.58E-01)	ND (4.48E-02)		
01303		17BE3B-SS	0-0.5	1.91E+01	1.66E+01	8.89E-01	8.62E-01	7.89E-01	1.94E-01	ND (6.77E-02)		
01303	17BE10-SS	0-0.5	2.43	3.37	7.55E-01	7.60E-01	1.30	ND (4.07E-01)	4.81E-01			
01303	17BE5B-SS	0-0.25	ND (2.02)	ND (1.12)	5.28E-01	6.03E-01	1.11	ND (3.57E-01)	2.05E-01			
17C	01584	(Figure 4.4.3-5) 17C-GR-001-0-SS-01	0-0.5	ND (5.57)	ND (1.33)	5.49E-01	7.57E-01	ND (1.49)	ND (4.30E-01)	6.65E-02		
	01584	17C-GR-002-0-SS-01	0-0.5	ND (5.58)	ND (1.41)	6.24E-01	6.90E-01	4.59E-01	ND (4.15E-01)	6.13E-01		
	01584	17C-GR-003-0-SS-01	0-0.5	ND (5.76)	ND (1.38)	5.98E-01	5.31E-01	ND (1.46)	ND (4.23E-01)	1.33E-01		
	01584	17C-GR-004-0-SS-01	0-0.5	ND (5.49)	ND (1.49)	7.05E-01	6.74E-01	7.10E-01	ND (4.27E-01)	4.01E-01		
	01584	17C-GR-005-0-SS-01	0-0.5	ND (5.24)	ND (1.27)	4.60E-01	5.31E-01	ND (1.41)	ND (3.85E-01)	ND (6.03E-02)		
	04270	17C-GR-005-0-SSD-04	0-0.5	ND (2.15)	ND (8.02E-01)	7.51E-01	5.69E-01	ND (1.59)	ND (3.83E-01)	ND (5.77E-02)		
	01584	17C-GR-006-0-SS-01	0-0.5	ND (5.42)	ND (1.28)	5.43E-01	7.11E-01	6.36E-01	ND (4.03E-01)	ND (6.00E-02)		
	01584	17C-GR-007-0-SS-01	0-0.5	ND (5.68)	ND (1.27)	5.17E-01	4.78E-01	ND (1.40)	ND (3.98E-01)	2.63E-01		
	01584	17C-GR-008-0-SS-01	0-0.5	ND (5.30)	ND (1.18)	4.21E-01	5.03E-01	ND (1.40)	ND (3.68E-01)	1.02E-01		
	01584	17C-GR-009-0-SS-01	0-0.5	ND (5.15)	ND (1.21)	5.71E-01	5.17E-01	ND (1.35)	ND (3.63E-01)	1.12E-01		
01584	17C-GR-010-0-SS-01	0-0.5	ND (5.97)	ND (1.41)	4.57E-01	5.94E-01	9.98E-01	ND (4.42E-01)	3.70E-01			

Refer to footnotes at end of table.

Table 4.4.3-3 (Continued)
 Summary of SWMU 17 Confirmatory Surface Soil Samples Gamma Spectroscopy Analysis Results, August 1995
 (On-Site Laboratory Only)

SWMU	Sample Attributes		Gamma Spectroscopy Activity (pCi/g)									
	Record Number*	ER Sample ID	Sample Depth (ft)	Uranium-238	Thorium-234	Thorium-232	Radium-228	Thorium-228	Uranium-235	Cesium-137		
17D	01584	17C-GR-011-0-SS-01	0-0.5	ND (5.78)	ND (1.33)	9.15E-01	7.64E-01	7.05E-01	ND (4.03E-01)	ND (6.28E-02)		
	01584	17C-GR-012-0-SS-01	0-0.5	ND (5.93)	ND (1.38)	5.70E-01	5.86E-01	ND (1.20)	ND (4.08E-01)	3.92E-01		
	01584	17C-GR-013-0-SS-01	0-0.5	ND (6.13)	ND (1.33)	7.37E-01	6.59E-01	7.80E-01	ND (4.55E-01)	1.82E-01		
	01584	17C-GR-014-0-SS-01	0-0.5	ND (4.98)	ND (1.13)	5.13E-01	6.20E-01	6.09E-01	ND (3.68E-01)	1.60E-01		
	01584	17C-GR-015-0-SS-01	0-0.5	ND (6.47)	ND (1.49)	7.32E-01	7.55E-01	6.85E-01	ND (4.44E-01)	6.16E-02		
	04270	17C-GR-015-0-SSD-04	0-0.5	ND (2.44)	ND (6.83E-01)	6.90E-01	8.04E-01	4.85E-01	ND (4.20E-01)	ND (7.67E-02)		
	01584	17C-GR-016-0-SS-01	0-0.5	ND (5.81)	ND (1.34)	6.78E-01	7.42E-01	ND (1.54)	ND (4.04E-01)	ND (6.28E-02)		
	01584	17C-GR-017-0-SS-01	0-0.5	ND (5.46)	ND (1.39)	6.10E-01	6.11E-01	6.11E-01	ND (4.24E-01)	2.74E-01		
	01584	17C-GR-018-0-SS-01	0-0.5	ND (5.44)	ND (1.81)	6.84E-01	6.71E-01	6.58E-01	ND (4.18E-01)	1.17E-01		
	01584	17C-GR-019-0-SS-01	0-0.5	ND (5.58)	ND (1.29)	6.13E-01	6.43E-01	6.43E-01	ND (4.26E-01)	5.20E-01		
	01584	17C-GR-020-0-SS-01	0-0.5	ND (6.05)	ND (1.50)	5.39E-01	5.78E-01	ND (1.63)	ND (4.51E-01)	ND (7.94E-02)		
	01584	17C-GR-021-0-SS-01	0-0.5	ND (5.87)	ND (1.10)	4.79E-01	5.25E-01	ND (1.48)	ND (4.32E-01)	3.27E-01		
	01584	17C-GR-022-0-SS-01	0-0.5	ND (5.64)	ND (1.29)	4.69E-01	6.35E-01	ND (1.46)	ND (4.02E-01)	1.03E-01		
	01584	17C-GR-023-0-SS-01	0-0.5	ND (5.71)	ND (1.36)	6.78E-01	3.94E-01	4.55E-01	ND (3.93E-01)	4.34E-01		
	01584	17C-GR-024-0-SS-01	0-0.5	ND (5.83)	ND (1.41)	4.63E-01	6.66E-01	ND (1.51)	ND (4.25E-01)	3.54E-01		
	01584	17C-GR-025-0-SS-01	0-0.5	ND (5.23)	ND (1.29)	6.17E-01	6.70E-01	4.62E-01	ND (4.01E-01)	ND (5.99E-02)		
	04270	17C-GR-025-0-SSD-04	0-0.5	ND (2.26)	1.12	9.51E-01	7.16E-01	7.16E-01	ND (4.10E-01)	ND (6.41E-02)		
	01584	17C-GR-026-0-SS-01	0-0.5	ND (5.61)	ND (1.23)	5.97E-01	4.96E-01	7.62E-01	ND (4.03E-01)	1.61E-01		
01584	17C-GR-027-0-SS-01	0-0.5	ND (5.27)	ND (1.28)	7.00E-01	3.23E-01	6.55E-01	ND (3.78E-01)	2.34E-01			
01584	17C-GR-028-0-SS-01	0-0.5	ND (5.44)	ND (1.27)	6.20E-01	5.23E-01	ND (1.38)	ND (3.92E-01)	2.55E-01			
01584	17C-GR-029-0-SS-01	0-0.5	ND (5.44)	ND (1.30)	3.78E-01	4.14E-01	8.53E-01	ND (4.03E-01)	3.41E-01			
01584	17C-GR-030-0-SS-01	0-0.5	ND (5.49)	ND (1.29)	6.14E-01	4.98E-01	5.30E-01	ND (3.92E-01)	ND (6.17E-02)			
17E	508957	(Figure 4.4.3-6) 17D-GR-001-0-SS-01	0-0.5	ND (1.98)	7.16E-01	4.60E-01	5.80E-01	6.36E-01	ND (3.60E-01)	1.57E-01		
	508957	17D-GR-002-0-SS-01	0-0.5	ND (2.00)	ND (9.46E-01)	6.08E-01	5.09E-01	6.28E-01	ND (3.58E-01)	5.29E-02		
	508957	17D-GR-003-0-SS-01	0-0.5	ND (2.07)	ND (9.95E-01)	5.79E-01	4.08E-01	5.38E-01	ND (3.64E-01)	1.83E-01		
	508957	17D-GR-004-0-SS-01	0-0.5	ND (2.07)	8.79E-01	6.08E-01	3.61E-01	6.51E-01	ND (3.71E-01)	2.50E-01		
	04185	17D-GR-005-SS-01	0-0.5	ND (5.07)	ND (1.22)	7.32E-01	5.90E-01	ND (1.43)	ND (3.83E-01)	1.91E-01		
	04185	17D-GR-005-SSD-01	0-0.5	ND (5.21)	ND (1.24)	5.44E-01	5.79E-01	ND (1.43)	ND (3.82E-01)	2.12E-01		
	509437	(Figure 4.4.3-7) 17E-GR-001-0-SS-01	0-0.5	ND (5.55)	ND (1.24)	5.38E-01	ND (4.93E-01)	6.00E-01	ND (3.88E-01)	6.53E-02		
	509437	17E-GR-002-0-SS-01	0-0.5	ND (6.19)	ND (1.36)	6.43E-01	5.33E-01	ND (1.39)	ND (4.21E-01)	2.66E-01		
	509437	17E-GR-003-0-SS-01	0-0.5	ND (6.00)	ND (1.34)	5.81E-01	5.76E-01	5.69E-01	ND (4.35E-01)	3.35E-01		
	509437	17E-GR-004-0-SS-01	0-0.5	ND (4.85)	ND (1.10)	5.42E-01	4.33E-01	6.20E-01	ND (3.58E-01)	6.05E-02		
	509437	17E-GR-005-0-SSD-04	0-0.5	ND (5.26)	ND (1.18)	4.60E-01	5.75E-01	ND (1.25)	ND (3.62E-01)	2.10E-02		
	04210	17E-GR-005-0-SS-01	0-0.5	ND (5.26)	ND (1.11)	4.28E-01	3.53E-01	ND (1.12)	ND (3.56E-01)	3.25E-02		

Refer to footnotes at end of table.

Table 4.4.3-3 (Continued)
 Summary of SWMU 17 Confirmatory Surface Soil Samples Gamma Spectroscopy Analysis Results, August 1995
 (On-Site Laboratory Only)

SWMU	Record Number ^a	Sample Attributes		Gamma Spectroscopy Activity (pCi/g)									
		ER Sample ID (Figure 4.4.3-7)	Sample Depth (ft)	Uranium-238	Thorium-234	Thorium-232	Radium-228	Thorium-228	Uranium-235	Cesium-137			
17F	509489	17F-GR-001-0-SS-01	0-0.5	ND (2.07)	ND (8.51E-01)	6.85E-01	5.01E-01	ND (1.45)	ND (3.62E-01)	ND (6.50E-02)			
	509489	17F-GR-002-0-SS-01	0-0.5	ND (2.10)	ND (5.63E-01)	6.95E-01	4.64E-01	9.58E-01	ND (3.70E-01)	5.90E-02			
	509489	17F-GR-003-0-SS-01	0-0.5	ND (2.01)	ND (6.28E-01)	7.82E-01	5.23E-01	4.93E-01	ND (3.46E-01)	3.69E-02			
	509489	17F-GR-004-0-SS-01	0-0.5	ND (2.19)	ND (5.87E-01)	9.77E-01	4.72E-01	1.06	ND (3.93E-01)	7.06E-02			
	509489	17F-GR-005-0-SSD-04	0-0.5	ND (2.34)	1.20	5.93E-01	7.22E-01	ND (1.83)	ND (4.26E-01)	4.01E-02			
	04210	17F-GR-005-0-SS-01	0-0.5	ND (5.69)	ND (1.26)	5.56E-01	6.83E-01	5.38E-01	ND (4.23E-01)	ND (7.37E-02)			
17G	508958	(Figure 4.4.3-6) 17G-GR-001-0-SS-01	0-0.5	ND (1.89)	ND (8.81E-01)	3.97E-01	4.34E-01	4.28E-01	ND (3.18E-01)	4.13E-02			
	508958	17G-GR-002-0-SS-01	0-0.5	ND (1.91)	ND (9.05E-01)	5.35E-01	3.45E-01	5.20E-01	ND (3.37E-01)	3.72E-02			
	508958	17G-GR-003-0-SS-01	0-0.5	ND (1.76)	ND (6.12E-01)	3.37E-01	1.62E-01	ND (1.28)	ND (3.19E-01)	4.61E-02			
	508958	17G-GR-004-0-SS-01	0-0.5	ND (2.08)	ND (7.66E-01)	6.36E-01	5.55E-01	5.84E-01	ND (3.77E-01)	1.35E-01			
	04185	17G-GR-005-SS-01	0-0.5	ND (4.97)	ND (1.21)	5.38E-01	4.43E-01	ND (1.30)	ND (3.60E-01)	5.53E-02			
	17H	01508	(Figure 4.4.3-8) 17H-GR-001-0-SS-01	0-0.5	ND (5.95)	ND (1.56)	7.85E-01	9.26E-01	ND (1.73)	ND (4.59E-01)	ND (7.71E-02)		
01508		17H-GR-002-0-SS-01	0-0.5	ND (6.36)	ND (1.45)	7.22E-01	5.16E-01	8.22E-01	ND (4.27E-01)	1.13E-01			
01508		17H-GR-003-0-SS-01	0-0.5	ND (5.98)	ND (1.49)	4.86E-01	7.88E-01	ND (1.69)	ND (4.63E-01)	ND (7.52E-02)			
01508		17H-GR-004-0-SS-01	0-0.5	ND (6.14)	ND (1.41)	6.06E-01	4.96E-01	7.63E-01	ND (4.31E-01)	ND (7.44E-02)			
04097		17H-GR-005-0-SS-01	0-0.5	ND (2.47)	ND (7.15E-01)	5.67E-01	5.93E-01	7.58E-01	ND (4.37E-01)	4.81E-02			
01508		17H-GR-005-0-SSD-04	0-0.5	ND (6.71)	ND (1.50)	4.40E-01	3.61E-01	ND (1.75)	ND (4.71E-01)	4.45E-02			
01508		17H-GR-006-0-SS-01	0-0.5	ND (6.34)	ND (1.53)	8.16E-01	5.06E-01	ND (1.70)	ND (4.64E-01)	3.88E-02			
01508		17H-GR-007-0-SS-01	0-0.5	ND (5.78)	ND (1.41)	6.88E-01	4.52E-01	8.69E-01	ND (4.29E-01)	5.47E-02			
01508		17H-GR-008-0-SS-01	0-0.5	ND (6.26)	ND (8.03E-01)	8.10E-01	7.50E-01	9.27E-01	ND (4.95E-01)	ND (6.75E-02)			
01508		17H-GR-009-0-SS-01	0-0.5	ND (5.88)	ND (1.44)	8.91E-01	6.33E-01	ND (1.59)	ND (4.26E-01)	ND (7.16E-02)			
04097		17H-GR-010-0-SS-01	0-0.5	ND (2.52)	ND (6.61E-01)	7.82E-01	5.55E-01	1.00	ND (4.76E-01)	5.54E-02			
01508		17H-GR-011-0-SS-01	0-0.5	ND (6.39)	ND (1.49)	7.04E-01	6.52E-01	1.05	ND (4.69E-01)	ND (6.87E-02)			
01508		17H-GR-012-0-SS-01	0-0.5	ND (6.31)	ND (1.49)	7.54E-01	5.30E-01	ND (1.66)	ND (4.69E-01)	ND (7.33E-02)			
01508		17H-GR-013-0-SS-01	0-0.5	ND (6.18)	ND (1.44)	8.74E-01	4.84E-01	ND (1.56)	ND (4.29E-01)	ND (7.55E-02)			

Refer to footnotes at end of table.

Table 4.4.3-3 (Concluded)
 Summary of SWMU 17 Confirmatory Surface Soil Samples Gamma Spectroscopy Analysis Results, August 1995
 (On-Site Laboratory Only)

Sample Attributes			Gamma Spectroscopy Activity (pCi/g)									
SWMU	Record Number*	ER Sample ID	Sample Depth (ft)	Uranium-238	Thorium-234	Thorium-232	Radium-228	Thorium-228	Uranium-235	Cesium-137		
17H	01508	17H-GR-014-0-SS-01	0-0.5	ND (5.47)	ND (1.34)	6.75E-01	6.56E-01	9.96E-01	ND (4.19E-01)	ND (7.15E-02)		
	04097	17H-GR-015-0-SS-01	0-0.5	ND (2.37)	ND (8.20E-01)	7.58E-01	6.59E-01	7.79E-01	ND (4.30E-01)	3.79E-02		
	01508	17H-GR-015-0-SSD-04	0-0.5	ND (6.26)	ND (6.35E-01)	6.81E-01	7.00E-01	8.25E-01	ND (4.68E-01)	ND (8.06E-02)		
	01508	17H-GR-016-0-SS-01	0-0.5	ND (6.29)	ND (1.47)	9.79E-01	5.47E-01	9.78E-01	ND (4.32E-01)	ND (7.49E-02)		
	01508	17H-GR-017-0-SS-01	0-0.5	ND (6.15)	ND (1.11)	8.24E-01	7.37E-01	8.26E-01	ND (4.65E-01)	ND (7.17E-02)		
	01508	17H-GR-018-0-SS-01	0-0.5	ND (5.89)	ND (1.39)	5.23E-01	5.14E-01	5.04E-01	ND (4.10E-01)	3.70E-01		
	01508	17H-GR-019-0-SS-01	0-0.5	ND (5.46)	ND (7.92E-01)	6.51E-01	4.89E-01	7.92E-01	ND (4.40E-01)	5.27E-02		
	04097	17H-GR-020-0-SS-01	0-0.5	ND (2.41)	ND (8.32E-01)	5.60E-01	7.15E-01	8.18E-01	ND (4.30E-01)	4.76E-02		
	01508	17H-GR-020-0-SSD-04	0-0.5	ND (5.83)	ND (1.47)	5.29E-01	7.22E-01	ND (1.65)	ND (4.10E-01)	ND (7.36E-02)		
Quality Assurance/Quality Control Samples (all in pCi/mL)												
17	04185	17D-GR-005-EB-01	NA	ND (1.69)	ND (3.84E-01)	ND (1.17E-01)	ND (1.22E-01)	ND (4.59E-01)	ND (1.50E-01)	ND (2.12E-02)		
	04185	17D-GR-005-FB-01	NA	ND (1.63)	ND (3.95E-01)	ND (1.21E-01)	ND (1.35E-01)	ND (4.55E-01)	ND (1.46E-01)	ND (2.23E-02)		
	04270	17C-GR-016-0-0-FB	NA	ND (6.01E-01)	ND (2.62E-01)	ND (1.27E-01)	ND (1.17E-01)	ND (4.63E-01)	ND (1.50E-01)	ND (2.18E-02)		
	04270	17C-GR-016-0-0-EB	NA	ND (5.69E-01)	ND (2.63E-01)	ND (1.32E-01)	ND (1.15E-01)	ND (4.55E-01)	ND (1.51E-01)	ND (2.16E-02)		
	04210	17F-GR-005-0-FB-12	NA	ND (1.59)	ND (3.50E-01)	ND (1.22E-01)	ND (1.31E-01)	ND (4.34E-01)	ND (1.47E-01)	ND (2.19E-02)		
	04210	17F-GR-005-0-EB-13	NA	ND (1.52)	ND (3.62E-01)	ND (1.25E-01)	ND (1.29E-01)	ND (4.12E-01)	ND (1.48E-01)	ND (2.28E-02)		
	04097	17H-GR-020-FB-01	NA	ND (5.97E-01)	ND (2.62E-01)	ND (1.36E-01)	ND (1.21E-01)	ND (4.62E-01)	ND (1.52E-01)	ND (2.26E-02)		
	04097	17H-GR-020-EB-01	NA	ND (5.98E-01)	ND (2.72E-01)	ND (1.27E-01)	ND (1.20E-01)	ND (4.82E-01)	ND (1.54E-01)	ND (2.21E-02)		
HRMB	Maximum Background Surface Soil Concentrations—Southwest Area*			1.4	1.4	1.01	1.01	1.01	0.16	0.664		

*Analysis Request/chain of custody.

*Value in parenthesis represents the minimum detectable activity (MDA).

*Dinwiddie September 24, 1997.

*Brown January 1998.

- EB = Equipment blank
- ER = Environmental restoration
- FB = Field blank
- ft = Foot (feet)
- HRMB = Hazardous and Radioactive Materials Bureau.
- GR = Grab sample.
- ID = Identification.
- NA = Not applicable.
- ND = Radionuclide not present above the MDA.
- pCi/g = Picocurie(s) per gram.
- pCi/mL = Picocurie(s) per milliliter.
- RAD = Radiological.
- SNL/NM = Sandia National Laboratories/New Mexico.
- SS = Surface soil sample.
- SSD = Duplicate surface soil sample.
- SWMU = Solid waste management area.
- UTL = Upper tolerance limit.
- VCM = Voluntary Corrective Measure.

Table 4.4.3-4
Summary of SWMU 17 Confirmatory Surface Soil Samples VOC Analysis Results,
August 1995

Sample Attributes				VOCs (EPA Method 8240)* (µg/kg)				
SWMU	Record Number ^b	ER Sample ID	Sample Depth (ft)	Methylene Chloride	Acetone	Trichloroethene	2-Hexanone	
17C		(Figure 4.4.3-5)						
	01583	17C-GR-001-0-SS-18	0-0.5	ND (1.0) ^e	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-002-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-003-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-004-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-005-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-005-0-SSD-19	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	04268	17C-GR-005-0.0-SSO [^]	0-0.5	ND (5.2)	ND (10)	ND (5.2)	ND (5.2)	
	01583	17C-GR-006-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-007-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-008-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-009-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-010-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	04268	17C-GR-010-0.0-SSO [^]	0-0.5	1.2 J (5.2)	ND (10)	ND (5.2)	ND (5.2)	
	01583	17C-GR-011-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-012-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-013-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-014-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-015-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-015-0-SSD-19	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	04268	17C-GR-015-0.0-SSO [^]	0-0.5	ND (5.7)	ND (11)	ND (5.7)	ND (5.7)	
	01583	17C-GR-016-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-017-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-018-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-019-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-020-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	04268	17C-GR-020-0.0-SSO [^]	0-0.5	ND (5.6)	22	ND (5.6)	ND (5.6)	
	01583	17C-GR-021-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-022-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-023-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-024-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-025-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-025-0-SSD-19	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	04268	17C-GR-025-0.0-SSO [^]	0-0.5	ND (5.4)	19	ND (5.4)	ND (5.4)	
	01583	17C-GR-026-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-027-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-028-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-029-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01583	17C-GR-030-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	04268	17C-GR-030-0.0-SSO [^]	0-0.5	ND (5.3)	11	ND (5.3)	ND (5.3)	
	17H		(Figure 4.4.3-8)					
		01510	17H-GR-001-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)
01510		17H-GR-002-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
01510		17H-GR-003-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
01510		17H-GR-004-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
01510		17H-GR-005-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
01510		17H-GR-005-0-SSD-19	0-0.5	SNA	SNA	SNA	SNA	
04269		17H-GR-005-0-SS-11 [^]	0-0.5	ND (5.7)	ND (11)	ND (5.7)	ND (5.7)	
01510	17H-GR-006-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)		
01510	17H-GR-007-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)		
17H	01510	17H-GR-008-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01510	17H-GR-009-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01510	17H-GR-010-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	04269	17H-GR-010-0-SS-11 [^]	0-0.5	ND (5.5)	ND (11)	ND (5.5)	ND (5.5)	
	01510	17H-GR-011-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
	01510	17H-GR-012-0-SS-18	0-0.5	ND (1.0)	12 J* (20)	ND (1.0)	8.5 J* (20)	
	01510	17H-GR-013-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)	
01510	17H-GR-014-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)		

Refer to footnotes at end of table.

Table 4.4.3-4 (Concluded)
Summary of SWMU 17 Confirmatory Surfaces Soil Sample VOC Analysis Results,
August 1995

Sample Attributes				VOCs (EPA 8240)* (µg/kg)			
SWMU	Record Number ^b	ER Sample ID	Sample Depth (ft)	Methylene Chloride	Acetone	Trichloroethene	2-Hexanone
	01510	17H-GR-015-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)
	01510	17H-GR-015-0-SSD-19	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)
	04269	17H-GR-015-0-SS-11 [^]	0-0.5	ND (5.5)	13	ND (5.5)	ND (5.5)
	01510	17H-GR-016-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)
	01510	17H-GR-017-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)
	01510	17H-GR-018-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)
	01510	17H-GR-019-0-SS-18	0-0.5	ND (1.0)	ND (5.0)	ND (1.0)	ND (5.0)
	01510	17H-GR-020-0-SS-18	0-0.5	ND (1.0)	34	5.6	ND (5.0)
	01510	17H-GR-020-0-SSD-19	0-0.5	ND (1.0)	20	ND (1.0)	ND (5.0)
	04269	17H-GR-020-0-SS-11 [^]	0-0.5	ND (5.4)	ND (11.)	ND (5.4)	ND (5.4)
	04269	17H-GR-020-SSD-11 [^]	0-0.5	ND (5.4)	ND (11.)	ND (5.4)	ND (5.4)
Quality Assurance/Quality Control Samples (µg/L, water)							
17	04268	17C-GR-016-0.0-EB [^]	NA	ND (5.0)	ND (10)	ND (5.0)	ND (10)
	04268	17C-GR-016-0.0-FB [^]	NA	ND (5.0)	ND (10)	ND (5.0)	ND (10)
	04268	17C-GR-016-0.0-TB [^]	NA	ND (5.0)	ND (10)	ND (5.0)	ND (10)
	04269	17H-GR-020-0-EB-08 [^]	NA	ND (5.0)	ND (10)	ND (5.0)	ND (10)
	04269	17H-GR-020-0-FB-09 [^]	NA	ND (5.0)	ND (10)	ND (5.0)	ND (10)
	04269	17H-GR-020-0-TB-10 [^]	NA	ND (5.0)	ND (10)	ND (5.0)	ND (10)

*EPA November 1986.

^bAnalysis request/chain of custody.

[^]Value in parenthesis represents the method detection limit (MDL) for on-site laboratory analyses or PQL for off-site laboratory analyses.

EB = Equipment blank.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

FB = Field blank.

ft = Foot (feet).

GR = Grab sample.

ID = Identification.

J () = Estimated value—constituent detected at a level less than the reporting detection limit or PQL, shown in parenthesis, and greater than or equal to the MDL.

J* () = Reported value is either below the PQL, shown in parenthesis, or above the highest calibration level and therefore is an estimated value.

µg/kg = Microgram(s) per kilogram.

µg/L = Microgram(s) per liter.

NA = Not applicable.

ND = Not detected above the MDL for on-site laboratory analyses or the PQL for off-site laboratory analyses.

PQL = Practical quantitation limit.

SNA = Sample not analyzed.

SS = Surface soil sample.

SSD = Duplicate surface soil sample.

SSO = Surface soil sample for off-site analysis.

SWMU = Solid waste management unit.

TB = Trip blank.

VOC = Volatile organic compound.

[^] = Off-site lab sample.

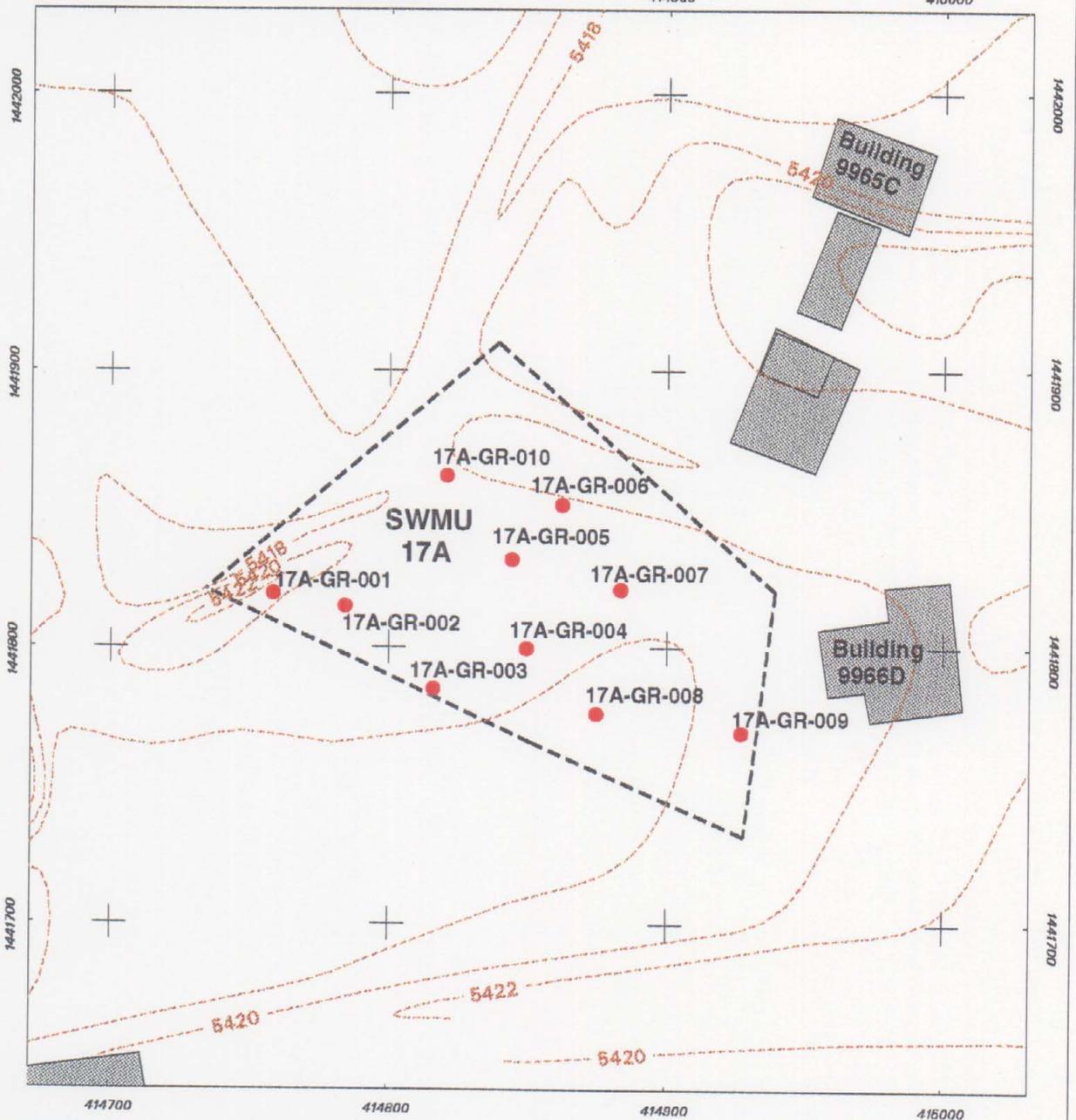
and silver is very close to their nonquantified background concentration limits. The cadmium MDL is 1.1 milligrams (mg) /kg as compared to the background concentration limit of less than 1.0 mg/kg. The selenium MDL is 1.0 mg/kg as compared to the background concentration limit of less than 1.0 mg/kg. The silver MDL ranges from 2.1 to 2.3 mg/kg as compared to a background concentration limit less than 1.0 mg/kg. However, the lower MDLs for the off-site split samples generally compared to the background concentration limits. In some instances, the measured activity of thorium-228 slightly exceeded the background (or less than background) activity of its thorium-232 or radium-228 precursors. This would lead one to the erroneous conclusion that thorium-228 exceeds background and that it should be considered in the health-risk assessment of radioactive COCs. However, this is not the case since the condition of *transient equilibrium* exists between thorium-228 and its precursor. In this condition, it is expected that the daughter activity will slightly exceed the parent activity. Therefore, unless either thorium-232 or radium-228 activity exceeds background, thorium-228 will not be evaluated further.

4.4.3.4.1 ER Site 17A

Ten surface soil samples and one duplicate sample were collected at ER Site 17A and were analyzed on site for metals and gamma activity. In addition to the duplicate sample (17A-GR-010-0-SSD-03), two split samples (17A-GR-005-0-SS-02 and 17A-GR-010-0-SS-02) were sent to an off-site laboratory for verification analysis for metals. Table 4.4.3-2 summarizes the on- and off-site analytical results for metals. Table 4.4.3-4 summarizes the results of the gamma spectroscopy analysis. Figure 4.4.3-3 shows ER Site 17A confirmatory surface soil sample locations.

Metals

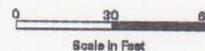
Table 4.4.3-2 presents a summary of the metals results for the ten surface soil samples, one duplicate sample, and the two split samples collected during confirmatory sampling at SWMU 17A. Concentrations of beryllium, cadmium, mercury, selenium, and silver were not detected in any samples. However, the cadmium, selenium, and silver detection limits exceeded the nonqualified maximum background concentration limits. Arsenic was detected in the off-site analyses at concentration levels less than maximum background concentration limits. Barium concentration levels were slightly elevated relative to maximum background concentration limits in the eastern portion of the site, with a maximum concentration level of 180 mg/kg (17-GR-010-0-SS-02). Chromium was also slightly elevated (at 18 mg/kg) in sample 17A-GR-010-0-SS-02 but was less than the background levels in all other samples. Lead and nickel were detected in samples 17A-GR-005-0-SS-02 and 17A-GR-010-0-SS-02 in off-site analyses. The lead concentration level was slightly elevated relative to maximum background concentrations (at 23 mg/kg) in sample 17A-GR-005-0-SS-02 and (at 26 mg/kg) in sample 17A-GR-010-0-SS-02. The nickel concentration level was elevated relative to maximum background concentrations (at 16 mg/kg) in sample 17A-GR-010-0-SS-02.



Legend

- Sampling Location
- - - - 2 Foot Contour
- Roadway
- ○ ○ ○ Fence
- - - - SWMU 17A Boundary
- Building

**Figure 4.4.3-3
 Soil Sampling Locations
 at SWMU 17A**



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Radionuclides

Table 4.4.3-3 presents a summary of the on-site gamma spectroscopy results for the ten surface soil samples and two duplicate samples collected during confirmatory sampling at SWMU 17A. Gamma activity resulting from uranium-238 and uranium-235 was not detected in the samples collected. However, a comparison to background is not possible because the minimum detectable activities (MDA) used in the analyses for uranium-238 and uranium-235 were above background levels. Although the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based preliminary remediation goal (PRG), which is based upon a 15-millirem-per-year (mrem/yr) effective dose equivalent (EDE) maximum dose limit found in EPA's OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA August 1997). Therefore, the analytical results are acceptable. Gamma activity resulting from thorium-234 was not detected above the background limit in any samples collected for SWMU 17A.

Gamma activity attributed to thorium-232 and radium-228 was detected in each of the samples collected, but at levels below background. Gamma activity from cesium-137 was detected in sample 17A-GR-010-0-SS-01 at 0.0468 picocuries per gram (pCi/g), which is well below the 0.664 pCi/g background activity limit. Results for the remaining samples indicate gamma activity from cesium-137 was not detected.

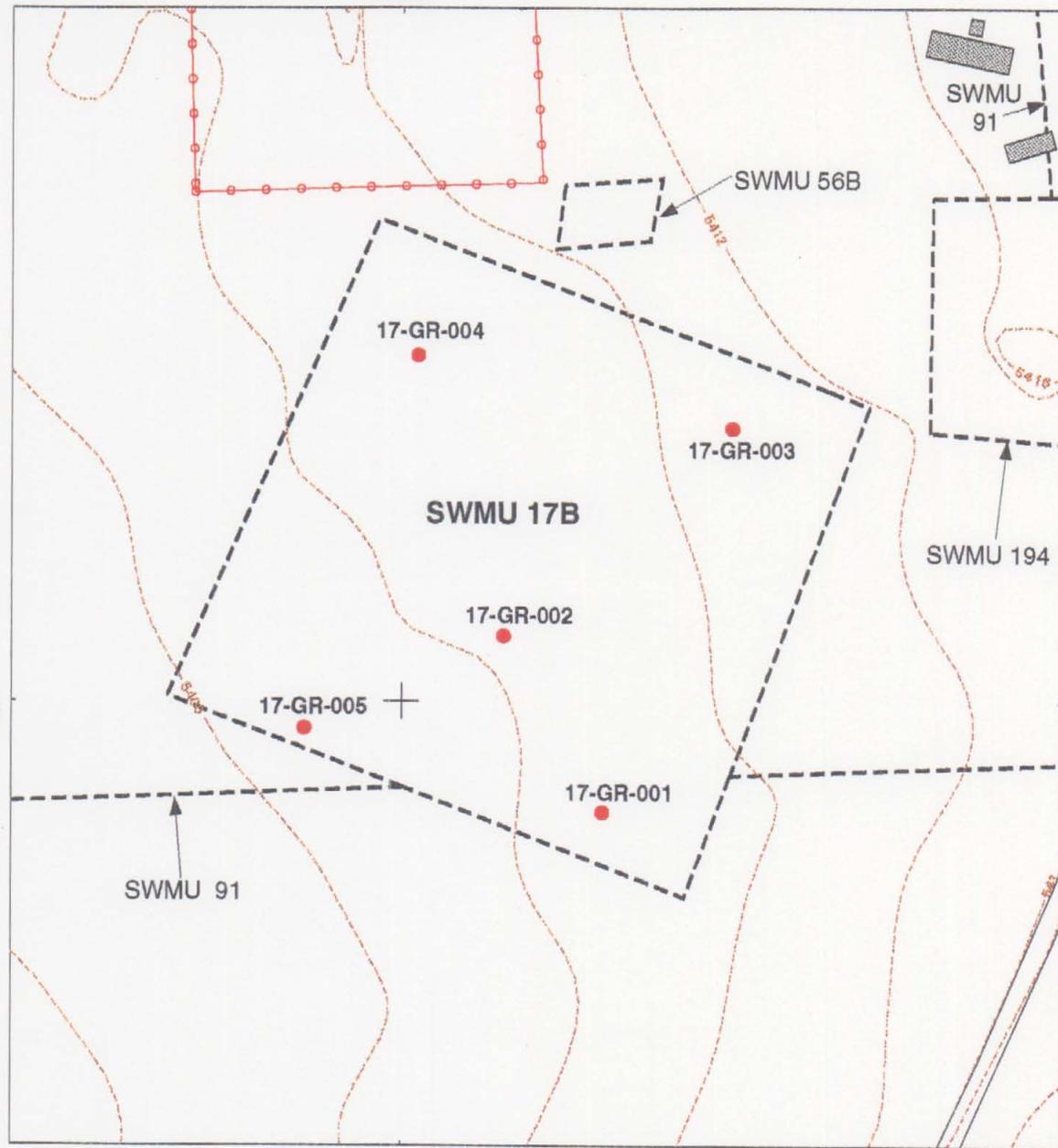
4.4.3.4.2 SWMU 17B

Five surface soil samples were collected at SWMU 17B and analyzed on site for metals and gamma activity. In addition, one split sample was sent to an off-site laboratory for verification analysis for metals. Table 4.4.3-2 summarizes the on- and off-site analytical results for metals. Table 4.4.3-3 summarizes results on gamma spectroscopy analysis. Figure 4.4.3-4 shows SWMU 17B confirmatory surface soil sample locations.

Metals

Table 4.4.3-2 presents a summary of the results of the metals analysis for the five surface soil samples and the one split sample collected during confirmatory sampling at SWMU 17B. Beryllium, cadmium, selenium, and silver were not detected in any of the samples. However, the cadmium, silver, and selenium detection limits exceeded nonquantified maximum background concentration limits. Mercury had one detection at an estimated concentration level of 0.07 J mg/kg in sample 17B-GR-005-0-SS-02. Arsenic and chromium were detected in the off-site analysis (17B-GR-005-0-SS-02) at concentration levels less than maximum background concentration limits. Barium (at 160 mg/kg and 220 mg/kg) and lead (270 mg/kg) concentration levels exceeded maximum background screening level concentration limits in samples 17B-GR-004-0-SS-02 and 17B-GR-005-0-SS-02. Nickel was detected above the maximum background at a concentration level of 14 mg/kg in the off-site analysis in sample 17B-GR-005-0-SS-02.

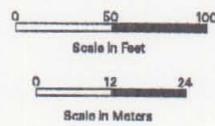
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Legend

- Sampling Location
- - - 2 Foot Contour
- Roadway
- ○ ○ Fence
- - - SWMU Boundary
- Building

Figure 4.4.3-4
Confirmatory Surface Soil Sample
Locations at SWMU 17B



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Radionuclides

Table 4.4.3-3 presents a summary of the on-site gamma spectroscopy results for the five surface soil samples and one duplicate sample collected during confirmatory sampling at SWMU 17B. Gamma activity resulting from uranium-238 and the short-lived daughter thorium-234 was not detected in the samples collected. However, for uranium-238 a comparison to background is not possible because the MDA used in the analyses were above background levels. The MDA used in the analyses for thorium-234 were all below or comparable to the background limit. Gamma activity resulting from uranium-235 was also not detected in the samples collected, and the MDAs were again above background. Although the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based PRG, which is based upon a 15-mrem/yr EDE maximum dose limit found in EPA's OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA August 1997). Therefore, the analytical results are acceptable. The results indicate that gamma activity attributed to thorium-232 and radium-228 was detected in each of the samples collected, but at levels below background. Gamma activity from cesium-137 was either detected at levels below background or not detected.

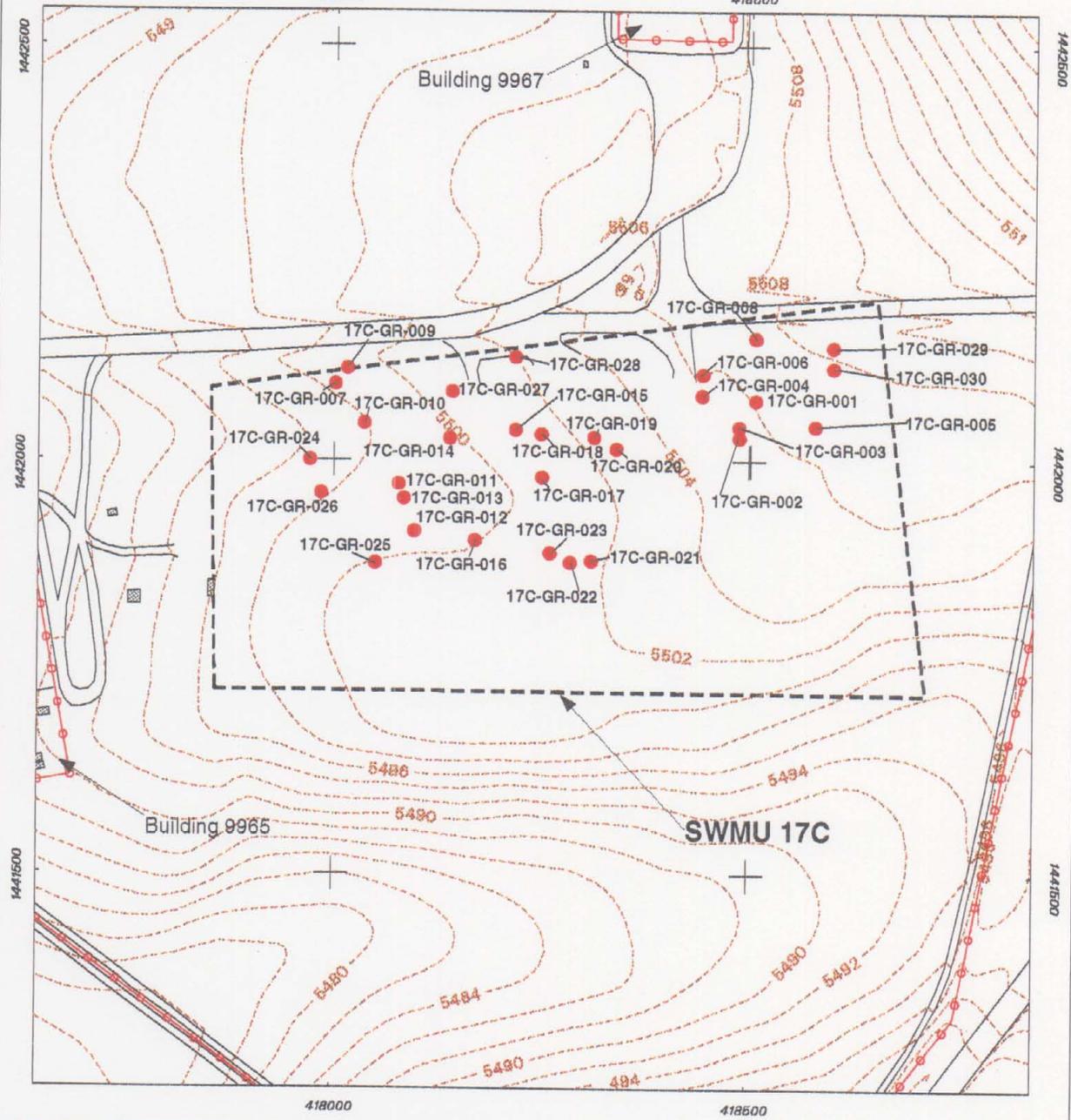
4.4.3.4.3 SWMU 17C

Thirty surface soil samples and three duplicate samples collected at SWMU 17C were analyzed on site for metals, gamma activity, and VOCs. In addition to the three duplicate samples, six split samples were sent to an off-site laboratory for verification analysis for metals and VOCs. Tables 4.4.3-2, 4.4.3-3, and 4.4.3-4 present the on- and off-site analytical results for metals, radionuclides, and VOCs, respectively. Figure 4.4.3-5 shows SWMU 17C confirmatory surface soil sample locations. Soil samples 17C-GR-002-0-SS-02, 17C-GR-003-0-SS-02, and 17C-GR-004-0-SS-02 were collected from the area where the two drums labeled *contaminated liquids* were stored.

Metals

Table 4.4.3-2 presents a summary of the results of the metals analysis for the 30 surface soil samples and six split samples collected during confirmatory sampling at SWMU 17C. Beryllium, cadmium, mercury, selenium, and silver were not detected in any of the samples. However, the cadmium, selenium, and silver detection limits exceeded maximum nonquantified background screening levels. Chromium and lead were detected in the off-site analyses below the maximum background concentration limits. Barium concentration levels were all at or below the maximum background concentration limit with the exception of sample 17C-GR-025-0.0-SSO (at a slightly elevated concentration level of 140 mg/kg). Arsenic (at 16S and 7.9 mg/kg) and nickel (at 17, 15, and 12 mg/kg) slightly exceeded the maximum background concentration limits in off-site analyses of samples 17C-GR-015-0.0-SSO, 17C-GR-020-0.0-SSO, and 17C-GR-025-0.0-SSO, respectively.

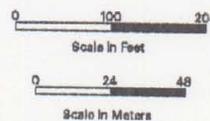
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Legend

- Sampling Location
- - - 2 Foot Contour
- Roadway
- Fence
- - - - SWMU Boundary
- ▒ Building

**Figure 4.4.3-5
Confirmatory Surface Soil Sample
Locations at SWMU 17C**



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Radionuclides

Table 4.4.3-3 presents a summary of the on-site gamma spectroscopy results for the 30 surface soil samples and three duplicate samples collected during confirmatory sampling at SWMU 17C. Gamma activity resulting from uranium-238 and uranium-235 was not detected in the samples collected. However, a comparison to background is not possible because the MDA used in the analyses for uranium-238 and uranium-235 were above background levels. Gamma activity resulting from thorium-234 was only detected in the duplicate sample 17C-GR-025-0-SSD-04 at 1.12 pCi/g, which is below the 1.4 pCi/g background level. Although the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based PRG, which is based on a 15-mrem/yr EDE maximum dose limit found in EPA's OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA August 1997). Therefore, the analytical results are acceptable. Gamma activity from thorium-234 was not detected in the remaining samples and the MDA used in those analyses were either below or comparable to the background limit. Gamma activity attributed to thorium-232 and radium-228 was detected in each of the samples collected, but at levels below background. Gamma activity from thorium-228 and cesium-137 was either not detected or detected below background in all the samples collected.

VOCs

Table 4.4.3-4 presents a summary of the results of the VOC analysis for 30 surface soil samples and six split samples collected for verification analysis during confirmatory sampling at SWMU 17C. No VOCs were detected in the samples analyzed at the on-site ER Chemistry Laboratory. VOCs were detected in four of the six split samples sent off site for analysis. Acetone was detected at concentration levels of 22, 19, and 11 µg/kg in samples 17C-GR-020-0.0-SSO, 17C-GR-025-0.0-SSO, and 17C-GR-030-0.0-SSO, respectively. Methylene chloride was detected at an estimated concentration level of 1.2 µg/kg in sample 17C-GR-010-0.0-SSO.

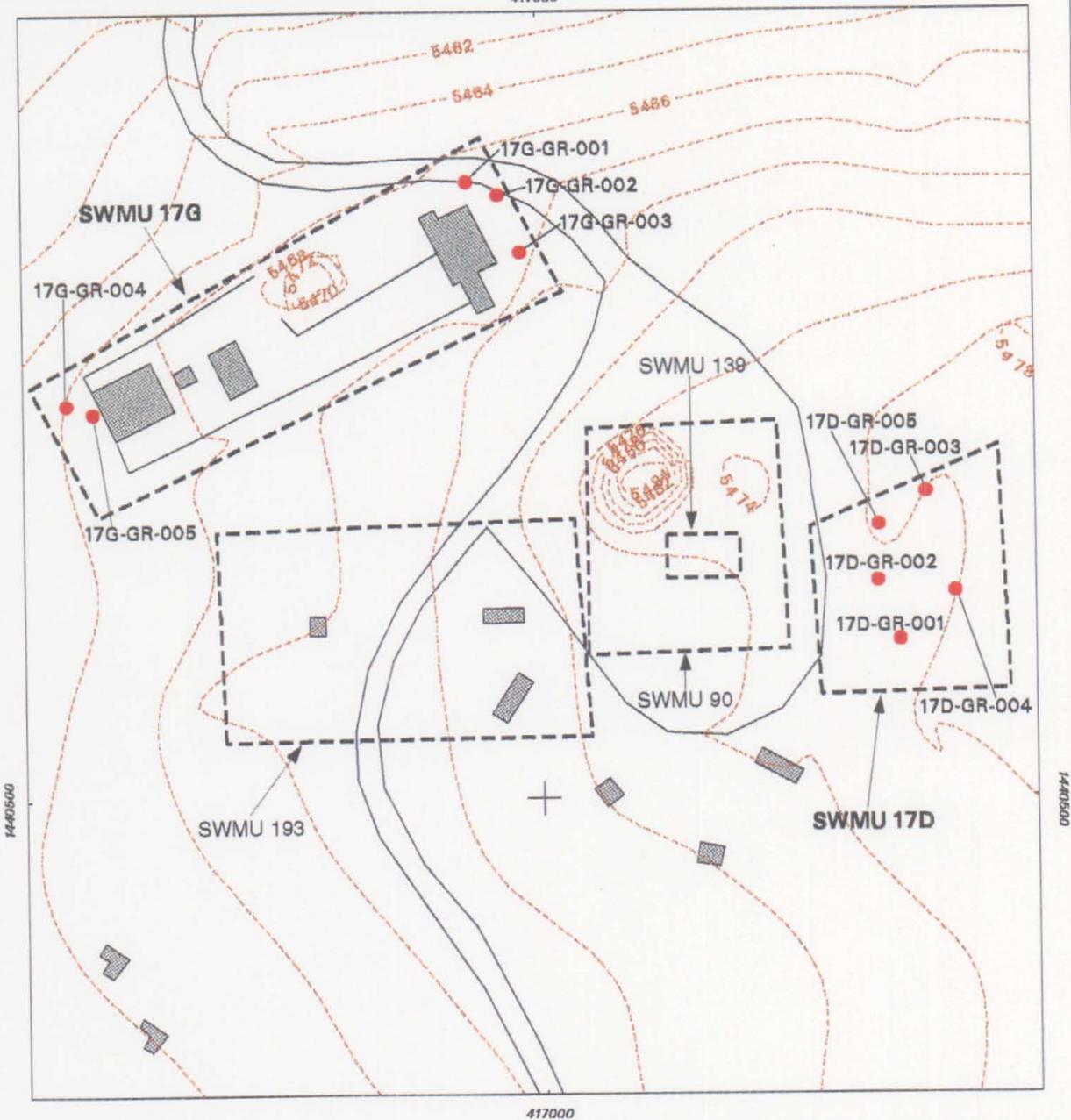
4.4.3.4.4 SWMU 17D

Five surface soil samples were collected at SWMU 17D and analyzed on site for metals and gamma activity. In addition, one split sample and one split duplicate sample were sent to an off-site laboratory for verification analysis for metals. Tables 4.4.3-2 and 4.4.3-3 present the on- and off-site analytical results for metals and radionuclides, respectively. Figure 4.4.3-6 shows SWMU 17D confirmatory surface soil sample locations.

Metals

Table 4.4.3-2 presents a summary of the results of the metals analysis for the five surface soil samples, one split sample, and one split duplicate sample collected during confirmatory sampling at SWMU 17D. Beryllium, cadmium, selenium, and silver were not detected in any of the samples. However, the cadmium, selenium, and silver detection limits exceeded

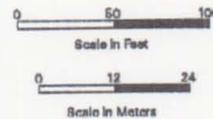
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Legend

- Sampling Location
- - - 2 Foot Contour
- Roadway
- - - SWMU Boundary
- Building

Figure 4.4.3-6
Confirmatory Surface Soil Sample
Locations at SWMU 17D and SWMU 17G



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nonquantified maximum background screening levels. Barium was below the background concentration limit in all samples with the exception of a slightly elevated concentration of 160 mg/kg in sample 17D-GR-003-0-SS-02. Chromium and lead were detected below the background concentration limits. Nickel was detected slightly above background (at 12 mg/kg) in sample 17D-GR-005-0-SS-02. The nickel concentration level in the duplicate split of this sample (17D-GR-005-SSD) (at 10 mg/kg) was less than the background concentration level of 11.5 mg/kg. Mercury was detected at a concentration of 0.12 J mg/kg (17D-GR-001-0-SS-02). Mercury does not have a quantified background value.

Radionuclides

Table 4.4.3-3 presents a summary of the on-site gamma spectroscopy results for the five surface soil samples and one duplicate sample collected during confirmatory sampling at SWMU 17D. Gamma activity resulting from uranium-238 and uranium-235 was not detected in the samples. However, a comparison to background is not possible because the MDA used in the analyses for uranium-238 and uranium-235 were above background levels. Although the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based PRG, which is based upon a 15-mrem/yr EDE maximum dose limit found in EPA's OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA August 1997). Therefore, the analytical results are acceptable. Gamma activity resulting from thorium-234 was not detected above the 1.4 pCi/g background level in any samples collected at SWMU 17D.

Gamma activity attributed to thorium-232 and radium-228 was detected in each sample collected but at levels below background. Similarly, gamma activity from cesium-137 was detected in each sample collected, but not above the background limit.

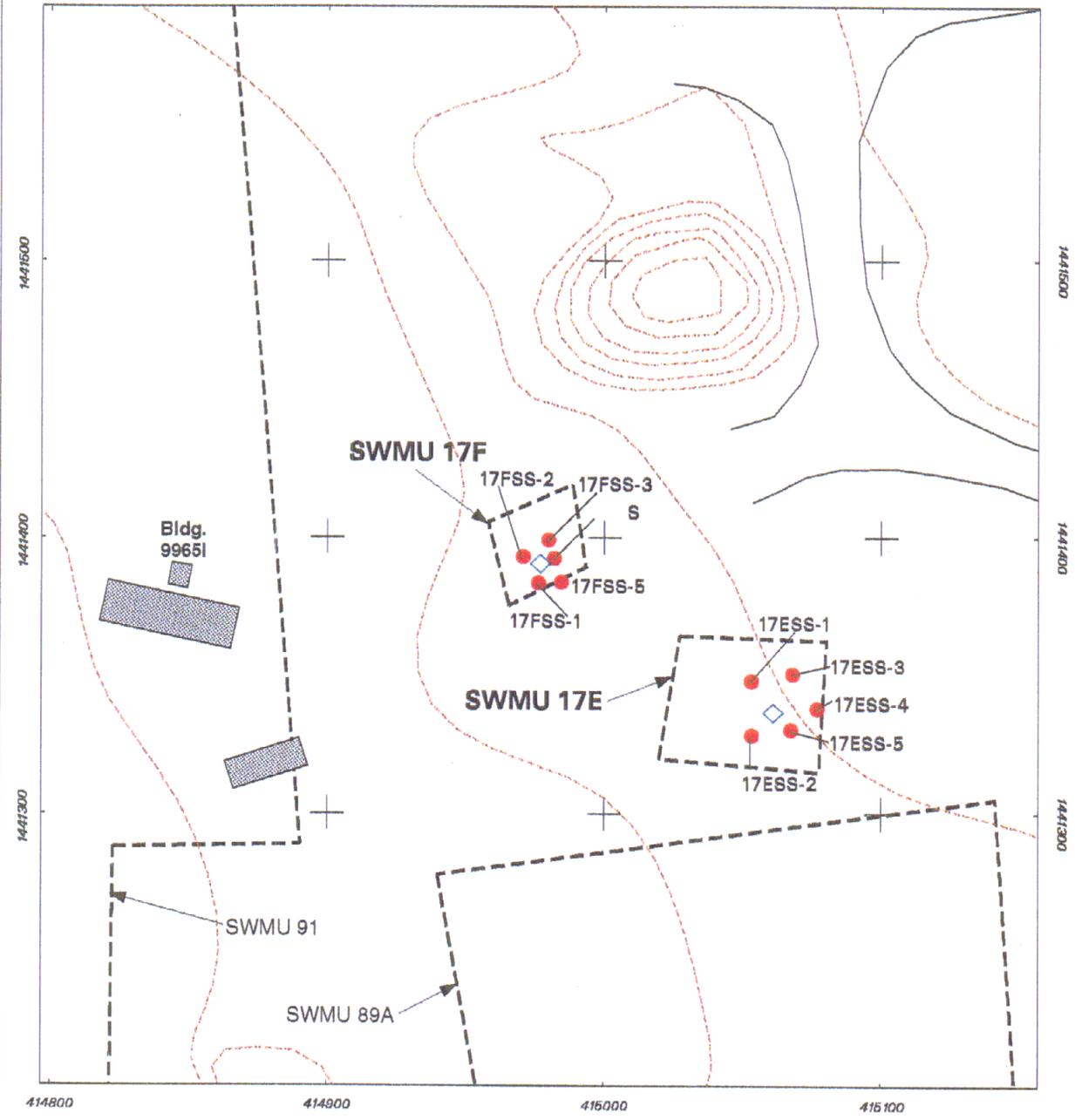
4.4.3.4.5 *SWMU 17E*

Five surface soil samples were collected at SWMU 17E and analyzed on site for metals and gamma activity. In addition, one split sample was sent to an off-site laboratory for verification analysis for metals. Tables 4.4.3-2 and 4.4.3-3 present the on- and off-site analytical results for metals and radionuclides, respectively. The samples were collected from areas around existing scrap piles. Figure 4.4.3-7 shows SWMU 17E confirmatory surface soil sample locations.

Metals

Table 4.4.3-2 presents a summary of the results of the metals analysis for the five surface soil samples and one split sample collected during confirmatory sampling at SWMU 17E. Arsenic, beryllium, cadmium, mercury, selenium, and silver were not detected in any of the samples. However, the cadmium, arsenic, selenium, and silver detection limits exceeded nonquantified maximum background screening levels.

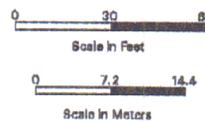
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Legend

-  Scrap Pile Location
-  Sampling Location
-  2 Foot Contour
-  Roadway
-  SWMU Boundary
-  Building
-  Concrete Pad

Figure 4.4.3-7
Confirmatory Surface Soil Sample Locations
at SWMU 17E and SWMU 17F



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Barium, chromium, and lead were found at levels below the background concentration limits. Nickel (at 12 mg/kg) was detected by the off-site analysis at a slightly elevated level above the background concentration limits of 11.5 mg/kg.

Radionuclides

Table 4.4.3-3 presents a summary of the on-site gamma spectroscopy results for the five surface soil samples and one duplicate sample collected during confirmatory sampling at SWMU 17E. Gamma activity resulting from uranium-238 and the short-lived daughter thorium-234 was not detected in the samples collected. However, for uranium-238 a comparison to background is not possible because the MDA used in the analyses were above background levels. The MDAs used in the analyses for thorium-234 were all below the background limit. Gamma activity resulting from uranium-235 was also not detected in the samples collected and the MDA was again above background. Although the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based PRG, which is based upon a 15-mrem/yr EDE maximum dose limit found in EPA's OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA August 1997). Therefore, the analytical results are acceptable. Gamma activity attributed to thorium-232 and radium-228 was either not detected or detected at levels below background. Gamma activity from cesium-137 was not detected above background in the samples collected.

4.4.3.4.6 SWMU 17F

Five surface soil samples and one duplicate sample were collected at SWMU 17F and analyzed on site for metals and gamma activity. In addition, one split duplicate sample was sent to an off-site laboratory for verification analysis for metals. Tables 4.4.3-2 and 4.4.3-3 present the on- and off-site analytical results for metals and radionuclides, respectively. The samples were collected from areas around existing scrap piles. Figure 4.4.3-7 shows SWMU 17F confirmatory surface soil sample locations.

Metals

Table 4.4.3-2 presents a summary of the results of the metals analysis for the five surface soil samples, one split sample, and split duplicate sample collected during confirmatory sampling at SWMU 17F. Beryllium, cadmium, mercury, selenium, and silver were not detected in any of the samples. However, the cadmium, selenium, and silver detection limits exceeded the nonquantified maximum background screening levels. Arsenic, barium, chromium, lead, and nickel were detected at levels at or below the background concentration limits. Mercury was detected at a concentration of 0.08 J mg/kg. Mercury does not have a quantified background concentration.

Radionuclides

Table 4.4.3-3 presents a summary of the on-site gamma spectroscopy results for the five surface soil samples and one duplicate sample collected during confirmatory sampling at SWMU 17F. Gamma activity resulting from uranium-238 and uranium-235 was not detected in the samples collected. However, since the MDA used in the analyses for uranium-238 and uranium-235 were above background levels, no comparison is possible. Although the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based PRG, which is based upon a 15-mrem/yr EDE maximum dose limit found in EPA's OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA August 1997). Therefore, the analytical results are acceptable. Gamma activity resulting from thorium-234 was not detected above the 1.4 pCi/g background limit.

Gamma activity attributed to thorium-232 and radium-228 was detected in each sample collected but at levels below background. Gamma activity from cesium-137 was either not detected or detected below the 0.664 pCi/g background activity limit.

4.4.3.4.7 SWMU 17G

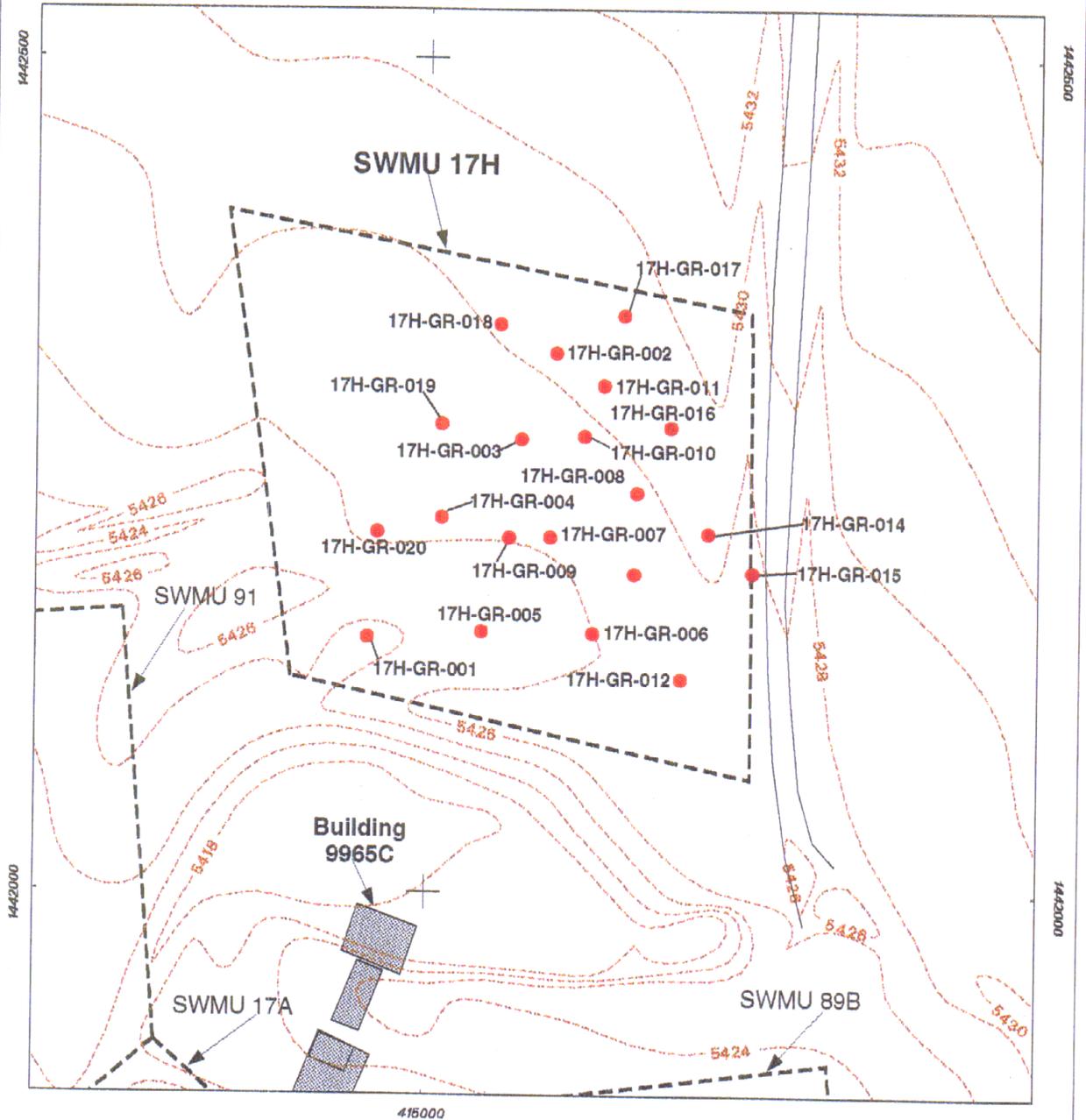
Five surface soil samples were collected at SWMU 17G and analyzed on site for metals and gamma activity. In addition, one split sample was sent to an off-site laboratory for verification analysis for metals. Tables 4.4.3-2 and 4.4.3-3 present the on- and off-site analytical results for metals and radionuclides, respectively. SWMU 17G was actually the site of a small shock tube. Sample locations were selected at the ends of the shock tube to determine soil quality in these areas. Figure 4.4.3-6 shows SWMU 17G confirmatory surface soil sample locations.

Metals

Table 4.4.3-2 presents a summary of the results of the metals analysis for the five surface soil samples and one split sample collected during confirmatory sampling at SWMU 17G. Arsenic, beryllium, cadmium, mercury, nickel, selenium, and silver were not detected in any of the samples. Barium, chromium, and lead were detected at levels below background concentration limits. However, the arsenic, cadmium, selenium, and silver detection limits exceeded maximum nonquantified background concentration limits.

Radionuclides

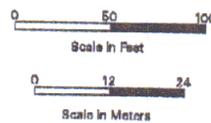
Table 4.4.3-3 presents a summary of the on-site gamma spectroscopy results for the five surface soil samples collected during confirmatory sampling at SWMU 17G. Gamma activity resulting from uranium-238 and the short-lived daughter thorium-234 was not detected in the samples collected. However, for uranium-238 a comparison to background is not possible because the MDA used in the analyses were above background levels. The MDA used in the analyses for thorium-234 were all below the background limit. Similarly, gamma activity resulting from uranium-235 was not detected in the samples collected, and the MDA was again above background. Although the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude



Legend

- Sampling Location
- - - - - 2 Foot Contour
- Roadway
- - - - - SWMU Boundary
- ▒ Building

**Figure 4.4.3-8
Soil Sampling Locations
at SWMU 17H**



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

less than a risk-based PRG, which is based upon a 15-mrem/yr EDE maximum dose limit found in EPA's OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA August 1997). Therefore, the analytical results are acceptable.

Gamma activity attributed to thorium-232 and radium-228 was detected at levels well below the 1.01 pCi/g background limit. Similarly, gamma activity from cesium-137 was not detected above background in the samples collected.

4.4.3.4.8 SWMU 17H

Twenty surface soil samples and three duplicate samples were collected at SWMU 17H and analyzed on site for metals, gamma activity, and VOCs. In addition to the three duplicate samples, four split samples and one duplicate split sample were sent to an off-site laboratory for verification analysis for metals and VOCs. Tables 4.4.3-2, 4.4.3-3, and 4.4.3-4 present the on- and off-site analytical results for metals, radionuclides, and VOCs, respectively. Figure 4.4.3-8 shows SWMU 17H confirmatory surface soil sample locations.

Metals

Table 4.4.3-2 presents a summary of the results of the metals analysis for the 20 surface soil samples three duplicate, and five split samples collected during confirmatory sampling at SWMU 17H. Beryllium, cadmium, selenium, and silver were not detected in any of the samples. However, the cadmium, selenium, and silver detection limits exceed the maximum nonquantified background concentration limits. Chromium and lead were detected below the background concentration limits. Mercury was detected at 0.24 mg/kg in sample 17H-GR-015-0-SS-02 (on-site laboratory). Mercury was not detected in any of the off-site sample analyses.

Arsenic levels (at 57 mg/kg) exceeded the background concentration limit of 5.6 mg/kg in one of the samples analyzed on site (17H-GR-009-0-SS-02). In all other samples arsenic was detected at levels less than the background concentration limit. Barium concentration levels were slightly elevated (at from 140 to 160 mg/kg) in samples 17H-GR-005-0-SS-05, 17H-GR-006-0-SS-02, 17H-GR-010-0-SS-05, 17H-GR-015-0-SS-05, 17H-GR-020-0-SS-05, and 17H-GR-020-0-SSD-05. Nickel concentrations were also slightly elevated (at from 12 to 14 mg/kg) in samples 17H-GR-005-0-SS-05, 17H-GR-010-0-SS-05, 17H-GR-015-0-SS-05, and 17H-GR-020-0-SSD-05.

Radionuclides

Table 4.4.3-3 presents a summary of the on-site gamma spectroscopy results for the 20 surface soil samples and three duplicate samples collected during confirmatory sampling at SWMU 17H. Gamma activity resulting from uranium-238 and the short-lived daughter thorium-234 was not detected in the samples collected. However, for uranium-238 a comparison to background is not possible because the MDA used in the analyses were above background levels. The MDA used in the analyses for thorium-234 were either below or comparable to the background limit. Similarly, gamma activity resulting from uranium-235 was not detected in the samples collected, and the MDA was again above background. Although the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based PRG, which is based upon a 15-mrem/yr EDE maximum dose limit found in EPA's OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA August 1997). Therefore, the analytical results are acceptable.

Gamma activity attributed to thorium-232 and radium-228 was detected in each of the samples collected, but at levels below the 1.01 pCi/g background limit. Similarly, gamma activity from cesium-137 was either not detected or not detected above background in each sample collected.

VOCs

Table 4.4.3-4 presents a summary of the results of the VOC analysis for the 20 surface soil samples, four split samples, and one duplicate sample collected during confirmatory sampling at SWMU 17H. Acetone, trichloroethene, and 2-hexanone were detected at low parts-per-billion concentration levels (5.6 to 34 µg/kg) in three of the surface soil samples analyzed on site from two sampling locations (17H-GR-012-0-SS-18, 17H-GR-020-0-SS-18, and 17H-GR-020-0-SSD-19 [duplicate]). Acetone was detected at a concentration level of 13 µg/kg in only one of the five split samples sent off site for verification analysis (17H-GR-015-0-SS-11).

4.4.3.4.9 Quality Assurance/Quality Control Results

Metals

Table 4.4.3-2 presents results of the analysis of metals quality assurance/quality control (QA/QC) samples collected during confirmatory sampling. All QA/QC samples for metals analyses were performed on split samples sent off-site for verification analysis. In addition, QA/QC samples consisted of four field blanks (17C-GR-016-0.0-FB, 17F-GR-005-0-FB-07, 17G-GR-005-FB-16, and 17H-GR-020-0-FB-07) and four equipment blanks (17C-GR-016-0.0-EB, 17F-GR-005-0-EB-06, 17G-GR-005-EB-15, and 17H-GR-020-0-EB-06). Results of analyses showed concentration levels of arsenic present at the detection limit (0.010 mg/liter [L]) in two field blanks and two equipment blanks. Lead was present at approximately the detection limit (0.0032 mg/L) in one equipment blank and one field blank. No other metals were detected in the equipment or field blanks.

Eight duplicate soil samples (17A-GR-010-0-SSD-03, 17C-GR-005-0-SSD-03, 17C-GR-015-0-SSD-03, 17C-GR-025-0-SSD-03, 17F-GR-005-0-SSD-03, 17H-GR-005-0-SSD-03, 17H-GR-015-0-SSD-03, and 17H-GR-020-0-SSD-03) were collected during confirmatory

sampling at SWMU 17 and analyzed on site for metals. The relative percent difference (RPD) for barium (only metal detected) ranged from 0 percent to 58 percent.

Nineteen split samples (17A-GR-005-0-SS-02, 17A-GR-010-0-SS-02, 17B-GR-005-0-SS-02, 17C-GR-005-0.0-SSO, 17C-GR-010-0.0-SSO, 17C-GR-015-0.0-SSO, 17C-GR-020-0.0-SSO, 17C-GR-025-0.0-SSO, 17C-GR-030-0.0-SSO, 17D-GR-005-0-SSD-02, 17D-GR-005-SSD, 17E-GR-005-0-SS-02, 17F-GR-005-0-SS-02, 17G-GR-005-SSD-02, 17H-GR-005-SS-05, 17H-GR-010-SS-05, 17H-GR-015-SS-05, 17H-GR-020-0-SS-05, and 17H-GR-020-0-SSD-05) were collected during confirmatory sampling at SWMU 17 and were analyzed off site for verification analysis for metals. The RPDs for all metals detected ranged from 0 percent to 18 percent. Because of the lower MDL in off-site analyses, metals such as arsenic, barium, chromium, lead, and nickel were detected in the off-site samples only.

Radionuclides

Table 4.4.3-3 presents analytical results of radionuclides in QA/QC samples collected during confirmatory sampling. All QA/QC analyses for radionuclides were performed on site. QA/QC samples consisted of four field blanks (17C-GR-016-0.0-FB, 17D-GR-005-FB-01, 17F-GR-005-0-FB-12, and 17H-GR-020-FB-01) and four equipment blanks (17C-GR-016-0.0-EB, 17D-GR-005-EB-01, 17F-GR-005-0-EB-13, and 17H-GR-020-EB-01). No radionuclides were detected in any of the equipment or field blanks.

Twelve duplicate soil samples (17A-GR-005-0-SSD-04, 17A-GR-010-0-SSD-04, 17B-GR-005-0-SSD-04, 17C-GR-005-0-SSD-04, 17C-GR-015-0-SSD-04, 17C-GR-025-0-SSD-04, 17D-GR-005-SSD-01, 17E-GR-005-0-SSD-04, 17F-GR-005-0-SSD-04, 17H-GR-005-0-SSD-04, 17H-GR-015-0-SSD-04, and 17H-GR-020-0-SSD-04) were collected during confirmatory sampling at SWMU 17 and were analyzed on site for radionuclides using gamma spectroscopy. Activities of radionuclides in the duplicate samples were comparable to those detected in the equivalent primary samples (Annex 4-B).

VOCs

Two field blanks (17C-GR-016-0.0-FB and 17H-GR-020-0-FB-09), two equipment blanks (17C-GR-016-0.0-EB and 17H-GR-020-0-EB-08), and two trip blanks (17C-GR-016-0.0-TB and 17H-GR-020-0-TB-10) were collected during confirmatory sampling at SWMU 17 and were analyzed at the off-site analytical laboratory. No VOCs were detected in any of the blanks.

Six duplicate soil samples (17C-GR-005-0-SSD-19, 17C-GR-015-0-SSD-19, 17C-GR-025-0-SSD-19, 17H-GR-005-0-SSD-19, 17H-GR-015-0-SSD-19, and 17H-GR-020-0-SSD-19) were collected during confirmatory sampling at SWMUs 17C and 17H and were analyzed on site for VOCs. With the exception of 20 µg/kg of acetone in sample 17H-GR-020-0-SSD-19, no concentrations of VOCs were detected in any of the duplicate samples analyzed on site. The RPD for sample 17H-GR-020 was 52 percent.

Eleven split samples (17C-GR-005-0.0-SSO, 17C-GR-010-0.0-SSO, 17C-GR-015-0.0-SSO, 17C-GR-020-0.0-SSO, 17C-GR-025-0.0-SSO, 17C-GR-030-0.0-SSO, 17H-GR-005-0-SS-11, 17H-GR-010-0-SS-11, 17H-GR-015-0-SS-11, 17H-GR-020-0-SS-11, and 17H-GR-020-SSD-11) collected during confirmatory sampling at SWMU 17 were analyzed off-site for verification analyses of VOCs. In most cases, absence of detectable VOCs in the split samples analyzed

off site were comparable to the on-site laboratory analytical results. However, low concentrations of acetone (at up to 22 µg/kg) were detected in three of the samples from SWMU 17C and in one sample from SWMU 17H. No duplicate samples were analyzed for VOCs and therefore no RPD was calculated.

Data Validation

The SNL/NM Sample Management Office conducted Data Validation I and Data Validation II reviews of off-site data in accordance with Technical Operating Procedure 94-03, Rev. 0 (SNL/NM July 1994). An independent review of the validation process confirmed that the reviews performed by SNL/NM were accurate and that the data are acceptable for use in this NFA proposal for SWMU 17 (Annex 4-C). All gamma spectroscopy data were reviewed by SNL/NM Department 7713 in accordance with the RPSD Procedure RPSD-02-11 (SNL/NM July 1996). Although the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based PRG, which is based upon a 15-mrem/yr EDE maximum dose limit found in EPA's OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA August 1997). Therefore, the analytical results are acceptable.

4.5 Site Conceptual Model

4.5.1 Nature and Extent of Contamination

The COCs at the eight subunits within SWMU 17 are metals and radionuclides associated with the weathering of scrap metal, and in the case of SWMU 17B, with additional dispersion testing. In almost all cases, the COCs are only slightly elevated above the maximum background limits specified for the Southwest Test Area (Dinwiddie September 24, 1997). The COCs for the SWMU 17 subunits are summarized in Table 4.5.1-1. The COCs that exceed the maximum background limits typically occur as isolated *hot spots* of one or two different COCs with no particular COC associations, no correlation to particular scrap pile sources, or areas that could be delineated as contaminated. No elevated concentrations of metals or radionuclides are anticipated below the ground surface at any of the eight scrap yard subunits because the release mechanism at the sites is the surficial weathering of scrap material stored above ground. The additional dispersion testing at SWMU 17B may have released COCs as airfall of radionuclides to the ground surface during testing activities. There has been no documented historical activities at the subunits causing a ground surface disturbance that could have mixed surface and subsurface soil.

4.5.1.1 SWMU 17A

Environmental samples were collected from 10 locations from surface soils across the subunit. Barium concentrations exceeded the maximum background limit of 130 mg/kg in five samples collected from the northern and eastern sampling locations (17A-GR-006, -007, -008, -009, and -010). However, the average barium concentration for the subunit is 127 mg/kg. Lead was elevated in two samples collected from the center of the site at concentrations of 26 J mg/kg

**Table 4.5.1-1
Summary of COCs for SWMU 17**

SWMU Subunit	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
17A	10 environmental, 3 duplicates	Barium	130	180	127	17A-GR-006 17A-GR-007 17A-GR-008 17A-GR-009 17A-GR-010
		Chromium	17.3	18	10.6	17A-GR-010
		Nickel	11.5	16	5.5	17A-GR-010
		Lead	21.4	26 J	12.6	17A-GR-005 17A-GR-010
		Cadmium	<1	ND <10	8.6	All samples
		Selenium	<1	ND <50	42.5	All samples
		Silver	<1	ND <10	8.8	All samples
		U-238	1.4 pCi/g	ND (6.5) pCi/g	Not calculated	All samples
		U-235	0.16 pCi/g	ND (0.461) pCi/g	Not calculated	All samples
17B	5 environmental, 1 duplicate, 5 radiological VCM, 1 duplicate	Barium	130	220	143	17B-GR-004 17B-GR-005
		Nickel	11.5	14	5.6	17B-GR-005
		Lead	21.4	270	54.8	17B-GR-004
		Cadmium	<1	ND <10	8.5	All samples
		Selenium	<1	ND <50	41.8	All samples
		Silver	<1	ND <10	8.7	All samples
		U-238	1.4 pCi/g	19.1 pCi/g	Not calculated	17BE3B-SS
		U-235	0.16 pCi/g	0.26 pCi/g ^a	Not calculated	17BE3B-SS
		Arsenic	5.6	16 S	43.3	17C-GR-015 17C-GR-020
17C	30 environmental, 9 duplicates	Barium	130	140	81	17C-GR-025
		Nickel	11.5	17	5.2	17C-GR-015 17C-GR-020 17C-GR-025
		Cadmium	<1	ND <10	8.6	All samples
		Selenium	<1	ND <50	42.4	All samples
		Silver	<1	ND <10	8.8	All samples
		U-238	1.4 pCi/g	ND (6.47) pCi/g	Not calculated	All samples
		U-235	0.16 pCi/g	ND (0.455) pCi/g	Not calculated	All samples
		Acetone	Not applicable	22 µg/kg ^a	6.4 µg/kg	17C-GR-020 17C-GR-025 17C-GR-030
		Methylene Chloride	Not applicable	1.2 J µg/kg	1.6 µg/kg	17C-GR-010

Refer to footnotes at end of table

**Table 4.5.1-1 (Continued)
Summary of COCs for SWMU 17**

SWMU Subunit	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
17D	5 environmental, 2 duplicates	Barium	130	160	99	17D-GR-003
		Nickel	11.5	12	6	17D-GR-005
		Cadmium	<1	ND <10	7.4	All samples
		Selenium	<1	ND <50	36.0	All samples
		Silver	<1	ND <10	7.7	All samples
		U-238	1.4 pCi/g	ND (5.21) pCi/g	Not calculated	All samples
		U-235	0.16 pCi/g	ND (0.383) pCi/g	Not calculated	All samples
17E	5 environmental, 1 duplicate	Nickel	11.5	12	5.3	17E-GR-005
		Cadmium	<1	ND <10	8.5	All samples
		Selenium	<1	ND <50	41.8	All samples
		Silver	<1	ND <10	8.7	All samples
		U-238	1.4 pCi/g	ND (6.19) pCi/g	Not calculated	All samples
		U-235	0.16 pCi/g	ND (0.388) pCi/g	Not calculated	All samples
17F	5 environmental, 2 duplicates	Cadmium	<1	ND <10	8.7	All samples
		Selenium	<1	ND <50	43.0	All samples
		Silver	<1	ND <10	8.9	All samples
		U-238	1.4 pCi/g	ND (5.69) pCi/g	Not calculated	All samples
		U-235	0.16 pCi/g	ND (0.426) pCi/g	Not calculated	All samples
17G	5 environmental, 1 duplicate	Cadmium	<1	ND <10	8.5	All samples
		Selenium	<1	ND <50	41.8	All samples
		Silver	<1	ND <10	9.0	All samples
		U-238	1.4 pCi/g	ND (4.97) pCi/g	Not calculated	All samples
		U-235	0.16 pCi/g	ND (0.377) pCi/g	Not calculated	All samples
17H	20 environmental, 8 duplicate	Arsenic	5.6	57	42.1	17H-GR-009
		Barium	130	160	113	17H-GR-005 17H-GR-006 17H-GR-010 17H-GR-015 17H-GR-020
		Nickel	11.5	14	5.6	17H-GR-005 17H-GR-010 17H-GR-015 17H-GR-020
		Mercury	Not applicable	0.24	Not calculated	17H-GR-015
		Cadmium	<1	ND <10	8.4	All samples
		Selenium	<1	ND <50	41.2	All samples
		Silver	<1	ND <10	8.6	All samples
		U-238	1.4 pCi/g	ND (6.71) pCi/g	Not calculated	All samples
		U-235	0.16 pCi/g	ND (0.495) pCi/g	Not calculated	All samples

Refer to footnotes at end of table

Table 4.5.1-1 (Concluded)
Summary of COCs for SWMU 17

SWMU Subunit	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
		Acetone	Not Applicable	34 µg/kg	8 µg/kg	17H-GR-012 17H-GR-015 17H-GR-020
		Trichloroethene	Not Applicable	5.6 µg/kg	2 µg/kg	17H-GR-020
		2-Hexanone	Not Applicable	8.5 J µg/kg	5.2 µg/kg	17H-GR-012

^aSWTA = Southwest Test Area (Dinwiddie September 24, 1997).

^bAverage concentration includes all samples and duplicates. For nondetectable results, the detection limit is used to calculate the average.

^cpCi/g = Picocurie(s) per gram.

^dAn average MDA is not calculated because of the variability of the counting error and the number of reported non-detectable activities. These nondetectable activities are solely a function of instrument counting duration and not an indication of presence or absence of a specific radionuclide in the environment.

^eU-235 was calculated using the U-238 concentration and assuming that the U-238 to U-235 ratio was equal to that detected during waste characterization of depleted uranium-contaminated soils during the radiological corrective measures project where U-235 = U-238/73 (Brown January 1998).

^fDetection limit 50 mg/kg for 23 samples.

^gµg/kg = micrograms per kilogram.

COC = Constituent of concern.

J = The estimated value reported is either above the highest calibration standard or less than the practical quantification limit.

MDA = Minimum detectable activity.

mg/kg = Milligram(s) per kilogram.

ND = Radionuclide not present above the MDA give in ().

S = Reported value was determined from the method of standard addition.

SWMU = Solid waste management unit.

and 23 mg/kg. Sample location 17A-GR-010, located in the northwestern corner of the site, contained slightly elevated chromium (at 18 mg/kg) and nickel (at 16 mg/kg) in addition to the elevated barium concentration. The average metals concentrations for all COCs are below the maximum background limits. In most samples, the uranium-238 and uranium-235 activities could not be defined because the MDAs exceeded the maximum background limits. Although the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based PRG, therefore, the analytical results are acceptable. A summary of the COCs exceeding maximum background limits and the location of the COCs are provided in Table 4.5.1-1 and Figure 4.4.3-3, respectively.

4.5.1.2 SWMU 17B

Following the radiological VCM at the subunit, five radiological VCM confirmation samples were collected in addition to five environmental samples for metals and radionuclides from surface soils. Barium (at 160 mg/kg) and nickel (at 14 mg/kg) were slightly elevated in the southwestern corner of the site. In the northwestern corner of the site, barium (at 220 mg/kg), and lead (at 270 mg/kg) were elevated relative to maximum background limits. The uranium-238 and uranium-235 activities could not be defined in the environmental samples because the MDAs exceeded the maximum background limits. Although the MDA for gamma emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based PRG, therefore, the analytical results are acceptable. Residual gamma activity following the VCM included uranium-235, uranium-238, and thorium-234 activity in all sampling locations with the exception of uranium-238 in 17BE5-SS. A summary of the COCs exceeding maximum background limits and the location of the COCs is provided in Table 4.5.1-1. VCM confirmation and environmental sample locations are shown on Figures 4.4.3-2 and 4.4.3-4, respectively.

4.5.1.3 SWMU 17C

Environmental samples were collected from 30 locations from surface soils across the subunit. Barium concentrations slightly exceeded the maximum background limit in one sample collected from the southwest quadrant of the subunit. Elevated nickel concentrations of 17 mg/kg, 15 mg/kg, and 12 mg/kg in sample locations 17C-GR-015, 17C-GR-020, and 17C-GR-025, respectively. Arsenic was also detected in sample locations 17C-GR-020 and 17C-GR-025 at concentrations of 16 S mg/kg and 7.9 mg/kg, respectively. The uranium-238 and uranium-235 activities at all sample locations could not be defined in the environmental samples because the MDAs exceeded the maximum background limits. At seven environmental sample locations thorium-234 activities could not be defined because the MDA also exceeded the maximum background limits. Low concentrations of VOCs were restricted to several off-site duplicate samples. Like the occurrence of metal COCs, the location of VOCs detections is spurious. Acetone was detected at concentrations of 22 µg/kg, 19 µg/kg, and 11 µg/kg in sample locations 17C-GR-020, 17C-GR-025, and 17C-GR-030, respectively. Methylene chloride was estimated at 1.2 J µg/kg in sample location 17C-GR-010. A summary of the COCs detected and the location of the COCs is provided in Table 4.5.1-1 and Figure 4.4.3-5, respectively.

4.5.1.4 SWMU 17D

Environmental samples were collected from five locations from surface soils across the subunit. The only metal COCs identified above background were nickel (17D-GR-005) and barium (17D-GR-003) on the north side of the site. The nickel concentration of 12 mg/kg and the barium concentration of 160 mg/kg were both slightly elevated above the maximum background limits. Average concentrations of nickel and barium were well below the background concentration limits for those metals. In most samples, the uranium-238 and uranium-235 activities could not be defined because the MDAs exceeded the maximum background limits. Although the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based PRG, which is based upon a 15-mrem/yr EDE maximum dose limit found in EPA's OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA August 1997). Therefore, the analytical results are acceptable. A summary of the COCs exceeding maximum background limits and the location of the COCs is provided in Table 4.5.1-1 and Figure 4.4.3-6, respectively.

4.5.1.5 SWMU 17E

Only one of the five environmental sample locations contained a metal COC exceeding the maximum background limit in surface soil. A nickel concentration of 12 mg/kg, slightly exceeding the maximum background limit of 11.5 mg/kg, was detected in the surface soil sample 17E-GR-005 on the southeastern corner of the existing scrap pile. The uranium-238 and uranium-235 activities could not be defined because the MDAs exceeded the maximum background limits. Although the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based PRG, which is based upon a 15-mrem/yr EDE maximum dose limit found in EPA's OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA August 1997). Therefore, the analytical results are acceptable. A summary of the COCs exceeding maximum background limits and the location of the COCs is provided in Table 4.5.1-1 and Figure 4.4.3-7, respectively.

4.5.1.6 SWMU 17F

Environmental samples collected from five locations from surface soils at the subunit contained no metal COCs exceeding the maximum background limits except for mercury because mercury does not have a quantified background limit. In most samples, the uranium-238 and uranium-235 activities could not be defined because the MDAs exceeded the maximum background limits. Although the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based PRG, which is based upon a 15-mrem/yr EDE maximum dose limit found in EPA's OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA August 1997). Therefore, the analytical results are acceptable. A summary of the COCs exceeding maximum background limits and the location of the COCs is provided in Table 4.5.1-1 and Figure 4.4.3-7, respectively.

4.5.1.7 SWMU 17G

There are no nonradiological COCs identified from the five surface soil analyses performed from the subunit above background. The uranium-238 and uranium-235 activities could not be defined because the MDAs exceeded the maximum background limits. Although the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based PRG, which is based on a 15-mrem/yr EDE maximum dose limit found in EPA's OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA August 1997). Therefore, the analytical results are acceptable. A summary of the COCs exceeding maximum background limits and the location of the COCs is provided in Table 4.5.1-1 and Figure 4.4.3-6, respectively.

4.5.1.8 SWMU 17H

Samples were collected from 20 surface soil locations across the subunit. Barium and nickel were both slightly elevated above the maximum background limits in four sample locations. Barium was also detected in a fifth location as the only COC. However, the average concentrations of barium (113 mg/kg) and nickel (5.6 mg/kg) are below the maximum background limits. Arsenic was detected in one isolated sample location (17H-GR-009) at a concentration of 57 mg/kg. Mercury does not have a quantified background concentration. The uranium-238 and uranium-235 activities at all sample locations could not be defined in the environmental samples because the MDAs exceeded the maximum background limits. At thirteen sample locations, thorium-234 activities could not be defined because the MDA exceeded the maximum background limits. Although the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based PRG, which is based upon a 15-mrem/yr EDE maximum dose limit found in EPA's OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA August 1997). Therefore, the analytical results are acceptable. Low concentrations of VOCs were detected in three sample locations, and like the occurrence of metal COCs, the location of VOCs detections is sporadic. An estimated concentration of 2-hexanone of 8.5 $\mu\text{g}/\text{kg}$ was detected in sample location 17H-GR-012. Acetone was detected at concentrations of 12 $\mu\text{g}/\text{kg}$, 13 $\mu\text{g}/\text{kg}$, and 34 $\mu\text{g}/\text{kg}$ (maximum) from sample locations 17H-GR-012, 17H-GR-015, and 17H-GR-020, respectively. Trichloroethene was also detected in sample location 17H-GR-020 at a concentration of 5.6 $\mu\text{g}/\text{kg}$. A summary of the COCs exceeding maximum background limits and the location of the COCs is provided in Table 4.5.1-1 and Figure 4.4.3-8, respectively.

4.5.2 Environmental Fate

Primary sources of COCs for the SWMU 17 scrap yards were former scrap piles containing metal and other solid waste potentially contaminated with radionuclides (Figure 4.5.2-1). In addition, dispersion testing with DU was performed at the SWMU 17B subunit, and isolated drums of hazardous liquids may have been stored at SWMUs 17C and 17H. With the exception of the noncontaminated solid waste remaining at SWMUs 17E and 17F subunits, all other scrap material met the criteria for unrestricted release of nonradioactive, nonhazardous waste and was removed from the eight scrap yards in 1989. Prior to 1989, the primary release mechanism

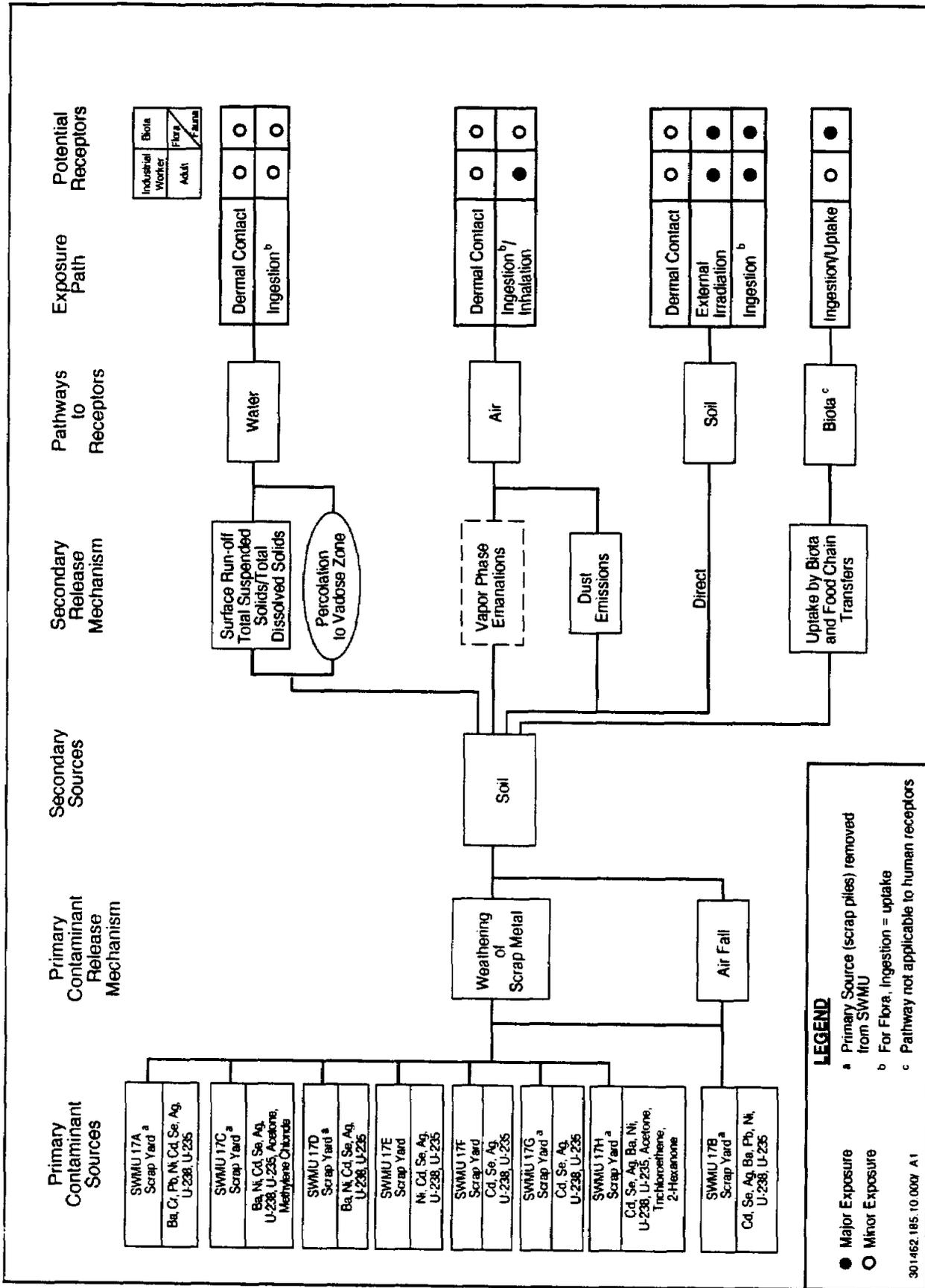


Figure 4.5.2-1
Conceptual Model Flow Diagram for SWMU 17, Scrap Yards

of COCs to the surface soil resulted from the weathering of potentially contaminated scrap metal, the airfall of DU particulates (SWMU 17B), and the potential leakage of drums (SWMUs 17C and 17H).

Potential COCs for SWMU 17 are summarized in Table 4.5.1-1. Based upon the nature and extent of contamination at the site (Section 4.5.1), COCs occur sporadically in the surface soil at the subunits at concentrations slightly elevated above the maximum background concentrations. The majority of the potential COCs are listed solely because the analytical detection limits exceeded the maximum background limits. With the exception of arsenic, all potential COCs are retained in the conceptual model and evaluated in the human health and ecological risk assessments. Arsenic concentrations exceeding maximum background limits were encountered sporadically in two soil samples from SWMU 17C and in one soil sample from 17H. Arsenic is not a potential COC from the weathering of scrap metal, nor is there historical documentation from SWMU 17 that identifies any arsenic compounds stored at the site. The presence of these three isolated occurrences of arsenic is probably related to residual methanearsonic acid in the soil from herbicide use at the scrap yards. Methanearsonic acid is the active ingredient in mono- and disodium salts commonly used in herbicides (Merck and Co., Inc. 1983). Herbicide use at the scrap yards is common practice (Jercinovic March 1998a, Jercinovic March 1998b). Although the herbicides currently in use at SNL/NM do not include products using methanearsonic acid (Jercinovic April 1998), it is highly probable that methanearsonic acid was used over the past 30 years at the site. In addition, soil sample locations were selected in areas denuded of vegetation increasing the likelihood of collecting soil with residual herbicide (SNL/NM July 1995). Since arsenic was most likely a constituent resulting from the intended use of an herbicide product it has not been included as a COC.

Since the removal of the scrap piles, the secondary source of COCs is residual metals, radionuclides, and possibly VOCs in the surface soil. There have been no historical testing activities at SWMU 17 that would have caused COC contamination below the surface soil, nor is there a history of construction activities that would have resulted in deeper penetration of surface soil into the subsurface. The secondary release mechanisms at SWMU 17 are the suspension and/or dissolution of COCs in surface-water runoff and percolation to the vadose zone, VOC vapor emanations (SWMUs 17C and 17H), direct contact with soil (radionuclides only), dust emissions, and the uptake of COCs in the soil by biota (Figure 4.5.2-1). Depth to groundwater at the site is approximately 167 feet bgs. The nature and low concentrations of COCs identified at the site, coupled with the depth to groundwater, do not make groundwater a viable pathway of concern. The pathways to receptors are surface water, soil water, air, and soil (radionuclides). Biota are also a pathway through food chain transfers. Additional discussion of the fate and transport of COCs at SWMU 17 is provided in Annex 4-D.

The current and future land use for SWMU 17 is industrial (DOE and USAF March 1996). The potential human receptor is the industrial worker. For all applicable pathways, the primary exposure route for the industrial worker is ingestion and inhalation of soil. In addition, the industrial worker may be exposed by external irradiation from radionuclides in soil. Potential biota receptors include flora and fauna at the site. Similar to the industrial worker, external irradiation and ingestion of soil are considered major exposure routes for biota, in addition to the ingestion of COCs through food chain transfers or the direct uptake of COCs. Additional discussion of the exposure routes and receptors at SWMU 17 is provided in Annex 4-D.

4.6 Site Assessments

4.6.1 Summary

The site assessment concludes that SWMU 17 has insignificant 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 17 were found to be insignificant. Brief descriptions of the site assessments are provided below and detailed in Annex 4-D.

4.6.2 Risk Screening Assessments

The following subsections describe human health and ecological risk screening for SWMU 17.

4.6.2.1 *Human Health*

SWMU 17 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 4-D. Due to the presence of several metals and radionuclides in concentrations or activities greater than background levels, it was necessary to perform a human health risk assessment analysis for the site. In addition to metals, any VOCs detected at concentration levels above their reporting limits and any radionuclide compounds detected either above background levels and/or at minimum detectable activities were included in this assessment. The risk assessment process provides a quantitative evaluation of the potential adverse human health effects caused by COCs in the site's soil. The Risk Assessment Report (Annex 4-D) 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 17 nonradiological COCs is 0.01 for an industrial land-use setting which is less than the numerical standard of 1.0 suggested by the risk assessment guidance (EPA 1989). Incremental risk is determined by subtracting the risk associated with background levels from the potential nonradiological COC risk. The incremental hazard index is 0.01. The excess cancer risk for SWMU 17 nonradiological COCs is 4×10^{-6} for an industrial land use setting, which is also below the acceptable risk value provided by New Mexico Environmental Department (NMED) for an industrial land use (NMED March 1998). The incremental cancer risk for SWMU 17 is 4.4×10^{-6} . The incremental total effective dose equivalent for radionuclides for an industrial land-use setting for SWMU 17 is 0.49 mrem/yr, which is well below the numerical guidance of 15 mrem/yr found in EPA's Office of Solid Waste and Emergency Response Directive No. 9200.4-18 (EPA August 1997) and reflected in a document entitled, "Sandia National Laboratories/New Mexico Environmental Restoration Project—RESRAD Input Parameter Assumptions and Justifications" (SNL/NM February 1998). The incremental excess cancer risk for radionuclides is 5.6×10^{-6} for an industrial land-use scenario, which is much less than the risk values calculated because of 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 4-D). The report concludes that SWMU 17 has insignificant potential to affect human health under an industrial land-use scenario.

4.6.2.2 *Ecological*

As set forth by the NMED Risk-Based Decision Tree, an ecological screening assessment that corresponds with the screening procedures (NMED March 1998) in the EPA's Ecological Risk Assessment Guidance for Superfund (EPA August 1997) was performed. An early step in the evaluation is comparison of COC concentrations and identification of potentially bioactive constituents. This evaluation is presented in Annex 4-D. 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 4-D. Site-specific information was incorporated into the screening assessment when such data were available. Hazard Quotients 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 insignificant.

4.6.3 Risk Baseline Assessments

4.6.3.1 *Human Health*

Based upon the screening assessment summarized in Section 4.6.2.1, a baseline human health risk assessment is not required for SWMU 17.

4.6.3.2 *Ecological*

Based upon the screening assessment summarized in Section 4.6.2.2, a baseline ecological risk assessment is not required for SWMU 17.

4.6.4 Other Applicable Assessments

No other applicable assessments have been performed at SWMU 17.

4.7 No Further Action Proposal

4.7.1 Rationale

Based upon historical and process knowledge, field investigation data, and human and ecological risk 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 assessment for ecological receptors indicate that the ecological risks associated with SWMU 17 are expected to be insignificant.

4.7.2 Criterion

Based upon the evidence provided above, SWMU 17 is proposed for an NFA decision in conformance with Criterion 5 (NMED March 1998), which states that the SWMU has been 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.

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ANNEX 4-D
SWMU 17 Risk Screening Assessment Report

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SWMU 17: RISK SCREENING ASSESSMENT

I. Site Description and History

Sandia National Laboratories/New Mexico (SNL/NM) Solid Waste Management Unit (SWMU) 17 is located near the southeastern corner of Kirtland Air Force Base (KAFB) within the tract bounded by Magazine Road, Isleta Road, and University Ranch Road in South Thunder Range. Eight inactive scrap yards comprise SWMU 17: 17A, 17B, 17C, 17D, 17E, 17F, 17G, and 17H. SWMU 17 is located on land owned by the U.S. Air Force and permitted to the U.S. Department of Energy (DOE) and SNL/NM. Access to the site is limited through a locked gate at the entrance to South Thunder Range.

SWMU 17 lies on the western margin of the Sandia Fault Zone at a mean elevation of 5,415 feet above sea level. The site is underlain by alluvial fan and piedmont colluvium that overlies Santa Fe Group strata. The Santa Fe deposits are estimated to be approximately 3,000 feet thick beneath SWMU 17. Detailed descriptions of the regional geology are presented in the 1994 Site-Wide Hydrogeologic Characterization Project (SWHCP) Annual Report (SNL/NM March 1995).

SWHCP soil surveys and surficial mapping provide general soil characteristics for the area around SWMU 17. The dominant soil groups in the area include (1) the Tome very fine, sandy loam, (2) the Wink fine sandy loam, (3) the Latene sandy loam, and the (4) Madurez-Wink association (USDA 1977). The estimated recharge rate for soils immediately north of SWMU 17 range between 0.002 and 0.071 centimeters per year (cm/yr), which yields downward seepage velocities ranging between 0.03 and 11.8 cm/yr (SNL/NM October 1995). No perennial surface-water bodies are present near SWMU 17.

SWMU 17 lies in the HR-2 geohydrologic region described in the 1994 SWHCP Annual Report (SNL/NM March 1995). This region is a transitional geohydrologic zone between the HR-1 zone to the west and HR-3 to the east. It is comprised of a northeast/southwest-trending fault complex that includes segments of the Sandia, Tijeras, and Hubbell Springs Faults. The uppermost interval of groundwater saturation in HR-2 is found as unconfined-to-semiconfined aquifers in the alluvial facies of the Santa Fe Group and piedmont alluvium, and as semiconfined-to-confined aquifers in the local bedrock units. The nearest groundwater monitoring wells, TRE-1 and TRE-2, are located approximately 0.5 mile southeast of the site.

Based upon these wells, depth to groundwater is approximately 167 feet below ground surface (bgs) (SNL/NM March 1997). Local groundwater flow is to the west/northwest (SNL/NM March 1997). The nearest production well, KAFB-4, is located approximately 5.5 miles to the northwest of the site.

For a detailed discussion regarding the local setting at SWMU 17, refer to the Resource Conservation and Recovery Act (RCRA) Facility Investigation Work Plan for Operable Unit 1335, Southwest Test Area (SNL/NM March 1996).

II. Comparison of Results to Data Quality Objectives

The confirmatory sampling conducted at SWMU 17 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 each of the SWMU 17 subunits. The source of potential constituents of concern (COC) at each of the eight subunits is scrap metal. In addition to scrap metal, dispersion testing using depleted uranium (DU) was performed at SWMU 17B. Unknown "contaminated liquids" were stored in two drums at SWMU 17C and historical documentation suggests that hazardous substances may have been stored at SWMU 17H.

Table 1
Summary of Sampling Performed to Meet Data Quality Objectives

SWMU Subunit	Potential COC Source	Area of Site (acres)	Number of Sampling Locations	Sample Density (samples/acre)	Sampling Location Rationale
17A	Scrap metal	0.5	10	20	No historical photographs available to determine former scrap pile locations, sample locations distributed across site and collected from topographically low areas
17B	Scrap metal, DU dispersion tests	2	5	3	Sample locations distributed across site and collected from topographically low areas
17C	Scrap metal, drummed contaminated liquids, mercury associated with fluorescent bulbs	8	30	4	No scrap piles near southern boundary of site, sample locations distributed in remainder of site and collected from topographically low areas
17D	Scrap metal	0.33	5	15	Sample locations distributed across site and collected from topographically low areas
17E	Scrap metal	5.74E-2	5	Not applicable	Sample locations surrounded former scrap pile location
17F	Scrap metal	2.21E-2	5	Not applicable	Sample locations surrounded former scrap pile location
17G	Scrap metal (from former shock tube)	0.66	5	Not applicable	Sample locations on each end of former shock tube (only release potential from structure)
17H	Scrap metal, potential hazardous materials	2	20	10	No historical photographs available to determine former scrap pile locations, sample locations distributed across site and collected from topographically low areas

COC = Constituents of concern.

DU = Depleted uranium.

SWMU = Solid waste management unit.

The number and location of the samples collected depended upon the completeness of the historical information for each subunit. The samples were collected adjacent to the former scrap pile locations for those subunits where the location of the former scrap piles could be accurately identified. If information was not available on the location of former scrap piles, sample locations were distributed across the site. In addition, samples were collected from topographically low areas where surface runoff might concentrate sediment and potentially adsorbed COCs and areas denuded of vegetation.

Table 2 summarizes the analytical methods and data quality requirements necessary to (1) adequately characterize hazardous waste or hazardous constituents associated with scrap metal, DU dispersion tests, and unknown liquids and (2) support risk screening assessments.

Table 2
Summary of Data Quality Requirements

Analytical Requirement	Data Quality Level	ER Chemistry Laboratory Department 6133 SNL/NM	Radiation Protection Sample Diagnostics Laboratory Department 7713 SNL/NM	Lockheed Analytical Services Las Vegas, Nevada
TAL metals EPA Method 6010/7000	Level 3	85 samples 8 (internal duplicates)	Not applicable	17 samples (off-site duplicates) 2 samples (off-site internal duplicates)
VOCs EPA Method 8240 (SWMUs 17C and 17H only)	Level 3	50 samples 6 (internal duplicates)	Not applicable	10 samples (off-site duplicates) 1 sample (off-site internal duplicate)
Gamma spectroscopy	Level 2	Not applicable	85 samples 12 (internal duplicates)	Not applicable

EPA = U.S. Environmental Protection Agency.

ER = Environmental restoration.

SNL/NM = Sandia National Laboratories/New Mexico.

SWMU = Solid waste management unit.

TAL = Target analyte list.

VOC = Volatile organic compounds.

SNL/NM on-site laboratories analyzed samples from 85 locations at SWMU 17. Twenty percent of the samples were sent off site for verification analyses for both target analyte list metals and volatile organic compounds (VOC). The minimum detection limits (MDL) for all on-site analyses exceeded the background concentration limits for arsenic, cadmium, selenium, and silver. The off-site laboratory provided a lower MDL for metals analyses of split samples; however, the MDLs for cadmium, selenium, and silver are very close to nonquantifiable background concentration limits. The cadmium MDL is 1.1 milligrams per kilogram (mg/kg) as compared to the nonquantifiable background concentration limit of less than 1.0 mg/kg. The selenium MDL is 1.0 mg/kg as compared to the nonquantifiable background concentration limit of less than

1.0 mg/kg. The silver MDL ranges from 2.1 to 2.3 mg/kg as compared to the nonquantifiable background concentration limit of less than 1.0 mg/kg. In general, the lower MDLs for the off-site split samples compared to the background concentration limits.

The SNL/NM Sample Management Office conducted Data Validation I and II reviews for all off-site data in accordance with Technical Operating Procedure 94-03, Rev. 0 (SNL/NM July 1994). An independent review of the validation process confirmed that the reviews performed by SNL/NM were accurate and that the data are acceptable for use in the no further action (NFA) proposal for SWMU 17 (IT November 1996). All gamma spectroscopy data were reviewed by SNL/NM Department 7713 in accordance with the Radiation Protection Sample Diagnostics Procedure RPSD-02-11 (SNL/NM July 1996). The data quality objectives (DQO) for SWMU 17 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 17 was based upon an initial conceptual model validated with confirmatory sampling at the site. The initial conceptual model was developed from historical background information including numerous site inspections, personal interviews, historical photographs, and radiological surveys. The DQOs contained in the Sampling and Analysis Plan (SNL/NM July 1995) identified the sample locations, sample density, sample depth, and analytical requirements. The sample data used to characterize SWMU 17 were collected in accordance with the rationale and procedures described in the Sampling and Analysis Plan (SNL/NM July 1995). The data collected were subsequently used to develop the final conceptual model for SWMU 17, which is presented in Section 4.5 of the associated NFA proposal. The quality of the data specifically used to determine the nature, rate, and extent of contamination is described below.

III.2 Nature of Contamination

The nature of contamination at SWMU 17 was determined with analytical testing of soil media and the potential for degradation of relevant COCs (Section V). The analytical requirements included metals to characterize weathering of scrap metal. Gamma spectroscopy was used as a general screening analysis for all subunits and was appropriate for DU dispersion testing at SWMU 17B. VOC analyses were performed on selected soil samples from SWMU 17C and 17H to characterize the unknown "contaminated liquids" stored in two drums at SWMU 17C and hazardous substances that may have been stored at SWMU 17H. These analytes and methods are appropriate to characterize the COCs and potential degradation products associated with historical activities at SWMU 17.

III.3 Rate of Contaminant Migration

All primary sources of COCs were removed from SWMU 17 in 1989 and the site has been inactive since that time. Secondary sources of COCs are adsorbed metals and adsorbed, dissolved, or volatilized organic compounds in the soil (SWMU 17C and 17H only). The rate of

COC migration predominantly depends upon site meteorological and surface hydrologic processes as described in Section V. Data available from the SWHCP (published annually); numerous SNL/NM air, surface-water, and radiological monitoring programs; biological surveys; and other governmental atmospheric monitoring at KAFB (i.e., National Oceanographic and Atmospheric Administration) are adequate to characterize the rate of COC migration at SWMU 17.

III.4 Extent of Contamination

Soil samples were collected directly from locations where the former scrap pile location could be accurately identified. Soil samples were collected from the entire subunit if the former scrap pile locations could not be identified. Potentially contaminated soil/sediment was sampled in topographically low areas. In addition, locations with disturbed soils or lack of vegetation were also sampled. These sample locations are deemed appropriate to determine the lateral extent of COC migration.

The sample density depended upon the size of the subunit, size of former scrap pile locations, and availability of historical photographs to identify former scrap pile locations. The sample number was deemed sufficient to establish the presence of detectable residues from the storage of scrap material associated with the operations and/or dismantlement of the former shock tubes at SWMU 89. The sample density ranged from 3 to 20 samples per acre, consistent with comparable U.S. Environmental Protection Agency (EPA) RCRA investigations/feasibility studies (Selman et al. 1994).

Because of the relatively low solubility of most metals and organic compounds, limited precipitation, and high evapotranspiration, the vertical rate of contamination migration is expected to be extremely low. Therefore, samples were collected from the ground surface to a depth of 6 inches bgs. Any former release of metals from weathering scrap piles would have been to the surface soils. In addition, the dispersion testing at SWMU 17B or potentially leaking drums (2) at SWMU 17C would have released COCs to the surface soils. There is no historical information that any subsurface disturbance, testing, or disposal ever occurred at the site that could mix surface soils beneath the 6-inch depth. Therefore, the 6-inch surface sample depth represents the media potentially impacted by site activities and is sufficient to determine the vertical extent of COC migration.

In summary, the design of the confirmatory sampling was appropriate and adequate to determine the nature, rate, 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 the concentration levels of those COCs across the site are described in the SWMU 17 NFA proposal. Generally, COCs evaluated in this risk assessment include all detected organic 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 not included in this assessment were determined

to have sufficiently low 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.

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 include both VOCs and metals.

Nonradiological COCs for SWMU 17 are listed in Table 3; radiological COCs are listed in Table 4. Both tables show the associated approved SNL/NM maximum background concentration values (Dinwiddie September 24, 1997).

V. Fate and Transport

The primary release of COCs at SWMU 17 was to the surface soil. Wind, water, and biota are natural mechanisms of COC transport from the primary release point. Some COCs (VOCs) can migrate through the soil in liquid or vapor phases. Excavation and removal are potential human-caused mechanisms of transport. Winds can be strong in the open grassland environment at SWMU 17. Even at low velocities, the wind will rapidly remove volatile COCs at the soil surface. Moderate winds can transport 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 if the soil surface is moist or if vegetation or other cover protects it. No above-background particulate radioactive COCs have been observed (DOE June 1997).

Water at SWMU 17 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 total annual rainfall (Thomson and Smith 1985). Precipitation will either infiltrate or form runoff. Infiltration at the site is enhanced by the nearly flat relief at the site and the sandy nature of the soil. Runoff from the site is probably significant only during intense rainfall events and during extended rainfall periods when soils are near saturation. Surface runoff is to the southwest toward an internal drainage basin, but no major surface drainage features occur on or near the site. Runoff may entrain soil particles with adsorbed COCs. The distance of transport will depend upon the size of the particle and the velocity of the water (generally low because of the flat terrain).

Water that infiltrates into the soil may be retained as soil moisture removed through evapotranspiration or may penetrate more deeply into the soil profile. COCs desorbed from the soil particles into the soil solution may be leached into the subsurface soil with this percolation. The effective rooting depths of soils at SWMU 17 is 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 167 feet bgs, the potential for nonvolatile COCs to reach groundwater through

Table 3
Nonradiological COCs for Human Health and Ecological Risk Assessment at SWMU 17 with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log K_{ow}

COC Name	Maximum Concentration (mg/kg)	SNL/NM Background Concentration (mg/kg) ^c	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? ^b (BCF>40, log K _{ow} >4)
Barium	220	130	No	170 ^e	NA	Yes
Beryllium	0.06 ^d	0.65	Yes	19 ^e	NA	No
Cadmium	5 ^d	<1	No	64 ^b	NA	Yes
Chromium, total	18	17.3	No	16 ^b	NA	No
Lead	270	21.4	No	49 ^b	NA	Yes
Mercury	0.24	<0.25	Unknown	5500 ^b	NA	Yes
Nickel	17	11.5	No	47 ^b	NA	Yes
Selenium	25 ^d	<1	No	800 ^e	NA	Yes
Silver	5 ^d	<1	No	0.5 ^b	NA	No
Acetone	0.034	NA	NA	0.69 ^f	-0.24 ^f	No
2-Hexanone	0.0085 J	NA	NA	6 ^b	1.38 ^g	No
Methylene chloride	0.012	NA	NA	5 ^b	1.25 ^f	No
Trichloroethene	0.0056	NA	NA	10.6 ^b	2.29 ^g	No

^aDinwiddie (September 24, 1997), Southwest Test Area.

^bBCF from Yanicak (March 1997).

^cBCF from Neumann (1976).

^dCOC not detected, concentration assumed to be one-half of the detection limit.

^eBCF from Callahan et al. (1979).

^fBCF and log K_{ow} from Howard (1990).

^gBCF and log K_{ow} from Howard (1993).

^hNMED (March 1998).

BCF = Bioconcentration factor.

COC = Constituents of concern.

J = Estimated concentration.

K_{ow} = Octanol-water partition coefficient.

Log = Logarithm (base 10).

mg/kg = Milligrams per kilogram.

NA = Not applicable.

SNL/NM = Sandia National Laboratories/New Mexico.

SWMU = Solid waste management unit.

Table 4
Radiological COCs for Human Health and Ecological Risk Assessment at SWMU 17 with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log K_{ow}

COC Name	Maximum Concentration (pCi/g)	SNL/NM Background Concentration (pCi/g) ^a	is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (maximum aquatic)	Bioaccumulator? (BCF>40, log K _{ow} >4)
Cs-137	0.613	0.664	Yes	3000 ^e	Yes
Ra-228	0.926	1.01	Yes	30,000 ^d	No ^b
Th-232	0.979	1.01	Yes	---	No ^b
Th-234	16.6	1.4	No	---	No ^b
U-234 ^b	2.40	1.6	No	900 ^d	Yes
U-235 ^b	0.26	0.16	No	900 ^d	Yes
U-238	19.1	1.4	No	900 ^d	Yes

^aDinwiddie (September 24, 1997), Southwest Test Area.

^bU-234 and U-235 values were calculated using the U-238 concentration and assuming that the U-238 to U-234 ratio and U-238-to-U-235 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 14, 1998).

^cBCF from Yanicak (March 1997).

^dBaker and Soldat (1992).

^eNot 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.

--- = Insufficient data.

the unsaturated zone above the water table is very low. As water from the surface evaporates, the direction of COC movement may be reversed with capillary rise of soil water. Vegetation increases the rate of water loss from the soil through transpiration. Overall, the net transport of potential COCs is expected to be insignificant. 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. These COCs may be transported to the aboveground tissues with the xylem stream. Aboveground tissues can take up volatile constituents from the air and adsorbed constituents from direct contact with dust particles. Organic constituents in plant tissues may be metabolized. Other constituents may be released through volatilization, consumed by herbivores, or 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 in the herbivore from the site), or absorbed to be held in tissues, metabolized, or excreted. The herbivore may be eaten by a primary carnivore or scavenger and the constituent held in the consumed tissues will repeat the sequence of absorption, metabolism, excretion, and consumption by higher predators, scavengers, and decomposers. The potential for transport of the constituents depends 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.

Degradation of COCs at SWMU 17 may result from biotic or abiotic processes. Most COCs at SWMU 17 are inorganic and elemental in form and are, therefore, not considered to be degradable, although radiological COCs undergo decay to stable isotopes or radioactive daughter elements (Tables 3 and 4). Other transformations of inorganics in terrestrial environments may include changes in valence (oxidation/reduction reactions) or incorporation into organic forms (e.g., conversion of selenite or selenate from soil to seleno-amino acids in plants). Degradation processes for organic COCs may include photolysis, hydrolysis, and biotransformation. Photolysis requires light, and therefore takes place in the air, at the ground surface, or in surface water. Hydrolysis includes chemical transformations in water, and may occur in the soil solution. Biotransformation is the metabolism of COCs in biota, including microorganisms, plants, and animals.

Table 5 summarizes the fate and transport processes that may occur at SWMU 17. COCs at this site are primarily inorganics (metals and DU) in surface soil (Tables 3 and 4). Because the various scrap yards that comprise this site are disturbed, vegetative cover is low. Therefore, the potential for transport of COCs by wind is possible and the potential for uptake into the food chain is low. Transport by surface-water runoff is moderated by the low slope and high infiltration of the soil. Significant leaching into the subsoil is unlikely for most inorganics, and leaching to the groundwater is highly unlikely. Degradation of the inorganic COCs is insignificant. VOCs may have been released at some of the scrap yards (Table 3). For these, loss by wind (as volatilized molecules) is expected to be high. Photolysis of these compounds is the likely degradation process for these molecules. Vertical migration of VOCs in the soil as liquid or vapor is expected to be low because of low volumes that may have been released (if any at all). Uptake of these compounds by plants or soil organisms may occur, but because the $\log K_{ow}$ values of these compounds are small (less than 4), they are unlikely to biomagnify in the food chain, and biodegradation will likely be high.

Table 5
Summary of Fate and Transport at SWMU 17

Transport and Fate Mechanism	Viabile Mechanism	Significance
Wind	Yes	High
Surface runoff	Yes (to local internal basin)	Low
Migration to groundwater	Unlikely	Extremely low
Food chain uptake	Yes	Low
Transformation/degradation	Yes	Low (inorganics) Moderate (VOCs)

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 were 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 EPA and DOE to determine whether 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 17 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 17 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 direct gamma exposure for the radiological COCs. The inhalation pathway for both nonradiological and radiological COCs is included because of the potential to inhale dust and volatiles. Soil ingestion is also included for the radiological COCs. Because the historical operations at SWMU 17 released potential COCs only to the surface soil and the depth to groundwater at SWMU 17 is approximately 167 feet bgs, no groundwater pathway is considered. 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 and volatiles)	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 nonradiological 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 levels or 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 do not have a background value and are detected above the analytical minimum detectable activity are carried through the risk assessment at their maximum levels. This step (rather than carrying the below-background radiological COCs through the risk assessment and then performing a background risk assessment to determine incremental TEDE and estimated cancer risk) is performed to prevent the "masking" of radiological contamination that may occur if on-site background radiological COCs exist in concentrations far enough below the assigned background level. When this "masking" occurs, the final incremental TEDE and estimated cancer risk are reduced and, therefore, provide a nonconservative estimate of the potential impact to an on-site receptor. This approach is also consistent with the regulatory approach found in the Office of Solid Waste and Emergency Response Directive No. 9200.4-18 (EPA 1997a), which sets a TEDE limit to the on-site receptor in excess of background. The radiological COCs remaining after this step are referred to as background-adjusted radiological COCs.

VI.4.1.2 Results

A comparison of SWMU 17 maximum COC concentrations to the approved SNL/NM maximum background values (Dinwiddie September 24, 1997) is presented in Tables 3 and 4. For the nonradiological COCs, seven metals have maximum measured values greater than their respective background screening levels. One nonradiological COC has no quantifiable background concentration (mercury), so it is not known whether that COC exceeds background. Four of the COCs are organic compounds and do not have background screening levels.

The maximum concentration value for lead is 270 mg/kg. The EPA intentionally provides no human health toxicological data on lead, and therefore no risk parameter values can be calculated. However, EPA Region 6 guidance for the screening value for lead for an industrial land-use scenario is 2,000 mg/kg (EPA 1996a); for a residential land-use scenario, the EPA screening guidance value is 400 mg/kg (EPA July 1994). The maximum concentration value for lead at this site is less than both screening values, and therefore lead is eliminated from further consideration in the human health risk assessment.

For the radiological COCs, four metals (Th-234, U-234, U-235 and U-238) had maximum measured activities greater than their respective background.

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 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, 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

Because the SWMU 17 sample set has more than ten COCs that continue past the first screening level (including COCs that have no background screening values), the proposed Subpart S screening process was not performed. All nonradiological COCs not eliminated during the background screening process for SWMU 17 have a calculated hazard quotient (HQ) and excess cancer risk value.

Radiological COCs have no 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), Health Effects Assessment Summary Tables (HEAST) (EPA 1997b), EPA Region 9 (EPA 1996b), or EPA Region 3 (EPA 1997c) databases. Dose 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).

Table 6
Toxicological Parameter Values for SWMU 17 Nonradiological COCs

COC Name	RfD _o (mg/kg-d)	Confidence ^a	RfD _{inh} (mg/kg-d)	Confidence ^a	SF _o (mg/kg-day) ⁻¹	SF _{inh} (mg/kg-day) ⁻¹	Cancer Class ^b
Barium	7E-2 ^e	M	1.4E-4 ^d	--	--	--	--
Cadmium	5E-4 ^e	H	5.7E-5 ^d	--	--	6.3E+0 ^e	B1
Chromium III	1E+0 ^e	L	5.7E-7 ^e	--	--	--	--
Chromium VI	5E-3 ^e	L	--	--	--	4.2E+1 ^e	A
Mercury	3E-4 ^f	--	8.6E-5 ^e	M	--	--	D
Nickel	2E-2 ^e	M	--	--	--	--	--
Selenium	5E-3 ^e	H	--	--	--	--	D
Silver	5E-3 ^e	L	--	--	--	--	D
Acetone	1E-1 ^e	L	1E-1 ^d	--	--	--	D
2-Hexanone	4E-2 ^e	--	--	--	--	--	--
Methylene chloride	6E-2 ^e	M	8.6E-1 ^f	--	7.5E-3 ^e	1.7E-3 ^e	B2
Trichloroethene	6E-3 ^d	--	6E-3 ^d	--	1.1E-2 ^d	6E-3 ^d	--

^aConfidence associated with IRIS (EPA 1998) database values.

^bEPA weight-of-evidence classification system for carcinogenicity (EPA 1989) taken from IRIS (EPA 1998):

A = Human carcinogen.

B1 = Probable human carcinogen. Limited human data are available.

B2 = Probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.

D = Not classifiable as to human carcinogenicity.

^cToxicological parameter values from IRIS electronic database (EPA 1998).

^dToxicological parameter values from EPA Region 9 electronic database (EPA 1996b).

^eToxicological parameter values from EPA Region 3 electronic database (EPA 1997c).

^fToxicological parameter values from HEAST database (EPA 1997b).

COC = Constituents of concern.

Confidence: L = low, M = medium, H = high.

EPA = U.S. Environmental Protection Agency.

HEAST = Health Effects Assessment Summary Tables.

IRIS = Integrated Risk Information System.

mg/kg-day = Milligram(s) per kilogram day.

(mg/kg-day)⁻¹ = Per milligram per kilogram day.

RfD_{inh} = Inhalation chronic reference dose.

RfD_o = Oral chronic reference dose.

SF_{inh} = Inhalation slope factor.

SF_o = Oral slope factor.

SWMU = Solid waste management unit.

-- = Information not available.

Table 7
Radiological Toxicological Parameter Values for SWMU 17 COCs Obtained from
RESRAD Risk Coefficients

COC Name	SF_o (1/pCi)	Sf_{inh} (1/pCi)	SF_{ev} (g/pCi-yr)	Cancer Class^b
U-238	6.20E-11	1.20E-08	6.60E-08	A
U-234	4.40E-11	1.40E-08	2.10E-11	A
U-235	4.70E-11	1.30E-08	2.70E-07	A

^aYu et al. 1993a.

^bEPA weight-of-evidence classification system for carcinogenicity (EPA 1989): A = human carcinogen. U-238 value includes the effect of its Th-234 daughter product.

COC = Constituents of concern.

EPA = U.S. Environmental Protection Agency.

g/pCi-yr = Gram per picocurie-year.

SF_{ev} = External volume exposure slope factor.

SF_{inh} = Inhalation slope factor.

SF_o = Oral (ingestion) slope factor.

SWMU = Solid waste management unit.

1/pCi = One per picocurie.

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 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 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 an HI value of 0.01 for the SWMU 17 nonradiological COCs and an excess cancer risk of 4×10^{-8} for the designated industrial land-use scenario. The numbers presented include exposure from soil ingestion and dust and volatile inhalation for nonradiological COCs. Table 9 shows the HI is 0.00, assuming the maximum background concentrations of the SWMU 17 associated background constituents, and no quantifiable excess cancer risk for the designated industrial land-use scenario.

For the radiological 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 the majority of time indoors and for an industrial worker who spends time equally indoors and outdoors. After analyzing these two scenarios, the most conservative (the industrial worker who spends his time indoors and outdoors) resulted in an incremental TEDE of 0.49 millirem per year (mrem/yr). In accordance with proposed EPA guidance, an incremental TEDE of 15 mrem/yr (EPA 1997a) is used for the probable land-use scenario (industrial in this case); the calculated dose value for SWMU 17 for industrial land use is well below this guideline. The estimated excess cancer risk is 5.6×10^{-6} .

Table 8
Risk Assessment Values for SWMU 17 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
Barium	220	0.00	--	0.03	--
Cadmium	5 ^b	0.01	2E-9	4.09	3E-9
Chromium, total ^c	18	0.00	4E-8	0.01	7E-8
Mercury	0.24	0.00	--	0.41	--
Nickel	17	0.00	--	0.02	--
Selenium	25 ^b	0.00	--	8.80	--
Silver	5 ^b	0.00	--	0.21	--
Acetone	0.034	0.00	--	0.01	--
2-Hexanone	0.0085 J	0.00	--	0.00	--
Methylene chloride	0.012	0.00	8E-10	0.00	9E-8
Trichloroethene	0.0056	0.00	7E-10	0.00	2E-8
TOTAL		0.01	4E-8	14	2E-7

^aEPA 1989.

^bCOC not detected, concentration is assumed to be one-half of detection limit.

^cChromium, total is assumed to be chromium VI (most conservative).

COC = Constituents of concern.

EPA = U.S. Environmental Protection Agency.

J = Estimated concentration.

SWMU = Solid waste management unit.

mg/kg = Milligram(s) per kilogram.

-- = Information not available.

**Table 9
Risk Assessment Values for SWMU 17 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
Barium	130	0.00	--	0.02	--
Cadmium	<1	--	--	--	--
Chromium, total ^c	17.3	0.00	--	0.01	--
Mercury	<0.25	--	--	--	--
Nickel	11.5	0.00	--	0.02	--
Selenium	<1	--	--	--	--
Silver	<1	--	--	--	--
Total		0.00	--	0.04	--

^aDinwiddie (September 24, 1997) Southwest Test Area.

^bEPA 1989.

^cChromium, total assumed to be chromium III.

COC = Constituents of concern.

EPA = U.S. Environmental Protection Agency.

J = Estimated concentration.

SWMU = Solid waste management unit.

mg/kg = Milligram(s) per kilogram.

-- = Information not available.

For the residential land-use scenario nonradioactive COCs the HI value increases to 14, and the excess cancer risk is 2×10^{-7} (Table 8). The numbers presented included exposure from soil ingestion, dust and volatile inhalation, and plant uptake. Although the 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 an HI of 0.04 for the SWMU 17 associated background constituents, and no quantifiable excess cancer risk exists.

For the radiological COCs incremental TEDE for the residential land-use scenario is 1.4 mrem/yr. The guideline being used 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 17 for the residential land use is well below this guideline. Consequently, SWMU 17 is eligible for unrestricted radiological release because the residential land-use scenario resulted in an incremental TEDE of less than 75 mrem/yr to the on-site receptor. The estimated excess cancer risk is 1.8×10^{-5} . 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.

The industrial land-use scenario nonradiological COCs, the HI calculated is 0.01, much less than the numerical guideline of 1 suggested in RAGS (EPA 1989). Excess cancer risk is estimated at 4×10^{-8} . Guidance from the New Mexico Environment Department (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 total chromium (17.3 mg/kg) (assumed to be chromium VI, most conservative). Chromium VI is a Class A carcinogen. The excess cancer risk for this SWMU is below the suggested acceptable risk value (10^{-6}) for Class A carcinogens. This assessment also determined risks considering background concentrations of potential nonradiological COCs for both industrial and residential land-use scenarios. For nonradiological COCs, assuming the industrial land-use scenario, the HI is 0.00. There is no quantifiable excess cancer risk. Incremental risk is determined by subtracting risk associated with background from potential COC risk. These numbers are not rounded before the difference is determined and therefore may appear inconsistent with numbers presented in tables and text. Incremental HI is 0.01 and incremental cancer risk is 4.4×10^{-8} for the industrial land-use scenario. These incremental risk calculations indicate insignificant risk to human health from nonradiological COCs considering an industrial land-use scenario.

For radiological COCs of the industrial land-use scenario, incremental TEDE is 0.49 mrem/yr, which is significantly less than EPA's numerical guideline of 15 mrem/yr. Incremental estimated excess cancer risk is 5.6×10^{-6} .

The calculated HI for the residential land-use scenario nonradiological COCs is 14, which is above the numerical guidance. Excess cancer risk is estimated at 2×10^{-7} . Excess cancer risk is driven by total chromium (18 mg/kg) (assumed to be chromium VI, most conservative), methylene chloride (0.012 mg/kg), and trichloroethene (0.0056 mg/kg). Chromium VI is a Class A carcinogen. Methylene chloride is a Class B2 carcinogen. Currently trichloroethene is not classified. The excess cancer risk for this SWMU is below the suggested acceptable risk value (10^{-6}) for the more stringent Class A and B carcinogens. The HI for associated background for the residential land-use scenario is 0.04. There is no quantifiable excess cancer risk. The incremental HI is 13.54, and the incremental cancer risk is 1.8×10^{-7} for the residential land-use scenario. These incremental risk calculations indicate 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 1.4 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 1.8×10^{-5} .

VI.8 Step 7. Uncertainty Discussion

The determination of the nature, rate and extent of contamination at SWMU 17 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 1995), which is consistent with NMED guidelines (NMED March 1998). The DQOs contained in the Sampling and Analysis Plan (SNL/NM July 1995) are appropriate for use in risk screening 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) and was independently reviewed (Annex 4-C). Therefore, there is no uncertainty associated with the data quality used to perform the risk screening assessment at SWMU 17.

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 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 calculations are conservative and that calculated intakes are likely overestimates. Maximum measured values of COC concentrations 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), HEAST (EPA 1997b), EPA Region 9 (EPA 1996b), and EPA Region 3 (EPA 1997c) databases. Where values are not provided, information is not available from the HEAST (EPA 1997b), IRIS (EPA 1998), or the EPA regions (EPA 1996b, 1997c). Because of the conservative nature of the RME approach, uncertainties in toxicological values are not expected to be sufficiently high to change the conclusion of 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 17 has minor contamination consisting of some inorganic, VOC, 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 radionuclides. 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 (0.01) is significantly less than accepted numerical guidance from the EPA. Excess cancer risk (4×10^{-8}) is also below the acceptable risk value provided by the NMED for an industrial land use (NMED March 1998). The incremental HI is 0.01, and the incremental cancer risk is

4.4×10^{-6} for the industrial land-use scenario. Incremental risk calculations indicate insignificant risk to human health in 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 0.49 mrem/yr for the industrial land-use scenario. This value is much less than the numerical guidance of 15 mrem/yr (for industrial) in EPA guidance (EPA 1997a). The corresponding incremental estimated cancer risk value is 5.6×10^{-6} 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 1.4 mrem/yr. The guideline for this scenario is 75 mrem/yr (SNL/NM February 1998). Therefore SWMU 17 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 poses insignificant risk to 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 (COPECs) in soils at SWMU 17. 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. This assessment incorporates conservatism in the estimation of ecological risks; however, ecological relevance and professional judgment are also used as recommended by the 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), constituents in soil within the 0- to- 5-ft-depth interval that exceeded background concentrations were:

- Barium
- Chromium (total)
- Lead
- Mercury
- Nickel
- Th-234
- U-234
- U-235
- U-238

Organics detected in soil were:

- Acetone
- 2-Hexanone
- Methylene chloride
- Trichloroethene

In addition, cadmium, selenium, and silver were reported as not detected with detection limits exceeding background concentrations.

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):

- Barium
- Cadmium
- Lead
- Mercury
- Nickel
- Selenium
- U-234
- U-235
- U-238

As directed by the NMED (March 1998), bioaccumulation is exclusively assessed 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), significant fate and transport is expected to be associated with wind dispersion. Surface-water runoff is expected to be of low significance, while transformation and degradation are expected to be low for inorganics and moderate for organics. Food chain uptake is expected to be of low significance. Migration to groundwater is unlikely.

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 SWMU 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 SWMU. 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

Eight inactive scrap yards comprise SWMU 17: 17A, 17B, 17C, 17D, 17E, 17F, 17G, and 17H. The combined sites occupy an area approximately 13.25 acres and are located within the South Thunder Range area. The primary vegetation within this area is desert grassland vegetation. The topography is flat and there are no major drainages or surface-water features in the area. The South Thunder Range lies in an internal drainage basin; therefore, off-site surface-water drainage is not connected to the Rio Grande. Complete ecological pathways may exist at this site through the exposure of plants and wildlife to COPECs in surface and subsurface soil. No threatened, endangered, or other special-status species are known to occur at this site. This area was previously surveyed for sensitive species during the spring and summer of 1992 and 1993 (Sullivan and Knight 1994), and scattered grama grass cacti (*Pediocactus papyracanthus*) were found in the western tracts of SWMU 17. This species had once been listed as endangered by the New Mexico Forestry and Resource Conservation Division and as a C2 candidate for federal listing by the U.S. Fish and Wildlife Service, but has since been removed from both special-status categories by the respective agencies. The past disturbance of these sites makes the occurrence of this species highly unlikely within the boundaries of SWMU 17 (IT February 1995).

Direct uptake of COPECs from soil was assumed to be the major route of exposure for plants, with minor exposure of plants to wind-blown soil. Exposure modeling for wildlife receptors was limited to food and soil ingestion pathways. Because of the 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 167 feet bgs) is not expected to be affected by COCs at this site.

VII.3.1.2 COPECs

Very little information is available on the history of the scrap yards, but visits conducted in April 1994 indicated that most of the scrap was removed from the sites in 1989. Activities at the scrap yards involved handling and storing various materials used in operating and/or dismantling former shock tubes at SWMU 89 (South Thunder Range). The COPECs at this site are listed in Section VII.2.

This ecological risk assessment is based upon the maximum soil concentrations of the COPECs as measured in surface soil samples. Both radiological and nonradiological COPECs are evaluated. Nonradiological COPECs include metals, VOCs, and radionuclides. Inorganic analytes and radionuclides (Section IV, Tables 3 and 4) were screened against background concentrations, and those exceeding approved SNL/NM background screening levels (Dinwiddie September 24, 1997) for the area were considered COPECs. Because no background screening values exist for VOCs, all detected organic analytes were included as COPECs. In order to provide conservatism in this ecological risk screening assessment, exposure models use only the maximum concentration value of each COPEC determined for the entire site. 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 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), an omnivore (50 percent of its diet as plants and 50 percent as soil invertebrates), and 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 two 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

Table 10
Exposure Factors for Ecological Receptors at SWMU 17

Receptor Species	Class/Order	Trophic Level	Body Weight (kg) ^a	Food Intake Rate (kg/day) ^b	Dietary Composition ^c	Home Range (acres)
Deer mouse (<i>Peromyscus maniculatus</i>)	Mammalia/ rodentia	Herbivore	2.39E-2 ^d	3.72E-3	Plants: 100% (+ Soil at 2% of intake)	2.7E-1 ^e
Deer mouse (<i>Peromyscus maniculatus</i>)	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 (<i>Peromyscus maniculatus</i>)	Mammalia/ rodentia	Insectivore	2.39E-2 ^d	3.72E-3	Invertebrates: 100% (+ Soil at 2% of intake)	2.7E-1 ^e
Burrowing owl (<i>Speotyto cunicularia</i>)	Aves/ strigiformes	Carnivore	1.55E-1 ^f	1.73E-2	Rodents: 100% (+ Soil at 2% of intake)	3.5E+1 ^g

^aBody weights are in kilograms wet weight.

^bFood intake rates are estimated from the allometric equations presented in Nagy (1987). Units are kilograms dry weight per day.

^cDietary compositions are generalized for modeling purposes. Default soil intake value of 2 percent of food intake.

^dFrom Silva and Downing (1995).

^eFrom EPA (1993), based upon the average home range measured in semiarid shrubland in Idaho.

^fFrom Dunning (1993).

^gFrom Haug et al. (1993).

kg = Kilogram(s).

kg/day = Kilogram(s) per day.

SWMU = Solid waste management unit.

the site being investigated. The maximum measured COPEC concentrations from surface soil samples were used to conservatively estimate potential exposures and risks to plants and wildlife at this site.

For the radiological dose rate calculations, the deer mouse was modeled as a 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 two percent of the total dietary intake. Receptors are exposed to radiation both internally and externally from U-234, U-235, U-238, and Th-234. Internal and external dose rates to the deer mouse and burrowing owl are approximated using modified dose rate models from the Hanford Site Risk Assessment Methodology (DOE 1995) as presented in the ecological risk assessment methodology document for the SNL/NM ER Program (IT June 1998). 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 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 beta or alpha emitters. The external and internal dose rate results are summed to calculate a total dose rate due to exposure to radionuclides in soil.

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

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 (IAEA 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 17.

Table 11
Transfer Factors Used in Exposure Models for
Constituents of Potential Ecological Concern at SWMU 17

Constituent of Potential Ecological Concern	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor
Inorganic			
Barium	1.5E-1 ^a	1.0E+0 ^b	2.0E-4 ^c
Cadmium	5.5E-1 ^a	6.0E-1 ^d	5.5E-4 ^a
Chromium (total)	4.0E-2 ^c	1.3E-1 ^e	3.0E-2 ^c
Lead	9.0E-2 ^c	4.0 E-2 ^d	8.0E-4 ^c
Mercury	1.0E+0 ^c	1.0E+0 ^b	2.5E-1 ^a
Nickel	2.0E-1 ^c	3.8E-1 ^e	6.0E-3 ^a
Selenium	5.0E-1 ^c	1.0E+0 ^b	1.0E-1 ^c
Silver	1.0E+0 ^c	2.5E-1 ^d	5.0E-3 ^c
Organic			
2-hexanone	6.2E+0 ^f	1.5E+1 ^g	4.9E-7 ^f
Acetone	5.3E+1 ^f	1.3E+1 ^g	1.0E-8 ^f
Methylene chloride	7.3E+0 ^f	1.5E+1 ^g	3.6E-7 ^f
Trichloroethene	1.1E+0 ^f	1.8E+1 ^g	1.2E-5 ^f

^aFrom Baes et al. (1984).

^bDefault value.

^cFrom NCRP (January 1989).

^dFrom Stafford et al. (1991).

^eFrom Ma (1982).

^fFrom equation developed in Travis and Arms (1988).

^gFrom equation developed in Connell and Markwell (1990).

SWMU = Solid waste management unit.

VII.3.4 Risk Characterization

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

Analytes with HQs exceeding unity for plants were cadmium, chromium, lead, selenium, and silver. The only analyte with an HQ exceeding unity for the herbivorous mouse was selenium. Inclusion of soil invertebrates in the model diet of the deer mouse (i.e., omnivorous and insectivorous diets) resulted in HQs greater than 1.0 for barium and selenium. Two analytes, mercury (when assumed to be entirely in organic form) and selenium, resulted in HQs greater than 1.0 for the burrowing owl, although HQs for the burrowing owl could not be determined for the organic COPECs or 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 had HIs greater than unity.

Table 12
Media Concentrations^a for Constituents of
Potential Ecological Concern at SWMU 17

Constituent of Potential Ecological Concern	Soil (maximum)	Plant Foliage ^b	Soil Invertebrate ^b	Deer Mouse Tissues ^c
Inorganic				
Barium	2.2E+2	3.3E+0	2.2E+2	8.2E-2
Cadmium	5.0E+0	2.8E+0	3.0E+0	5.1E-3
Chromium (total)	1.8E+1	7.2E-1	2.3E+0	1.8E-1
Lead	2.7E+2	2.4E+1	1.1E+1	7.4E-2
Mercury	2.4E-1	2.4E-1	2.4E-1	1.9E-1
Nickel	1.7E+1	3.4E+0	6.5E+0	9.9E-2
Selenium	2.5E+1	1.3E+1	2.5E+1	6.0E+0
Silver	5.0E+0	5.0E+0	1.3E+0	5.0E-2
Organic				
2-Hexanone	8.5E-3	5.3E-2	1.3E-1	1.4E-7
Acetone	3.4E-2	1.8E+1	4.4E-1	3.7E-8
Methylene chloride	1.2E-2	8.8E-3	1.8E-2	1.5E-8
Trichloroethene	5.6E-3	5.9E-3	1.0E-1	1.9E-6

^aIn milligram(s) per kilogram. All are based upon dry weight of the media.

^bProduct of the soil concentration and the corresponding transfer factor.

^cBased 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).

SWMU = Solid waste management unit.

Tables 15 and 16 summarize the internal and external dose rate model results for the four radionuclides. The total radiation dose rate to the deer mouse was predicted to be 3.1E-3 rad/day. Total dose rate to the burrowing owl was predicted to be 3.0E-3 rad/day. The external radiation dose rate from exposure to these radionuclides for both receptors is the primary contributor to the total dose rate. 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 17. 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 were made that are more likely to overestimate exposures and risk rather than to underestimate them.

Table 13
Toxicity Benchmarks for Ecological Receptors at SWMU 17

Constituent of Potential Ecological Concern	Plant Benchmark ^{a,b}	Mammalian NOAELs			Avian NOAELs		
		Mammalian Test Species ^{c,d}	Test Species NOAEL ^{e,o}	Deer Mouse NOAEL ^{e,i}	Avian Test Species ^d	Test Species NOAEL ^{e,o}	Burrowing Owl NOAEL ^e
Inorganic							
Barium	500	Rat ^h	5.1	10.5	Chicks	20.8	20.8
Cadmium	3	Rat ⁱ	1.0	1.9	Mallard	1.45	1.45
Chromium (total)	1	Rat	2,737	5,354	Black duck	1.0	1.0
Lead	50	Rat	8.0	15.6	American kestrel	3.85	3.85
Mercury (inorganic)	0.3	Mouse	13.2	14.0	Japanese quail	0.45	0.45
Mercury (organic)	0.3	Rat	0.032	0.063	Mallard	0.0064	0.0064
Nickel	30	Rat	40	78	Mallard	77.4	77.4
Selenium	1	Rat	0.20	0.39	Screech owl	0.44	0.44
Silver	2	Rat	17.8	34.8	---	---	---
Organic							
2-hexanone	---	Rat	1,676 ^t	3,279	---	---	---
Acetone	---	Rat	10	20	---	---	---
Methylene chloride	---	Rat	5.85	11.44	---	---	---
Trichloroethene	---	Mouse	0.7	0.7	---	---	---

^aIn milligram(s) per kilogram soil.

^bFrom Will and Suter (1995), except where noted.

^cBody weights (in kilograms) for the no-observed-adverse-effect level (NOAEL) conversion are as follows: lab mouse, 0.030; lab rat, 0.350 (except where noted).

^dFrom Sample et al. (1996), except where noted.

^eIn milligrams per kilogram body weight per day.

^fBased 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.

^gBased 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.

^hBody weight: 0.435 kilogram.

ⁱBody weight: 0.303 kilogram.

--- Designates insufficient toxicity data.

^oBased upon mouse NOAEL for 2-butanone (Sample et al. 1996) and the ratio of the lethal dose to 50 percent of the population (LD₅₀) values from RTECS (1997).

Table 14
Hazard Quotients for Ecological Receptors at SWMU 17

Constituent of Potential Ecological Concern	Plant HQ ^a	Deer Mouse HQ (Herbivorous) ^a	Deer Mouse HQ (Omnivorous) ^a	Deer Mouse HQ (Insectivorous) ^a	Burrowing Owl HQ ^a
Inorganic					
Barium	4.4E-1	5.5E-1	1.9E+0	3.3E+0	2.4E-2
Cadmium	1.7E+0	2.4E-1	2.5E-1	2.6E-1	8.1E-3
Chromium (total)	1.8E+1	3.1E-5	5.5E-5	7.9E-5	6.0E-2
Lead	5.4E+0	2.0E-1	2.3E-1	1.6E-1	1.6E-1
Mercury (inorganic)	8.0E-1	2.7E-3	2.7E-3	2.7E-3	4.9E-2
Mercury (organic)	8.0E-1	6.1E-1	6.1E-1	6.1E-1	3.4E+0
Nickel	5.7E-1	7.4E-3	1.1E-2	1.4E-2	6.3E-4
Selenium	2.5E+1	5.2E+0	7.7E+0	1.0E+1	1.7E+0
Silver	2.5E+0	2.3E-2	1.4E-2	6.0E-3	... ^b
Organic					
2-Hexanone	---	2.5E-6	4.4E-6	6.2E-6	---
Acetone	---	1.4E-2	8.9E-3	3.5E-3	---
Methylene chloride	---	1.2E-4	1.8E-4	2.5E-4	---
Trichloroethene	---	1.3E-3	1.1E-2	2.1E-2	---
Hazard index ^c	5.4E+1	6.9E+0	1.1E+1	1.4E+1	5.4E+0

^aBold text indicates HQ or HI exceeds unity.

^b--- designates insufficient toxicity data available for risk estimation purposes.

^cThe hazard index is the sum of individual HQs using the value for organic mercury as a conservative estimate of the HI.

SWMU = Solid waste management unit.

HI = Hazard index.

HQ = Hazard quotient.

Table 15
Internal and External Dose Rates for
Deer Mice Exposed to Radionuclides at SWMU 17

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
U-234 ^a	2.4E+0	2.7E-5	2.7E-7	2.7E-5
U-235 ^a	2.6E-1	2.7E-6	4.2E-6	6.9E-6
U-238	1.9E+1	1.9E-4	2.9E-3	3.1E-3
Th-234+D ^b	1.7E+1	1.7E-8	2.6E-5	2.6E-5
Total		2.2E-4	2.9E-3	3.1E-3

^aU-234 and U-235 values were calculated using the U-238 concentration and assuming that the U-238 to U-234 ratio and U-238-to-U-235 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 14, 1998).

^bThe dose rate calculation for Th-234 includes its radiological 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 17

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
U-234 ^a	2.4E+0	9.4E-6	2.7E-7	9.7E-6
U-235 ^a	2.6E-1	1.0E-6	4.2E-6	5.2E-6
U-238	1.9E+1	6.6E-5	2.9E-3	3.0E-3
Th-234+D ^b	1.7E+1	1.2E-8	2.6E-5	2.6E-5
Total		7.6E-5	2.9E-3	3.0E-3

^aU-234 and U-235 values were calculated using the U-238 concentration and assuming that the U-238 to U-234 ratio and U-238-to-U-235 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 14, 1998).

^bThe dose rate calculation for Th-234 includes its radiological daughter, protactinium-234m.

pCi/g = Picocurie(s) per gram.

SWMU = Solid waste management unit.

These conservative assumptions protect ecological resources potentially affected at the site. Conservatism incorporated into this risk assessment include the use of 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 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. Each of these uncertainties, which are consistent among ER-specific ecological risk assessments, is discussed in detail in the uncertainty section of the ecological risk assessment methodology (IT June 1998).

Uncertainties associated with estimating risk to ecological receptors following exposure to U-234, U-235, 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 cadmium, selenium, and silver, which may give a false impression of ecological risks associated with these metals. Both situations result in conservative estimates of the mean concentrations that may not reflect actual site conditions.

Analytical data were examined closely to assess variability. Barium data revealed that the maximum detected concentration of 220 mg/kg resulted in an HQ greater than one. The average of 110 measured barium concentrations reported by the laboratory was 109 mg/kg (less than the background concentration of 130 mg/kg). The maximum detected total chromium concentration of 18 mg/kg used in the estimation of risk resulted in an HQ of 18. The average detected chromium concentration was 12.7 mg/kg (less than the background value of 17.3 mg/kg). Of the 113 soil samples analyzed for lead, approximately 80 percent did not contain detectable concentrations of the metal. The range of detected concentrations was 7 to 270 mg/kg, with an average detected concentration of 23.6 mg/kg. When the nondetected values are also considered, the average lead concentration for the site is similar to the background concentration of 21.4 mg/kg. It is therefore unlikely that overall site risk associated with exposure of ecological receptors to barium, chromium, or lead is greater than that experienced from background.

Background concentrations are included as a component of maximum on-site concentrations in the estimation of ecological risk. Table 17 illustrates risk estimates associated with exposure of each receptor to background concentrations of metal COPECs. With respect to the plant, an HQ greater than one was obtained for chromium. HQs greater than unity were also obtained for the omnivorous and insectivorous deer mouse exposed to barium and for the burrowing owl exposed to organic mercury, which is not expected to be the predominant form of mercury at the site. Almost 60 percent of the on-site maximum barium soil concentration was associated with background, whereas 96 percent of on-site maximum total chromium concentration was associated with background. Because of the uncertainties associated with exposure and

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

Constituent of Potential Ecological Concern	Plant HQ*	Deer Mouse HQ (Herbivorous)*	Deer Mouse HQ (Omnivorous)*	Deer Mouse HQ (Insectivorous)*	Burrowing Owl HQ*
Inorganic					
Barium	2.6E-1	3.3E-1	1.1E+0	2.0E+0	1.4E-2
Cadmium	1.7E-1	2.4E-2	2.5E-2	2.6E-2	8.1E-4
Chromium (total)	1.7E+1	3.0E-5	5.3E-5	7.5E-5	5.8E-2
Lead	4.3E-1	2.3E-2	1.8E-2	1.2E-2	1.3E-2
Mercury (inorganic)	4.2E-1	1.4E-3	1.4E-3	1.4E-3	2.5E-2
Mercury (organic)	4.2E-1	3.2E-1	3.2E-1	3.2E-1	1.8E+0
Nickel	3.8E-1	5.0E-3	7.1E-3	9.2E-3	4.3E-4
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 ^c	1.9E+1	8.1E-1	1.6E+0	2.6E+0	1.9E+0

***Bold** text indicates that the HQ or HI exceeds unity.

^b --- Designates insufficient toxicity data available for risk estimation purposes.

^cThe HI is the sum of individual HQs using the value for organic mercury as a conservative estimate of HI.

HI = Hazard index.

HQ = Hazard quotient

SWMU = Solid waste management unit.

toxicity, it is unlikely that barium and chromium (with exposure concentrations largely attributable to background) present a significant ecological risk.

As illustrated above, consideration of site-specific exposure conditions results in a more realistic estimation of risk. Based upon the minimum reported home range size of 35 acres for the burrowing owl and the size of the site (13.25 acres), an area use factor of approximately 0.38 or less could be applied to the HQs for this species. This would result in HQ estimates near or less than unity for the burrowing owl, indicating little potential for adverse risks to the owl from exposure to COPECs at SWMU 17.

Based upon this uncertainty analysis, ecological risks at SWMU 17 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, background risk, quality of analytical data, and the use of detection limits as exposure concentrations.

VII.3.6 Risk Interpretation

Ecological risks associated with SWMU 17 were estimated through a screening assessment that incorporates site-specific information when available. Overall, ecological risks to plants are expected to be low because predicted risks associated with exposure to cadmium, selenium, and silver are based upon calculations using a detection limit value and because average chromium and lead concentrations at the site are at background levels. With respect to the mouse, risk is also expected to be low. Predicted risk from exposure to selenium was calculated using a detection limit. In addition, average barium concentrations at the site were in the range of background concentrations. Selenium and organic mercury were predicted to be hazardous to the owl. As discussed above, the selenium concentration used in the risk model was based upon the detection limit. Potential risks associated with mercury were evaluated assuming total mercury occurred at the site entirely as either inorganic or organic mercury. The assumption of inorganic mercury did not result in an estimation of risk. If all mercury detected in soil was in the organic form, it could prove to be potentially hazardous to the owl.

However, an estimated HQ of less than 4 assumes that the maximum soil concentration represents mercury concentrations throughout the site and assumes that the burrowing owl's entire home range is confined to the site. The SWMU, however, constitutes less than 40 percent of the owl's home range, and based upon this final analysis, ecological risks associated with SWMU 17 are expected to be insignificant.

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 insignificant. The scientific/management decision is to recommend this site for NFA.

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APPENDIX 1 EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

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 solid waste management units (SWMU) have similar types of contamination and physical settings, SNL/NM 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 U.S. Environmental Protection Agency (EPA) Region VI and New Mexico Environment Department (NMED), SNL/NM proposes that these default exposure routes and parameter values be used in future risk assessments.

At SNL/NM, all ER sites exist within the boundaries of the KAFB. 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 HI, 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 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

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

RESRAD Manual (ANL 1993). Also shown are the default values SNL/NM ER suggests for use in 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., HQ/Hi, excess cancer risk, or radiation TEDE) 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 HI) 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 HI) 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 HI 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 use 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.

Summary

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 ^d
Averaging Time (days) for carcinogenic compounds (=70 y x 365 d/y)	25550 ^a	25550 ^a	25550 ^a
for noncarcinogenic compounds (=ED x 365 d/y)	10950	10950	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)	1.32E9 ^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.

^aRAGS, Vol 1, Part B (EPA 1991).

^bExposure Factors Handbook (EPA 1989b)

^cEPA Region VI guidance.

^dFor radionuclides, RESRAD (ANL 1993) is used for human health risk calculations; default parameters are consistent with RESRAD guidance.

^eDermal Exposure Assessment (EPA 1992).

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