

Sandia National Laboratories/New Mexico

**PROPOSAL FOR NO FURTHER ACTION
ENVIRONMENTAL RESTORATION PROJECT
SWMU 87 BUILDING 9990 FIRING SITE**

June 2003

Environmental
Restoration
Project



United States Department of Energy
Office of Kirtland Site Operations

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- 2-C Risk Screening Assessment
- 2-D Data Validation Reports
- 2-E Surface-Water Assessment for SWMU 87, September 28, 1998
- 2-F Investigation of Four Pits within the Cultural Resources Area, Solid Waste Management Unit Area 87

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CHAPTER 2.0 ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
AR/COC	Analysis Request/Chain-of-Custody
ATV	All-terrain vehicle
bgs	below ground surface
CEARP	Comprehensive Environmental Assessment and Response Program
COC	constituent of concern
DOE	U.S. Department of Energy
EB	equipment blank
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
FB	field blank
g	gram(s)
HE	high explosive(s)
HI	hazard index
HMX	cyclotetramethylene tetranitramine
HQ	hazard quotient
HRS	Hazard Ranking System
KAFB	Kirtland Air Force Base
kg	kilogram(s)
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
MDA	minimum detectable activity
mg	milligram(s)
mrem	millirem
NFA	no further action
NMED	New Mexico Environment Department
OU	Operable Unit
pCi	picocurie(s)
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RPD	relative percent difference
RPO	Radiation Protection Operations
RPSD	Radiation Protection Sample Diagnostics
SAP	Sampling and Analysis Plan
SNL/NM	Sandia National Laboratories/New Mexico
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
UXO	unexploded ordnance
VCA	Voluntary Corrective Action
VCM	Voluntary Corrective Measure
yr	year(s)

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2.0 SOLID WASTE MANAGEMENT UNIT 87, BUILDING 9990 FIRING SITE

2.1 Summary

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a risk-based no further action (NFA) decision for Environmental Restoration (ER) Solid Waste Management Unit (SWMU) 87, the Building 9990 Firing Site, Operable Unit (OU) 1332, on Kirtland Air Force Base (KAFB). Review and analysis of all relevant data for SWMU 87 indicate that concentrations of constituents of concern (COCs) at this site are less than applicable risk assessment action levels. Thus, SWMU 87 is proposed for an NFA decision based upon confirmatory sampling data demonstrating that COCs that may have been released from SWMU 87 into the environment pose an acceptable level of risk under current and projected future land uses as set forth by Criterion 5, which states, "[t]he SWMU/AOC [area of concern] 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).

2.2 Description and Operational History

This section describes SWMU 87 and discusses its operational history.

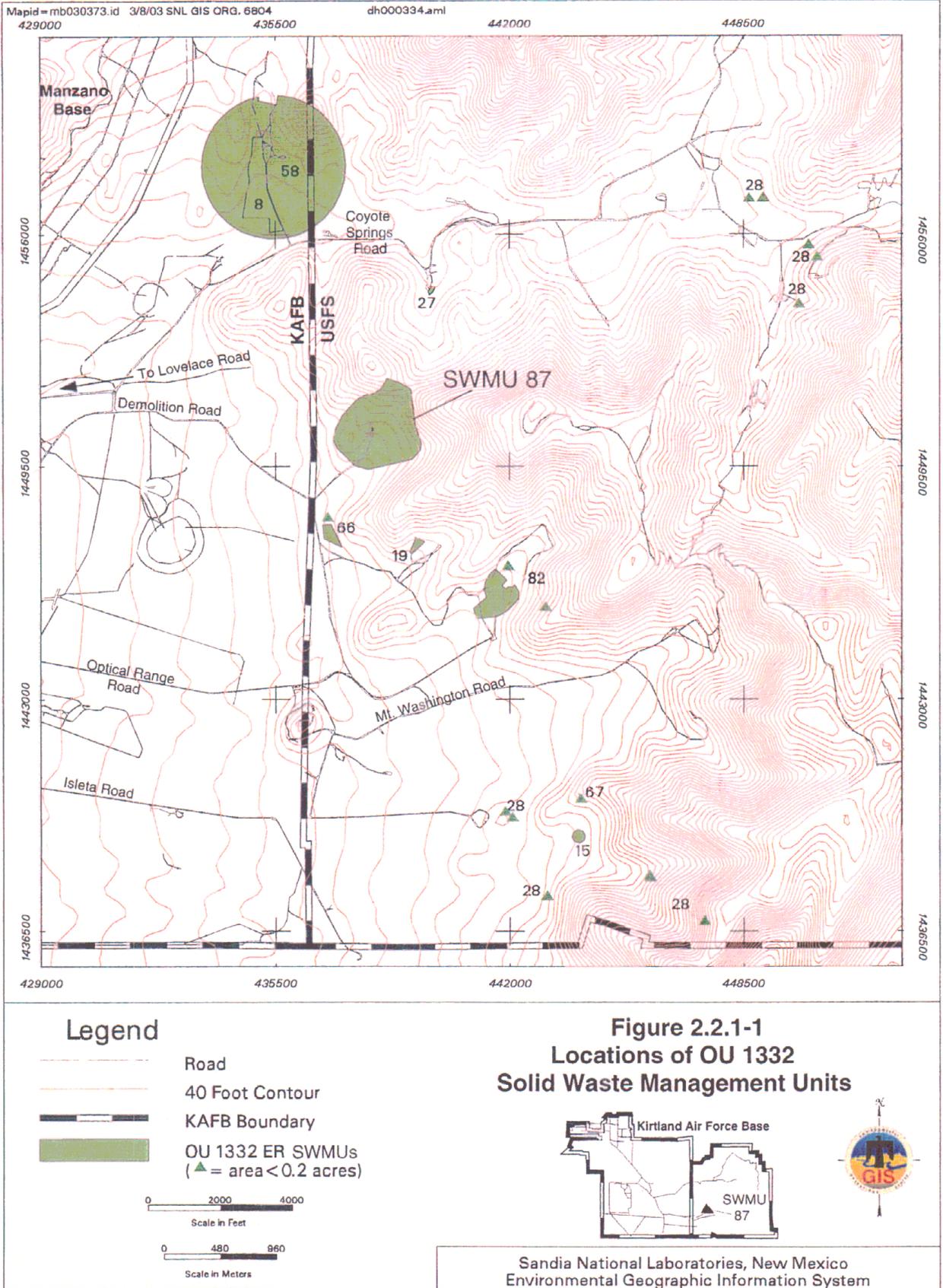
2.2.1 Site Description

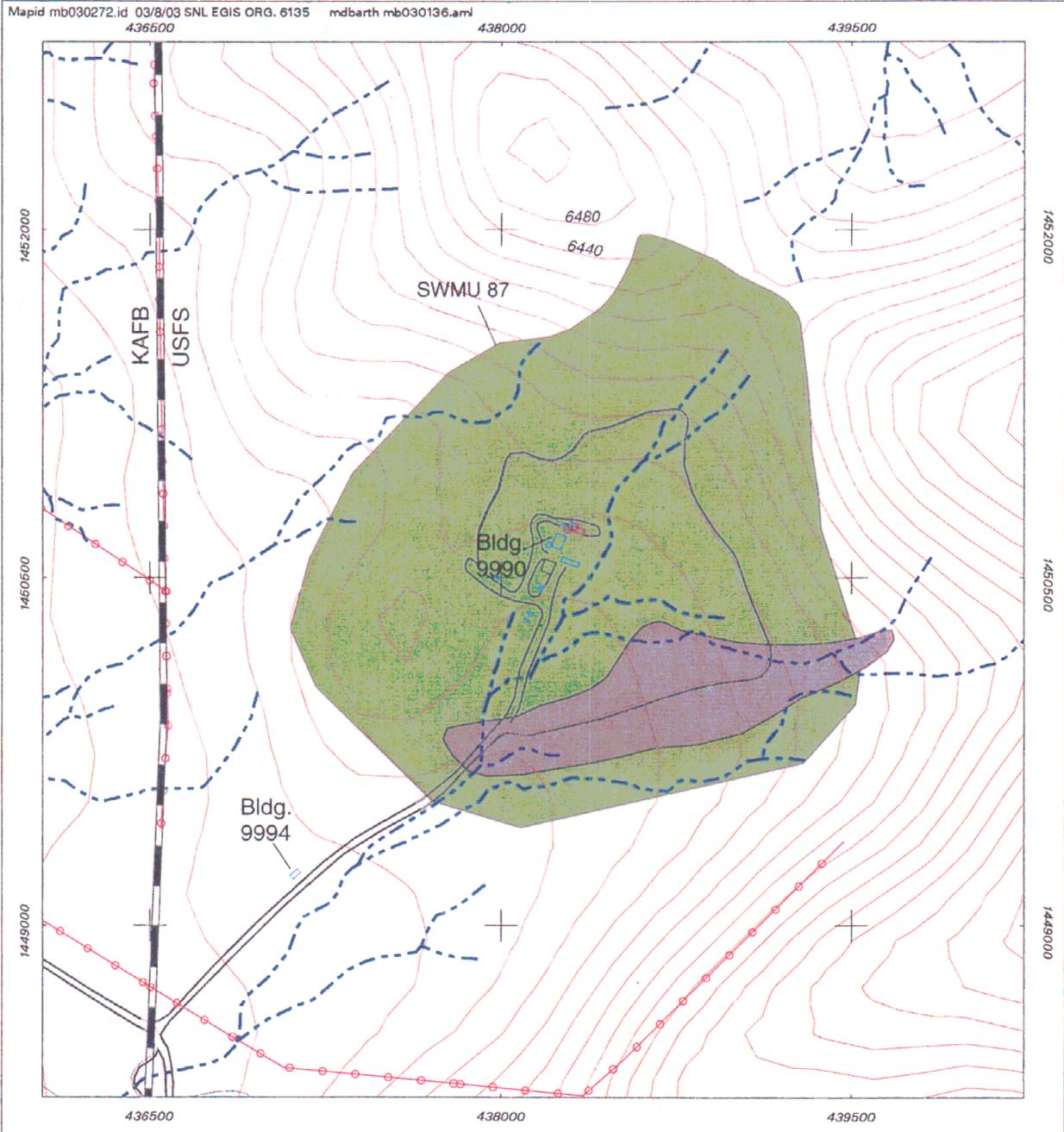
SWMU 87, the firing site located at the former Electro-Explosives Research Facility (Building 9990), is located on U.S. Air Force land withdrawn from the U.S. Forest Service and permitted to the U.S. Department of Energy (DOE). The site is located off of Demolition Road approximately 1.3 miles due east of the intersection with Coyote Springs Road, and approximately 2.7 miles due east of the intersection of Coyote Springs and Lovelace Road (Figure 2.2.1-1). The site covers 97.44 acres in a box canyon that opens to the southwest (Figure 2.2.1-2). Ground elevation at the site ranges from 6,070 to 6,490 feet above mean sea level. The outer boundary of the site was defined based upon unexploded ordnance (UXO)/high explosives (HE) surveys, surface gamma radiation scanning surveys, and voluntary corrective measure (VCM)/housekeeping activities.

Steep slopes form a U-shaped ridge that surrounds Building 9990. An arroyo trends southwest across the site. In the central part of the canyon where Building 9990 is located, the terrain is relatively flat, sloping gently to the southwest. Bedrock (granitic and metamorphic rocks of Precambrian age) is exposed at the surface in the surrounding ridges. A thin veneer of regolith (broken/eroded rock fragments and sand-sized material with little or no true soil) and alluvial sediment partially cover some of the ridge slopes and much of the canyon bottom near the central arroyo. This material is probably less than 1 foot thick in most areas. Vegetation in the area is spotty in distribution and primarily comprised of junipers, sagebrush, desert grasses, and cedar scrub.

A gravel road that branches off Demolition Road to the northeast provides access to SWMU 87. Within the box canyon area, another gravel road branches off the access road and forms a loop

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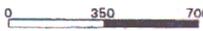




Legend

-  Building / Structure
-  Unpaved Road
-  Fence
-  KAFB / USFS Withdrawn Area Boundary
-  40-Foot Contour
-  Surface Drainage
-  SWMU 87
-  Cultural Resource Area

**Figure 2.2.1-2
 Site Map of
 Solid Waste Management
 Unit 87**



Scale in Feet



Scale in Meters



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around the Building 9990 area (Figure 2.2.1-2). This road primarily serves as a fire barrier or fire line.

The northern portion of the site encompasses the former Electro-Explosives Research Facility, with the outdoor firing site located at the north end of Building 9990 (Figure 2.2.1-3). The facility consists of the main concrete structure (Building 9990) and 11 associated concrete, transportainer, igloo, and metal ancillary structures (Figure 2.2.1-4).

The main building (Building 9990) is a concrete structure that was used as a control, instrumentation, and shop facility. The firing site, where detonations and tests occurred, is located on the immediate north side of Building 9990. The north-facing wall of Building 9990 is reinforced with steel plating. Located in this wall are protected camera ports for filming the outdoor experiments. The surrounding canyon area and ridge slopes are littered with various pieces of shrapnel.

Two pre-engineered metal buildings (9990A and 9990B) were used to house electromagnetic launchers and propulsion experiments. Building 9990A was erected just north of Building 9990 (Figure 2.2.1-5) in late 1986. Building 9990B was erected southeast of Building 9990. Several smaller building structures and concrete pads are also present in the area, primarily at the northeast end of the canyon. Building 9990D was a portable test assembly building that was removed from the site in June 1994. All other buildings were used for storage.

The testing group that operated the facility, SNL/NM Organization 1221, has since moved out of the facility. As of July 1994, all equipment and associated materials had been removed, and the facility is currently inactive. Radiation Protection Operations (RPO) (SNL/NM Organization 7714) personnel participated in the closeout activities, performing radiation release surveys on equipment and materials.

2.2.2 Operational History

The Electro-Explosives Research Facility, constructed in 1968, was active from 1969 to May 1994. Various types of outdoor tests were conducted at Building 9990 including:

- Explosive generator tests
- Electromagnetic launcher tests
- Contained (W45 mock warhead) tests
- Neutron Generator Proof Tests
- Stand Off Tests
- Davis Gun Tests
- Box Tests
- Flyer Plate Tests
- Simulated lightning experiments

All of the explosive tests were conducted in the firing site area immediately north of Building 9990. No large explosive tests have been conducted at the firing site since 1986 (Mitchell May 1994). Some of the tests described below dispersed shrapnel for distances greater than 1,200 feet based upon the surface radiation survey results, VCM/housekeeping activities, and visual inspections of the area. Although some shrapnel may have been propelled farther, the steep topography of the area has largely contained the distribution of fragments and/or shrapnel, and this is how the site boundary was defined.

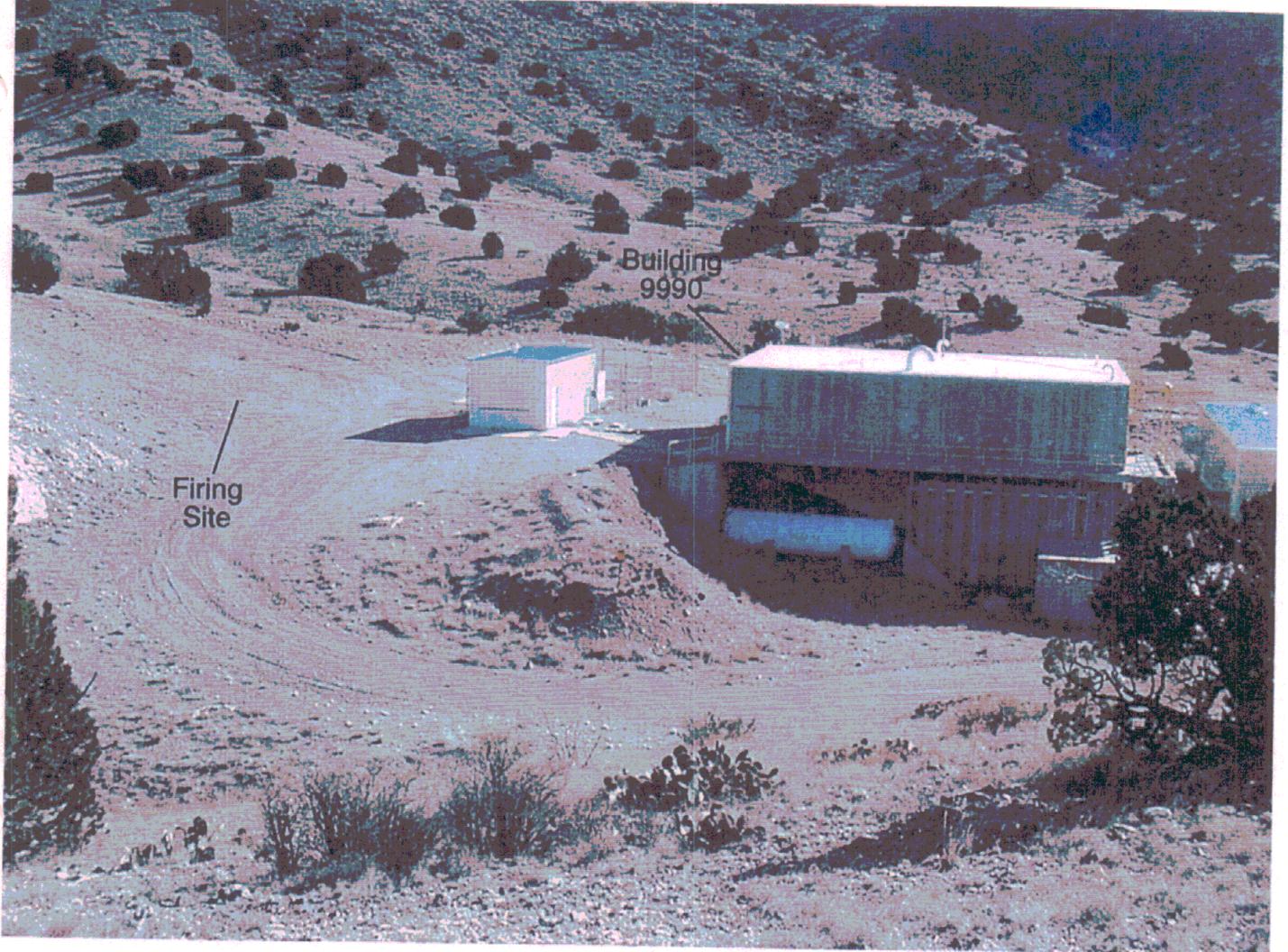


Photo Source: Ed Mignardot 01/16/03

Figure 2.2.1-3
Photograph of Solid Waste Management Unit 87,
showing firing site at north end of facility, January 2003.
View to the east.



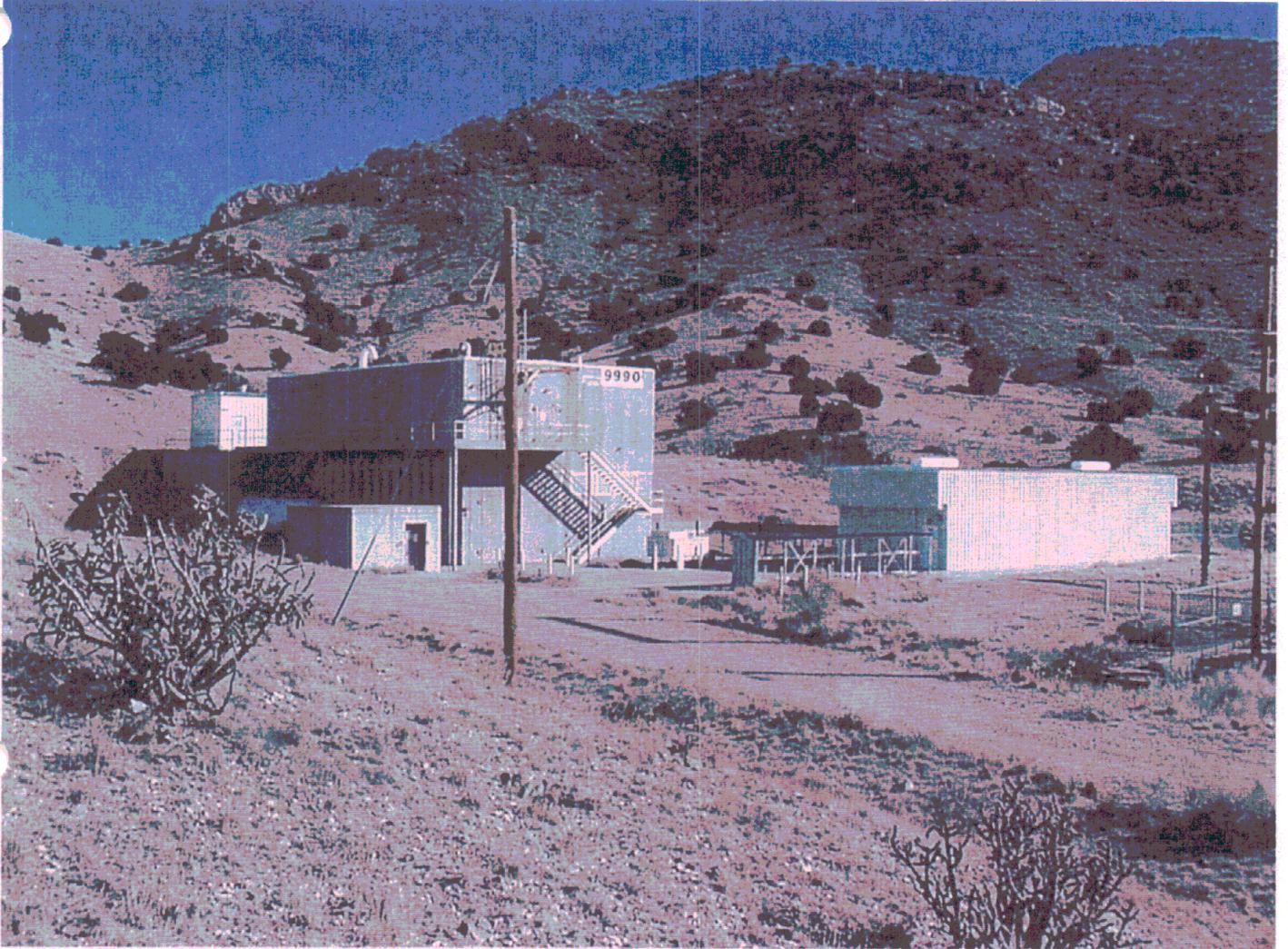
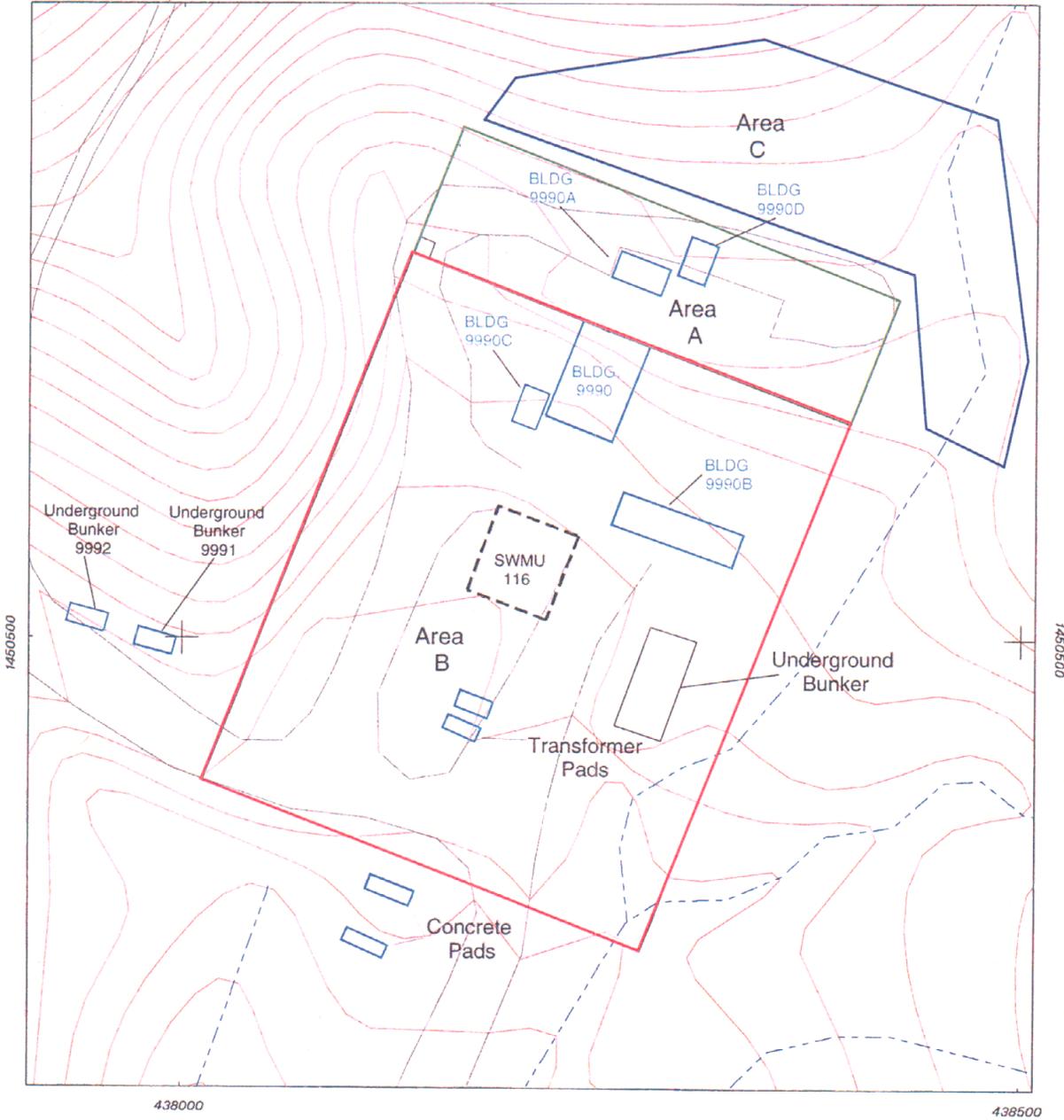


Photo Source: Ed Mignardot 01/16/03

Figure 2.2.1-4
Photograph of Building 9990
facility and ancillary structures, January 2003.
View to the northeast.





Legend

- Area C Sampling Boundary
- Area A Sampling Boundary
- Area B Sampling Boundary
- SWMU 116
- Building/Structure
- Unpaved Road
- 5 Foot Contour
- Surface Drainage

**Figure 2.2.1-5
Buildings and Structures at
Solid Waste Management
Unit 87**

0 50 100

Scale in Feet

0 12 24

Scale in Meters



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The primary purpose of the Electro-Explosives Research Facility was to conduct explosive generator and electromagnetic launcher research (Mitchell May 1994). The explosive generator tests involved producing large electrical currents (mega amperes) from explosions. Explosives were used to build large, short-lived electrical charges by collapsing electromagnetic coils with an induced electrical current. The resulting electrical current could theoretically be used to drive rail guns (launchers), lasers, or simulate electromagnetic pulses from thermonuclear devices. These tests constituted the bulk of the "hundreds of tests" performed at Building 9990 that involved HE but no radioactive materials (Wrightson May 1994). The tests did result in significant generation of metal debris, primarily aluminum, copper, and steel (shrapnel), when various components, instruments, and fixtures were blown up. Based upon recent visual inspections and housekeeping activities at the site, the debris was scattered throughout a 500-foot radius as a result of the explosions.

Approximately 30 electromagnetic launcher tests were also conducted at the site, which involved moving projectiles using an electromagnetic force. During these tests, projectiles were accelerated up to 1 kilometer/second (Mitchell May 1994). However, these tests did not involve radioactive materials or generate metal shrapnel/fragments. Most projectiles were fired into some type of containment feature, such as a catch box, although up to ten of the tests were not contained and some of the projectiles were not recovered (Mitchell June 1994).

In addition to explosive generator and electromagnetic launcher tests, other groups at SNL/NM used the Building 9990 area to conduct weapons-related testing. However, these tests constituted only a very small part of the overall testing conducted at Building 9990 (Mitchell May 1994).

In the summer or fall of 1979, contained tests (part of the W45 tests) were conducted at Building 9990, which involved detonating mock-up warheads that contained significant quantities of depleted uranium (exact volume or mass is not known). Prior to these contained tests, an instrumentation test shot resulted in the distribution of hundreds to thousands of small depleted uranium fragments over the surrounding area and hillsides (Mitchell July 1994a).

Another series of tests that involved depleted uranium are referred to as the "Neutron Generator Proof Tests" and "Stand Off Tests." The purpose of these tests was to evaluate weapon components reliability. These tests, conducted at Building 9990 from mid-1982 through 1986, involved about a dozen individual tests with weapons that contained depleted uranium and less than 50 pounds of HE. Although small in number, these tests were particularly significant because each resulted in the scattering of small fragments of depleted uranium (typically very thin and less than several inches in length and width) across the site. Other tests involving depleted uranium spheres were also conducted in the 1970s (Mitchell May 1994).

"Davis Gun Tests" were also performed at the Electro-Explosives Research Facility. These tests were conducted in a long cylinder (the Davis Gun) open at both ends with rocket propellant located mid-cylinder. An aluminum projectile was fired out of one end of the gun and aluminum and steel, used as counterbalances, were blown out of the other end. These tests did not involve any radioactive materials but did result in a significant amount of aluminum and steel fragments being scattered throughout the area (Mitchell July 1994b, Mitchell July 1994c).

"Box Tests" conducted at the site also did not involve radioactive materials but resulted in a significant amount of aluminum shrapnel being dispersed over the area. In these tests, HE was packed symmetrically around a gas cylinder and placed into an aluminum box. The HE was

detonated, resulting in the instantaneous compression of the gas. The resulting explosion shattered the aluminum box and scattered the pieces (Mitchell May 1994).

"Flyer Plate Tests" involved accelerating aluminum plates into the nose cone of a mock warhead to assess damage. The nose cone was made of carbon steel and was wired with sensors. These tests did not result in releases of radioactive material, but may have produced and dispersed metal shrapnel (Mitchell May 1994, Mitchell July 1994b, and Mitchell July 1994c).

"Simulated lightning experiments" were also conducted as part of the weapons components integrity tests. These experiments used the Building 9990 capacitor banks to deliver electrical pulses (three in succession) to missile carrier assemblies. No releases of radioactive or hazardous materials occurred as part of these tests (Mitchell July 1994a, Mitchell July 1994b, and Mitchell July 1994c).

In the period from 1982 to 1986, explosive generator experiments detonating up to 800 pounds of liquid nitromethane were performed north of Building 9990 (about 70 feet from the north, steel-reinforced wall). To minimize ground shock to Building 9990, the soil under the experiment area (firing site) was excavated 10 to 12 feet below grade by 10 to 12 feet wide by 40 feet long. The excavated area was then backfilled with soil and leveled for the experiments. COCs that may have already been present in the soil at the surface could have been mixed into the subsurface during this operation (Mitchell July 1994c).

In summary, the Electro-Explosives Research Facility has a long history of explosive and electromagnetic testing and experiments. A vast majority of the testing did not involve radioactive or hazardous materials, although the use of HE and lead was common. Lead was primarily used to anchor or hold materials in place. Most of the obvious shrapnel at the surface is aluminum, steel, or copper. Sporadic testing from the late 1970s to around 1986 did involve depleted uranium and possibly beryllium. The tests involving depleted uranium, although few in number, resulted in the widespread distribution of small radioactive fragments across the site, especially on the east, north, and west sides of the Electro-Explosives Research Facility. Additional detail on these tests is provided in the "RCRA [Resource Conservation and Recovery Act] Facility Investigation [RFI] Work Plan for OU 1332, Foothills Test Area" (SNL/NM June 1995).

Materials used or potentially used at SWMU 87 are listed in Table 2.2.2-1. COCs that may have been released at SWMU 87 are listed in Table 2.2.2-2, and were determined based upon the nature of the various tests conducted at the site, as well as activities related to testing, facility operation, and maintenance. Many of the tests or experiments were contained and did not result in any releases.

2.3 Land Use

This section discusses the current and future land uses of SWMU 87.

Table 2.2.2-1
Materials Used or Potentially Used at SWMU 87

Material Used or Potentially Used	Explanation
HE: Comp B, Tetryl, PBX 9404, nitromethane liquid, LX-04, Octol, nitrocellulose, and baratol	Tetryl was used in small quantities only; PBX-9404 was associated with tests involving DU; nitromethane liquid was used for big shots only. Other HE materials were used in larger quantities.
Tritium	Small volumes of tritium were possibly used in mock-up warheads.
DU	DU was used in the Neutron Generator Proof Tests, Stand Off Tests, and Contained Tests (part of W45 tests).
Lead	Lead was commonly used to anchor test objects.
Aluminum, steel, and copper	These metals were used extensively in explosive generator and electromagnetic launcher tests (especially aluminum), as well as weapons tests (such as Flyer Plate Tests).
Beryllium, barium	Some tests may have used beryllium. Barium is a component of the explosive baratol.
Toluene, acetone, and methanol	These agents were used to wash and clean test materials and used on the test pad.
Freon TF, TCE	Freon and TCE were used inside Building 9990, although there are no known releases.
Methylene chloride	Methylene chloride may have been stored temporarily adjacent to Building 9990; there are no known releases.
Photographic waste water	Waste water discharged to the septic system only. Investigation of the septic system is addressed under the Sampling and Analysis Plan for Shallow Subsurface Soil Sampling, RCRA Facility Investigation of Septic Tanks and Drainfields (OU 1295) (SNL/NM March 1994).

- DU = Depleted uranium.
- HE = High explosive(s).
- NFA = No further action.
- PBX = Plastic-bonded explosive.
- RCRA = Resource Conservation and Recovery Act.
- RFI = RCRA Facility Investigation.
- SWMU = Solid Waste Management Unit.
- TCE = Trichloroethylene.
- Tetryl = Trinitro-2,4,6-phenylmethylnitramine.

Table 2.2.2-2
Potential COCs Released at SWMU 87

COC Potentially Released	Explanation
HE: Comp B, Tetryl, PBX 9404, nitromethane liquid, LX-04, Octol, nitrocellulose, and baratol	Explosives could be present in the immediate vicinity of the firing pad, although unlikely.
DU	DU fragments (metal) are scattered across the surface of the site. An area greater than 52 acres has been impacted (surface only). DU could also be present in the subsurface in the immediate vicinity of the firing pad.
Tritium	It is not certain whether small amounts of tritium were present in the mock warheads tested at the site.

COC = Constituent of concern.
 DU = Depleted uranium.
 HE = High explosive(s).
 PBX = Plastic-bonded explosive.
 SWMU = Solid Waste Management Unit.
 Tetryl = Trinitro-2,4,6-phenylmethylnitramine.

2.3.1 Current Land Use

The current land use classification for SWMU 87 is recreational (DOE et al. October 1995).

2.3.2 Future/Proposed Land Use

The projected land use for SWMU 87 is recreational (DOE et al. October 1995).

2.4 Investigatory Activities

SWMU 87 has been characterized and remediated in a series of investigations, VCMs, and housekeeping activities. This section discusses these activities.

2.4.1 Summary

SWMU 87 was originally investigated under the DOE Comprehensive Environmental Assessment and Response Program (CEARP) (DOE September 1987), and the RCRA Facility Assessment (RFA) (EPA April 1987) identified SWMU 87 as a potential SWMU. The investigations included visual inspections of the site. The details are discussed in Section 2.4.2, Investigation #1—CEARP.

Preliminary investigations for SWMU 87 included personnel interviews, site inspections, site photographs, radiation surveys, pre-RFI sampling conducted by the SNL/NM RPO personnel, surveys for UXO/HE, surveys for cultural resources, and surveys for sensitive species. The details are discussed in Section 2.4.3, Investigation #2—SNL/NM ER Preliminary Investigations.

The SWMU was characterized during a series of sampling events conducted between 1995 and 2001. The details of the sampling efforts and the analytical results are discussed in Section 2.4.4, Investigation #3—RFI Sampling and Characterization Activities.

VCMs were conducted in 1994, 1995, and 1998 to remove surface radiation anomalies. Housekeeping activities were conducted in 2000 and 2003 to remove general debris and shrapnel. The details of both the VCMs and housekeeping activities are discussed in Section 2.4.5, Investigation #4—SNL/NM ER VCM/VCA and Housekeeping Activities.

2.4.2 Investigation #1—CEARP

2.4.2.1 *Nonsampling Data Collection*

SWMU 87 was evaluated during investigations conducted under the CEARP (DOE September 1987) and the RFA (EPA April 1987) and identified as a potential site during the investigation conducted under the CEARP.

The CEARP Phase I report (DOE September 1987) stated that:

Most of the large explosive test shots are conducted at the Building 9990 firing site (Site 87). Active tests include simulated lightning experiments and various weapons tests. The firing area is littered with pieces of shrapnel and high explosives, possibly including barium. The area may also be contaminated with lead, beryllium, or depleted uranium. A determination needs to be made of whether this material has been abandoned under the RCRA. Drums containing nitromethane are stored outside the adjacent bunkers.

The RFA report (EPA April 1987) noted that SWMU 87 was littered with shrapnel and HE debris including lead, beryllium, and uranium. In addition, adjacent bunkers contained nitromethane drums.

2.4.2.2 *Sampling Data Collection*

No sampling activities were conducted at SWMU 87 as part of the CEARP or RFA.

2.4.2.3 *Data Gaps*

No samples were obtained during the CEARP or RFA to determine whether hazardous materials or wastes were stored or released to the surrounding environment. Sufficient information was not available to calculate Hazard Ranking System (HRS) and Modified HRS migration mode scores.

2.4.2.4 *Results and Conclusions*

The Comprehensive Environmental Response, Compensation, and Liability Act finding was uncertain for RCRA-regulated hazardous waste.

2.4.3 Investigation #2—SNL/NM ER Preliminary Investigations

2.4.3.1 SNL/NM ER Nonsampling Data Collection

This section describes the nonsampling data collected at SWMU 87.

2.4.3.1.1 Background Review

A background review was conducted to collect available and relevant information regarding SWMU 87. Background information sources included interviews with SNL/NM staff and contractors familiar with the facility operational history and reviews of existing historical records and reports. The study was documented completely and has provided traceable references that sustain the integrity of the NFA proposal. Table 2.4.3-1 lists the information sources used to assist in evaluating SWMU 87.

Table 2.4.3-1
Summary of Background Information Reviewed for SWMU 87

Information Source	Reference
Visual walkover surveys and site inspections, site photographs, maps, aerial photographs, UXO/HE survey, cultural resources survey, sensitive species survey, and radiation surveys.	SNL/NM January 1968 SNL/NM January 1969 Sandhaus November 1993 Young and Byrd September 1994 Hoagland and Dello-Russo October 1994 IT Corporation February 1995 RUST Geotech Inc. December 1994 SNL/NM September 1997 Aerial Photographs USFS 1961 ST AP EJA PHO 612 128-137 USFS 1982 ST AP HAP PHO 82 367 51-52 USFS 1984 ST AP HAP84 PHO 84 158 106-107 USFS 1992 ST AP KAFB PHO 92 21-7
Reports, interviews, and site tours with SNL/NM facility personnel (current and retired).	Martz September 1985 Martz October 1985 Martz November 1985 Mitchell May 1994 Wrightson May 1994 Mitchell June 1994 Mitchell July 1994a Mitchell July 1994b Mitchell July 1994c

- HE = High explosive(s).
- KAFB = Kirtland Air Force Base.
- SNL/NM = Sandia National Laboratories/New Mexico.
- SWMU = Solid Waste Management Unit.
- USFS = U.S. Forest Service.
- UXO = Unexploded ordnance.

2.4.3.1.2 Unexploded Ordnance/High Explosives Survey

In February 1994, KAFB Explosive Ordnance Disposal personnel conducted a visual survey for the presence of UXO/HE on the ground surface at SWMU 87. The survey identified one M800 AI HE 57-millimeter round with a M13 dummy fuse live ordnance. The ordnance was removed. The survey report also documented that metal fragments were found in the hills surrounding this site (Young and Byrd September 1994).

2.4.3.1.3 Radiation Survey(s)

SWMU 87 is classified as a Radioactive Materials Management Area as determined from the presence of residual depleted uranium in the soil from earlier explosives testing activities. On October 22, 1993, SNL/NM radiation technicians surveyed the north wall of Building 9990 (Sandhaus November 1993). Elevated radiation was found on the wall, and a fragment of depleted uranium was found in an arroyo southeast of the building.

RUST Geotech Inc. conducted two surface gamma radiation surveys at SWMU 87 in 1994 and 1995. All of the point and area sources identified as having gamma activity 30 percent or greater than the natural background were removed from the site. Section 2.4.5.2 provides a detailed discussion of the VCM activities and results.

MACTECH Inc. conducted a surface gamma radiation survey north of Building 9990 in 1998. The survey was performed to determine whether erosion was causing additional depleted uranium to be uncovered at the ground surface. Additional point sources containing gamma activity 30 percent or greater than the natural background were found on the surface. These sources were subsequently removed from the site. Section 2.4.5.2 provides a detailed discussion of the Voluntary Corrective Action (VCA) activities and results.

2.4.3.1.4 Cultural Resources Survey

A cultural resources survey was conducted over the entire site in June 1994 (Hoagland and Dello-Russo October 1994). During the survey, the site was divided into northern and southern portions, which were separated by an east-west-trending unnamed arroyo. The survey covered approximately 148 acres and included the former firing site.

No cultural resources were identified in the northern portion of the site, which is where the building structures and the former firing site are situated. The southern portion of the site, however, is within a historic property and contains a cultural resources site (Historic Mine LA 88086), which is considered eligible or potentially eligible for to the National Register of Historic Properties. The cultural resources site consists of scattered artifacts and mining features.

2.4.3.1.5 Sensitive-Species Survey

A sensitive species survey and biological field investigation of SWMU 87 were conducted on June 24, 1994 (IT February 1995). The resulting report summarizes sensitive, threatened, and endangered species found on the site and gives a comprehensive assessment of biological habitats. Only scattered individual plants of the *Visnagita Cactus* were observed on the site. At

the time, *Visnagita Cactus* was considered an endangered plant by the State of New Mexico. However, since that time, the species has been taken off the New Mexico endangered plant list and is no longer considered a sensitive plant species (NMEMNRD August 1995).

2.4.3.2 *Sampling Data Collection*

In July 1995, a portion of SWMU 87 was investigated as part of a site-wide scoping sampling program. Surface (0 to 6 inches) soil samples were collected at 20 locations in the graded area north of Building 9990 (Area A, see Figure 2.2.1-5). The SNL/NM ER Chemistry Laboratory analyzed the samples for RCRA metals plus beryllium, copper, nickel, and zinc using modified U.S. Environmental Protection Agency (EPA) Method 6010 (EPA November 1986), and for HE using high-performance liquid chromatography. In addition, the Radiation Protection Sample Diagnostics (RPSD) Laboratory analyzed the samples for gamma-emitting radionuclides using gamma spectroscopy. Of the 20 sample locations, 6 were resampled in October 1997 in order to obtain enough acceptable data for performing a risk assessment for Area A.

2.4.3.3 *Results*

Section 2.4.4.3.6 presents the analytical results of the scoping sampling conducted in July 1995.

2.4.3.4 *Data Gaps*

Information gathered from process knowledge, reviewing historical site files, and personal interviews aided in identifying the most likely COCs at SWMU 87 and in selecting the types of analyses to be performed on soil samples. However, a portion of the preliminary scoping sampling data is not adequate to support a risk screening assessment.

2.4.4 *Investigation #3—RFI Sampling and Characterization Activities*

SNL/NM conducted RFI sampling and characterization events at SWMU 87 from August 1995 through October 2001. During this period, surface and subsurface soil samples were collected at Area A, Area B, Area C, the arroyo, and along the perimeter of the site. All samples were collected in accordance with the rationale and procedures described in the RFI Work Plan for OU 1332 (SNL/NM June 1995) and the associated Sampling and Analysis Plans (SAPs) (Annex 2-A). SNL/NM chain-of-custody and sample documentation procedures were followed for all samples.

Because of the size of the site, several discrete areas were investigated. The areas (see Figure 2.2.1-5) and the corresponding sampling/investigation dates include:

- Metal fragment sampling along four radial lines from the firing location in March 1996
- Surface soil sampling at Area A (20 samples) in August 1995, October 1997, September 1998, and March 2000 (tritium only)

- Subsurface sampling at Area A (5 borings) in October 2001
- Surface soil sampling at Area B (20 samples) in May 1996, October 1997, and September 1998
- Surface soil sampling beneath metal fragments at Area C (10 samples) in September 1996
- Surface soil sampling at arroyo (6 samples) in December 1996 and September 1998
- Surface soil sampling along perimeter of the site (12 samples) in May 1996, October 1997, and September 1998
- Exploratory trenching in mounds and fill areas in May 1999.

Table 2.4.4-1 provides a summary of field activities conducted at the site. Additional field activities including VCMs/VCA and housekeeping activities were also conducted at the site, and are summarized in Table 2.4.4-1. The VCMs/VCA and housekeeping activities are discussed in detail in Section 2.4.5.

2.4.4.1 Nonsampling Data Collection

Samples were screened for radiation in the field using a beta/gamma meter with a sodium-iodide detector. No elevated radiation levels were found at sample locations or on sample containers during the RFI sampling phase.

2.4.4.2 Metal Fragment Sampling

In March 1996, 80 metal fragments were randomly collected at SWMU 87. To determine locations for metal fragment sampling, four radial lines were initially surveyed out from the firing site (Figure 2.4.4-1). The line locations were selected to correspond to two arroyo channels where fragments were found, to the bank directly north of the firing point where a significant amount of radioactive fragments were found during the initial surface radiation survey, and to a gentle sloping area to the southeast where radioactive fragments were also found during the initial survey. The lines extended approximately 1,800 feet, which was the extent of significant fragment deposition based upon site visits. An area 10 feet to either side of the line was visually surveyed, and 20 visible fragments were collected along each line. The location and type of each fragment were recorded. The samples were collected in conformance with the RFI Work Plan (SNL/NM June 1995). SNL/NM chain-of-custody and sample documentation procedures were followed for all samples.

Metallic fragments were classified visually. The three types of material found included aluminum alloys, ferrous metals, and other metals. The majority of fragments were aluminum alloys. Ten of the eighty fragments collected were shipped off site for analysis, and included six aluminum alloys, two ferrous metal, and two other metal types (lead and beryllium). The analysis of representative fragments aided in defining the metal alloy composition of the fragments in each category.

Table 2.4.4-1
Summary of Field Activities Conducted at SWMU 87

SWMU 87 Feature	Surveys/Sampling			Housekeeping/VCMs/VCA		
	UXO/HE Survey	Radiation Survey	Soil/Metal Fragment Sampling	Nonradioactive Housekeeping Debris Removal	Trenching	Radioactive VCM/VCA Debris Removal
Area A	•	•	• ^{a,b,c}	•		•
Area B	•	•	• ^d	•		•
Area C	•	•	• ^e	•		•
Arroyo	•	•	• ^f	•		•
Perimeter	•	•	• ^g	•		•
Fill Areas	•	•		•	• ^h	•
Mounds	•	•		•	• ^h	•
Cultural Resources Area	•	•		•		•
Remainder of Site	•	•	• ⁱ	•		•

^aTwenty randomly selected surface soil samples were collected at Area A and analyzed for metals, HE, and radionuclides by gamma spectroscopy.

^bSix judgmentally selected surface soil samples were collected from Area A and analyzed for tritium.

^cFive judgmentally selected boreholes were advanced at Area A; 20 subsurface soil samples were collected and analyzed for metals and radionuclides by gamma spectroscopy.

^dTwenty randomly selected surface soil samples were collected at Area B and analyzed for metals, HE, and radionuclides by gamma spectroscopy.

^eTen judgmentally selected surface soil samples were collected from beneath metal fragments at Area C and analyzed for metals and radionuclides by gamma spectroscopy.

^fSix judgmentally selected surface soil samples were collected from the Arroyo and analyzed for metals, HE, and radionuclides by gamma spectroscopy.

^gTwelve judgmentally selected surface soil samples were collected from the Perimeter and analyzed for metals and radionuclides by gamma spectroscopy.

^hBecause no contamination was found based upon field screening and no stained soils were observed, no soil sampling was required.

ⁱTen judgmentally selected metal fragments were collected from the remainder of the site and analyzed for metals and radionuclides by gamma spectroscopy.

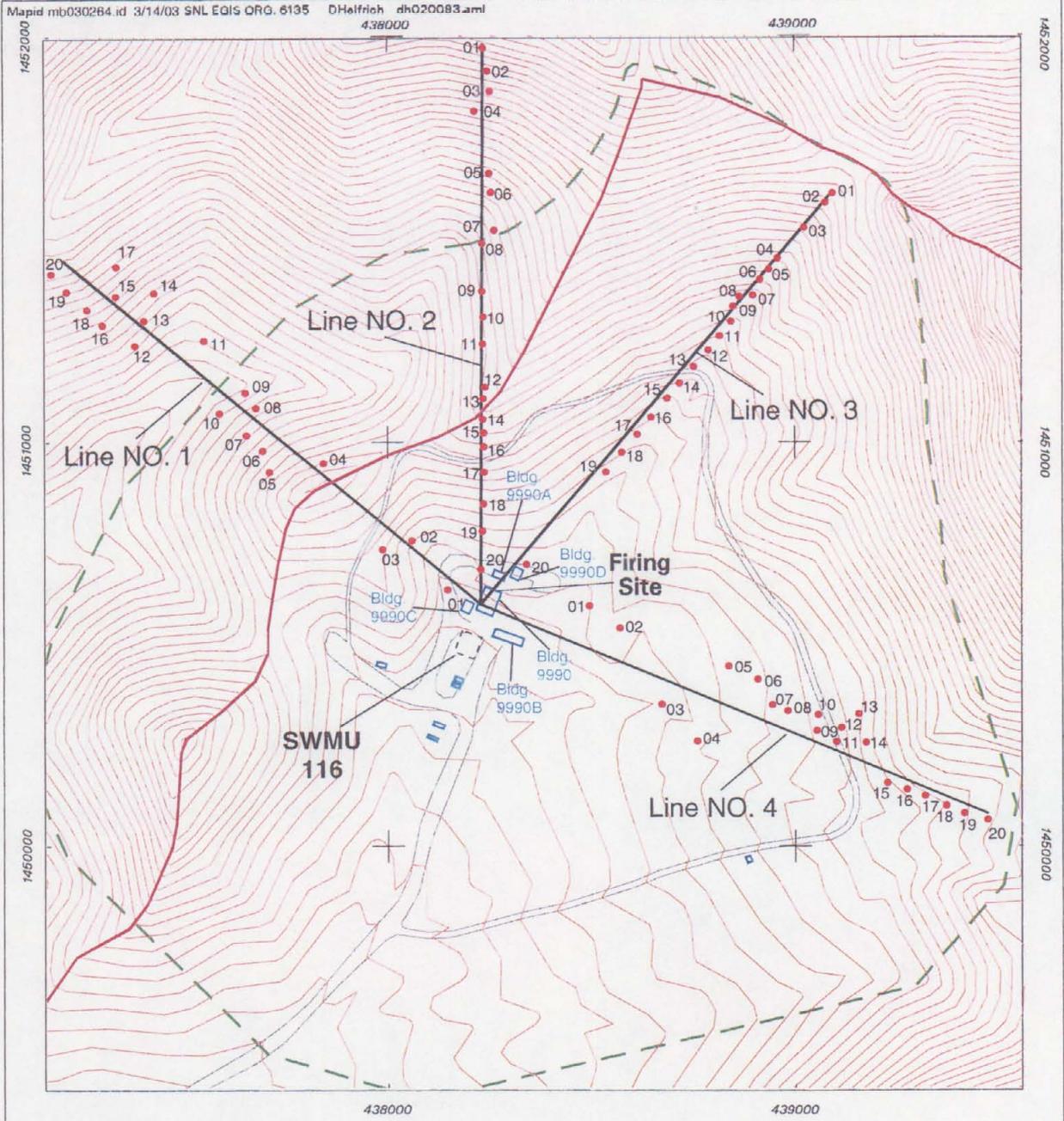
HE = High explosive(s).

SWMU = Solid Waste Management Unit.

UXO = Unexploded ordnance.

VCA = Voluntary Corrective Action.

VCM = Voluntary Corrective Measure.



Legend

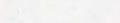
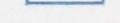
-  SWMU 87 Boundary
-  Fragment Survey Line
-  Bounding Ridge Line
-  10-foot Contour
-  Unpaved Road
-  Building / Structure
-  Approximate Sample Location

Figure 2.4.4-1
Fragment Survey Transects
Along Sample Locations
Solid Waste Management
Unit 87, March 1996

0 200 400

Scale in Feet

0 48 96

Scale in Meters



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

The samples were collected in conformance with the RFI Work Plan (SNL/NM June 1995) as reviewed by the New Mexico Environment Department (NMED). SNL/NM chain-of-custody and sample documentation procedures were followed.

Metal fragment samples were analyzed on site for radionuclides and off site for metals. SNL/NM RPSD Laboratory used gamma spectroscopy to analyze the samples for radionuclides. General Engineering Laboratories, Inc. of Charleston, South Carolina, analyzed the samples for Target Analyte List metals (TAL) using EPA Method 6010/7470/7471 (EPA November 1986).

2.4.4.2.1 *Results and Conclusions*

Tables 2.4.4-2 and 2.4.4-3 summarize the metal fragment sampling analyses for the samples collected at SWMU 87. Table 2.4.4-2 provides the metals analytical results, and Table 2.4.4-3 summarizes the radionuclides (i.e., gamma spectroscopy) analytical results. Sample numbers are coded to identify specific information regarding the samples. For example, for Sample 87-FR-3-17-SD, 87 designates a sample collected from SWMU 87. FR-3-17 indicates that a fragment sample was collected from Radial Line No. 3 at Sample Location No. 17, and SD designates a surface fragment sample. The remainder of this section describes the results of the fragment sampling at SWMU 87. Annex 2-B contains the values for minimum detectable activity (MDA) for the gamma spectroscopy analyses used during the RFI.

Metals

Table 2.4.4-2 summarizes the metals analysis results for the ten metal fragment samples collected from SWMU 87. Because these samples were metal fragments, all samples contained various concentrations of arsenic, chromium, copper, and nickel. Barium was detected in nine samples at concentrations ranging from 0.0717 J to 3.72 J milligrams (mg)/kilogram (kg). Beryllium was detected in four samples at concentrations ranging from 0.163 J to 2.17 J mg/kg. Three samples contained detectable cadmium at concentrations ranging from 1.79 J to 5.09 mg/kg. Lead was detected in eight samples at concentrations that ranged from 3.35 to 49.2 mg/kg. Three samples contained mercury at concentrations ranging from 0.00747 J to 0.0355 mg/kg. Selenium was detected in four samples at concentrations that ranged from 1.72 J to 11.3 mg/kg. Five samples contained silver at concentrations ranging from 1.88 J to 28 mg/kg. Zinc was detected in eight samples at concentrations that ranged from 15.3 to 62,500 mg/kg.

Radionuclides

Table 2.4.4-3 summarizes the on-site gamma spectroscopy analysis results for the ten metal fragment samples collected at SWMU 87. Gamma activity attributable to uranium-238, thorium-232, uranium-235, and cesium-137 was not detected above the respective MDAs in any of the samples. Annex 2-B lists the MDAs used for the gamma spectroscopy analyses during the metal fragment sampling activities.

Table 2.4.4-2
 Summary of SWMU 87 RFI Metal Fragment Sampling Metals Analytical Results
 March 1996
 (Off-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth	Metals (Methods 6010, 7470/7471 ^a and 8080/8081) (mg/kg)					
					Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper
05306	87-FR-3-17-SD	Frag	03-06-96	Surface	188	3.72 J (4.95)	ND (0.00564)	ND (0.960)	309	1,140
05306	87-FR-2-16-SD	Frag	03-05-96	Surface	45.9	3.30 J (5)	ND (0.00570)	ND (0.970)	554	320
05306	87-FR-3-3-SD	Frag	03-06-96	Surface	4.25 J (4.95)	0.0717 J	ND (0.00564)	1.79 J (2.475)	1.95 J (4.95)	1,040,000
05306	87-FR-4-8-SD	Frag	03-06-96	Surface	3.63 J (4.95)	ND (0.0328)	ND (0.00564)	2.25 J (2.475)	3.52 J (4.95)	1,040,000
05306	87-FR-4-17-SD	Frag	03-06-96	Surface	2.10 J (4.9)	1.01 J (4.9)	2.13 J (2.45)	ND (0.0475)	1,360	6,030
05306	87-FR-1-10-SD	Frag	03-05-96	Surface	1.85 J (5)	1.01 (5)	ND (0.00570)	ND (0.0485)	1,440	2,970
05306	87-FR-4-7-SD	Frag	03-06-96	Surface	2.74 J (4.95)	1.27 J (4.95)	0.163 J (2.475)	5.09	1,860	11,300
05306	87-FR-2-11-SD	Frag	03-05-96	Surface	ND (0.921)	1.37 J (4.95)	0.901 J (2.475)	ND (0.04800)	1,880	2,750
05306	87-FR-2-5-SD	Frag	03-05-96	Surface	2.01 J (4.95)	0.990 J (4.95)	2.17 J (2.475)	ND (0.0480)	1,340	6,030
05306	87-FR-2-20-SD	Frag	03-05-96	Surface	1.27 J (5)	1.14 J (5)	ND (0.00570)	ND (0.0485)	1,910	13,300

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth	Metals (Methods 6010, 7470/7471 ^a and 8080/8081) (mg/kg)					
					Lead	Mercury	Nickel	Selenium	Silver	Zinc
05306	87-FR-3-17-SD	Frag	03-06-96	Surface	ND (11.2)	ND (0.00238)	515	11.3	1.88 J (4.95)	15.3
05306	87-FR-2-16-SD	Frag	03-05-96	Surface	ND (11.3)	0.0176 J (0.0336)	306	10.8	2.3 J (5)	31.4
05306	87-FR-3-3-SD	Frag	03-06-96	Surface	7.62	0.00747 J (0.0282)	24.2	1.72 J (2.475)	27	ND (66.8)
05306	87-FR-4-8-SD	Frag	03-06-96	Surface	6.82	ND (0.00237)	21.2	2.66	28	ND (66.8)
05306	87-FR-4-17-SD	Frag	03-06-96	Surface	3.35	ND (0.00246)	43.6	ND (0.701)	ND (1.22)	45,200
05306	87-FR-1-10-SD	Frag	03-05-96	Surface	39.5	ND (0.00235)	39.7	ND (0.715)	ND (1.25)	1,000
05306	87-FR-4-7-SD	Frag	03-06-96	Surface	49.2	ND (0.00244)	48.9	ND (0.708)	3.46 J	48,400
05306	87-FR-2-11-SD	Frag	03-05-96	Surface	9.51	0.0355	24	ND (0.708)	ND (1.23)	830
05306	87-FR-2-5-SD	Frag	03-05-96	Surface	13.9	ND (0.00240)	42.6	ND (0.708)	ND (1.23)	43,200
05306	87-FR-2-20-SD	Frag	03-05-96	Surface	8.28	ND (0.00237)	21.7	ND (0.715)	ND (1.25)	62,500

Refer to footnotes at end of table.

Table 2.4.4-2 (Concluded)
Summary of SWMU 87 RFI Metal Fragment Sampling Metals Analytical Results
March 1996
(Off-Site Laboratory)

^aEPA November 1986.

^bAnalysis Request/Chain-of-Custody.

^cSample numbers are coded. For Sample ID 87-FR-3-17-SD, 87 designates the sample was collected at SWMU 87, FR-3-17 indicates that the fragment sample was collected from Radial Line No. 3 at Sample Location No. 17, and SD designates a surface fragment sample.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

FR = Fragment.

Frag = Fragment.

ID = Identification.

J = The estimated value reported is either above the MDL and less than the practical quantitation limit or above the instrument detection limit and less than the contract-required detection limit, shown in parentheses.

MDL = Method detection limit.

mg/kg = Milligram(s) per kilogram.

ND () = Analyte was not detected at or above the MDL, shown in parentheses.

RCRA = Resource Conservation and Recovery Act.

RFI = RCRA Facility Investigation.

SD = Surface fragment sample.

SWMU = Solid Waste Management Unit.

Table 2.4.4-3
 Summary of SWMU 87 RFI Metal Fragment Sampling Gamma Spectroscopy Analytical Results
 March 1996
 (On-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth	Gamma Spectroscopy Activity ^a (pCi/g)			
					Uranium-238 ^d	Error	Thorium-232 ^d	Error
05157	87-FR-3-17-SD	Frag	03-06-96	Surface	ND (1.35E-01)	NA	ND (2.44E-02)	NA
05157	87-FR-2-16-SD	Frag	03-05-96	Surface	ND (2.82E+00)	NA	ND (5.36E-01)	NA
05157	87-FR-3-3-SD	Frag	03-06-96	Surface	ND (1.35E+00)	NA	ND (2.57E-01)	NA
05157	87-FR-4-8-SD	Frag	03-06-96	Surface	ND (1.45E+00)	NA	ND (2.62E-01)	NA
05157	87-FR-4-17-SD	Frag	03-06-96	Surface	ND (6.52E-01)	NA	ND (1.13E-01)	NA
05157	87-FR-1-10-SD	Frag	03-05-96	Surface	ND (2.38E-01)	NA	ND (3.94E-02)	NA
05157	87-FR-4-7-SD	Frag	03-06-96	Surface	ND (9.23E-01)	NA	ND (1.67E-01)	NA
05157	87-FR-2-11-SD	Frag	03-05-96	Surface	ND (1.62E+00)	NA	ND (3.01E-01)	NA
05157	87-FR-2-9-SD	Frag	03-05-96	Surface	ND (1.47E+00)	NA	ND (2.36E-01)	NA
05157	87-FR-2-20-SD	Frag	03-05-96	Surface	ND (1.70E+00)	NA	ND (3.31E-01)	NA

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth	Gamma Spectroscopy Activity ^a (pCi/g)			
					Uranium-235 ^d	Error	Cesium-137 ^d	Error
05157	87-FR-3-17-SD	Frag	03-06-96	Surface	ND (2.06E-02)	NA	ND (5.05E-03)	NA
05157	87-FR-2-16-SD	Frag	03-05-96	Surface	ND (4.06E-01)	NA	ND (1.04E-01)	NA
05157	87-FR-3-3-SD	Frag	03-06-96	Surface	ND (2.10E-01)	NA	ND (4.63E-02)	NA
05157	87-FR-4-8-SD	Frag	03-06-96	Surface	ND (1.90E-01)	NA	ND (5.35E-02)	NA
05157	87-FR-4-17-SD	Frag	03-06-96	Surface	ND (9.21E-02)	NA	ND (2.26E-02)	NA
05157	87-FR-1-10-SD	Frag	03-05-96	Surface	ND (3.60E-02)	NA	ND (7.98E-03)	NA
05157	87-FR-4-7-SD	Frag	03-06-96	Surface	ND (1.37E-01)	NA	ND (3.21E-02)	NA
05157	87-FR-2-11-SD	Frag	03-05-96	Surface	ND (2.37E-01)	NA	ND (6.19E-02)	NA
05157	87-FR-2-9-SD	Frag	03-05-96	Surface	ND (1.86E-01)	NA	ND (5.15E-02)	NA
05157	87-FR-2-20-SD	Frag	03-05-96	Surface	ND (2.50E-01)	NA	ND (5.95E-02)	NA

Refer to footnotes at end of table.

Table 2.4.4-3 (Concluded)
Summary of SWMU 87 RFI Metal Fragment Sampling Gamma Spectroscopy Analytical Results
March 1996
(On-Site Laboratory)

^aUranium-238 and thorium-232 decay chain isotopes with a short half-life are not presented in this table.

^bAnalysis Request/Chain-of-Custody.

^cSample numbers are coded. For Sample ID 87-FR-3-17-SD, 87 designates the sample was collected at SWMU 87, FR-3-17 indicates that the sample was collected from Radial Line No. 3 at Sample Location No. 17, and SD designates a surface fragment sample.

^dValue in parentheses represents the MDA.

ER = Environmental Restoration.
FR = Fragment.
Frag = Fragment.
ID = Identification.
MDA = Minimum detectable activity.
NA = Not applicable.
ND () = Analyte was not detected above the MDA, shown in parentheses.
pCi/g = Picocurie(s) per gram.
RCRA = Resource Conservation and Recovery Act.
RFI = RCRA Facility Investigation.
SD = Surface fragment sample.
SWMU = Solid Waste Management Unit

2.4.4.3 Soil Sampling

RFI soil sampling was conducted at Area A, Area B, Area C, the arroyo, and along the perimeter of the site, as discussed in the following sections. Soil samples were collected in accordance with the OU 1332 RFI Work Plan and associated SAPs (Annex 2-A) and all applicable ER standard operating procedures.

2.4.4.3.1 Area A Sampling

Area A includes the graded area north of Building 9990, which includes the firing site. Surface and subsurface soil samples were collected in this area. In August 1995, October 1997, and September 1998, 20 randomly selected surface samples were collected over a grid at Area A (Figure 2.4.4-2). Samples collected from all 20 locations were analyzed for metals, HE, and radionuclides by gamma spectroscopy. Based upon a recommendation from the NMED, six additional judgmentally selected surface soil samples were collected in March 2000 at Area A and analyzed for tritium (Figure 2.4.4-3).

In October 2001, five Geoprobe boreholes were completed to 20 feet below ground surface (bgs) at Area A (Figure 2.4.4-4). The boring locations were judgmentally selected in areas where soil grading of the explosives tests may have mixed surface soil into the subsurface. Each borehole was advanced to a depth of 9 to 10.5 feet bgs and sampled every 3 feet starting at 0 to 1.5 feet bgs. Samples collected were analyzed for metals and radionuclides by gamma spectroscopy.

2.4.4.3.2 Area B Sampling

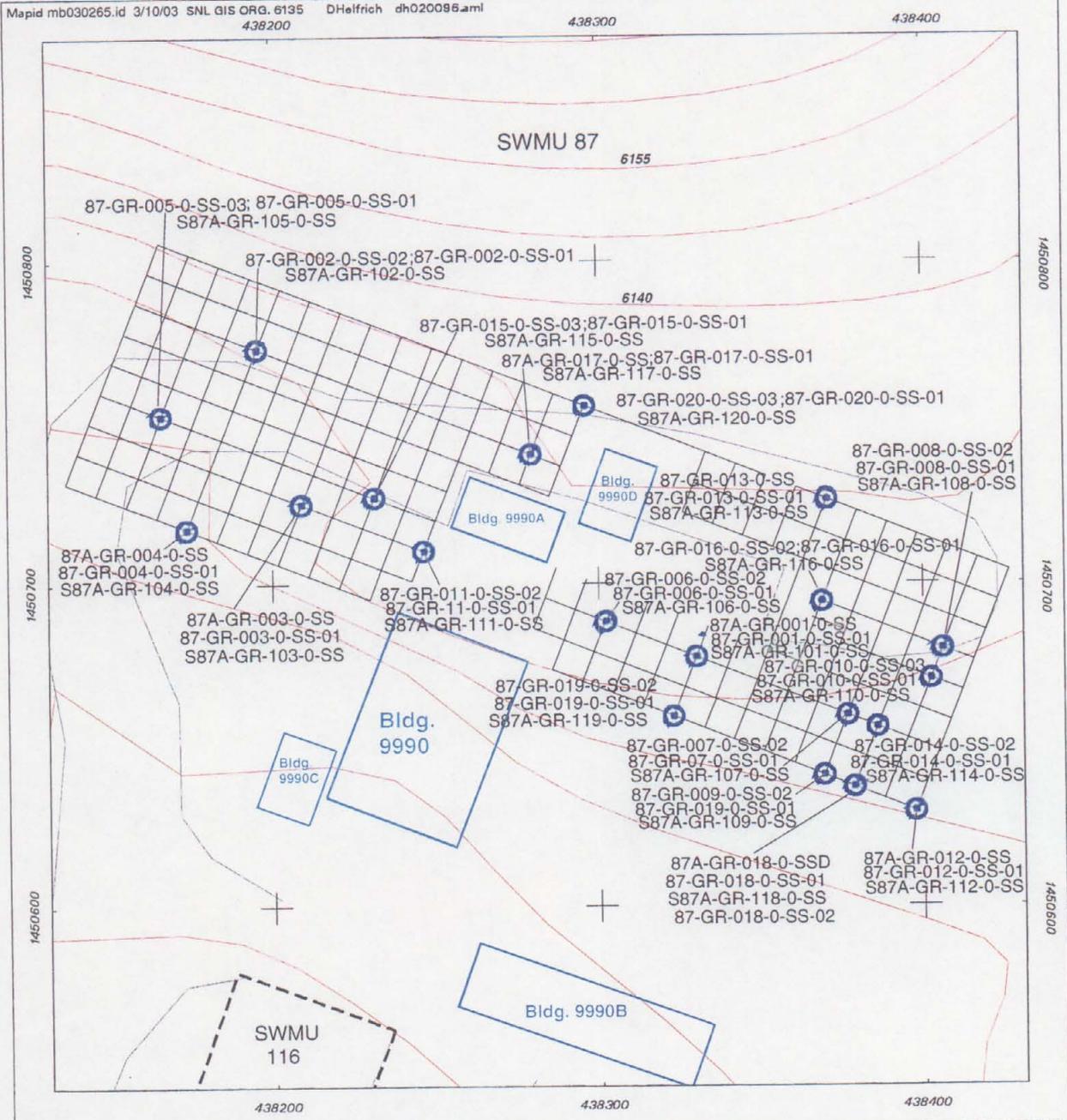
Area B includes the area south of the firing site. Surface soil samples were collected in this area. In May 1996, October 1997, and September 1998, 20 randomly selected surface samples were collected over a grid at Area B (Figure 2.4.4-5). Samples from all 20 locations were analyzed for metals, HE, and radionuclides by gamma spectroscopy.

2.4.4.3.3 Area C Sampling

Area C includes the area north and east of the firing site. In September 1996, ten judgmentally selected surface soil samples were collected from beneath metal fragments at Area C (Figure 2.4.4-6). All samples were analyzed for metals and radionuclides by gamma spectroscopy.

2.4.4.3.4 Arroyo Sampling

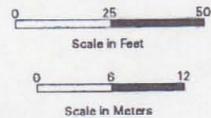
In August and December 1996 and September 1998, six judgmentally selected surface samples were collected at the arroyo on the east side of the facility structures (Figure 2.4.4-7). Samples collected from all six locations were analyzed for metals, HE, and radionuclides by gamma spectroscopy.



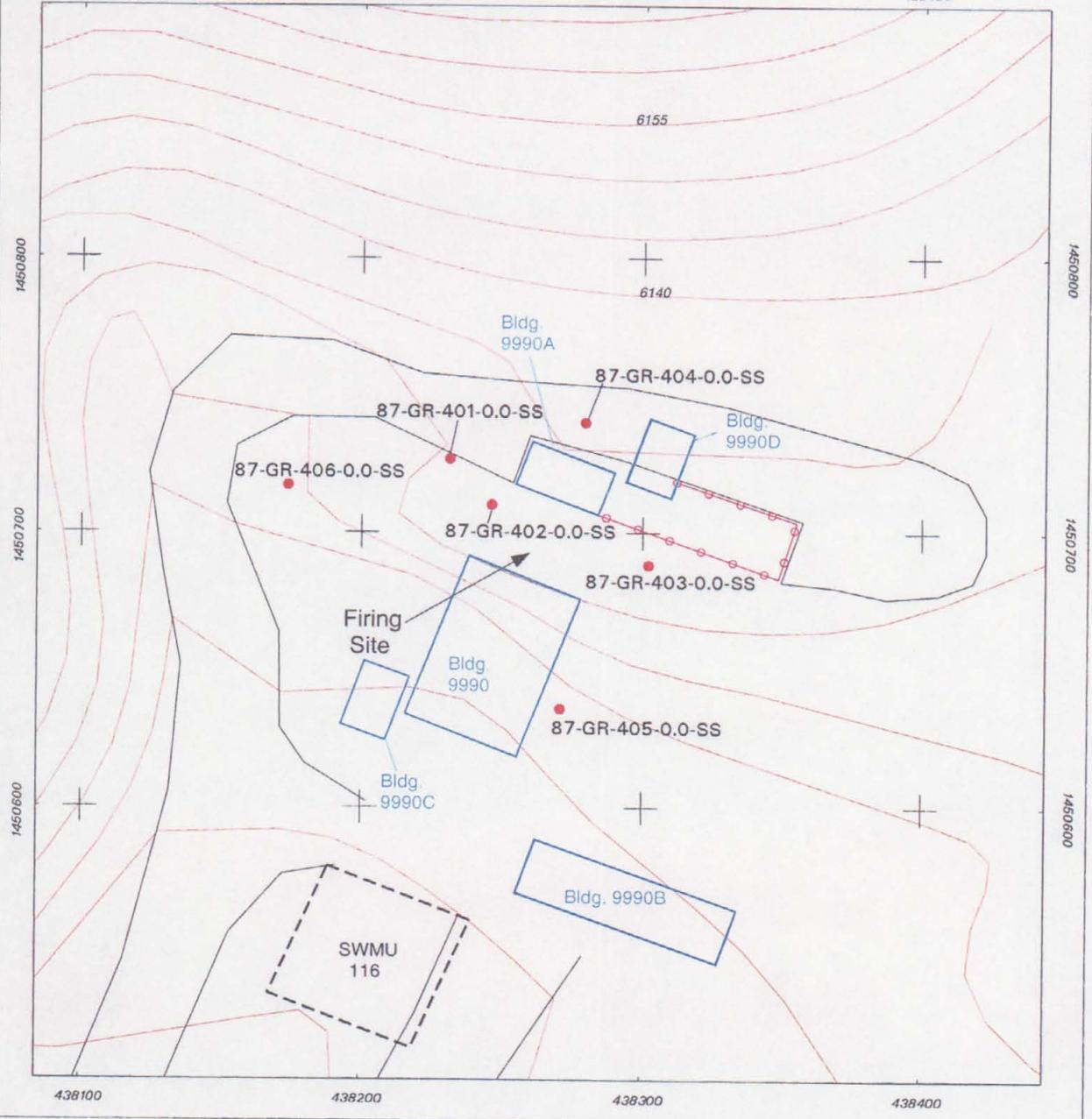
Legend

-  August 1995, October 1997, and September 1998 Randomly Selected Soil Sample Locations
-  SWMU 116
-  Building/Structure
-  Unpaved Road
-  5 Foot Contour
-  Grid A

Figure 2.4.4-2
Surface Sample Locations at Area A,
Solid Waste Management
Unit 87



Sandia National Laboratories, New Mexico
 Environmental Geographic Information System



Legend

- May 2000 Tritium Soil Sample Location
- Roadway & Parking Area
- Fence
- 5 Foot Contour
- Building
- SWMU

Figure 2.4.4-3
Tritium Surface Sample Locations at Area A,
Solid Waste Management
Unit 87

0 30 60

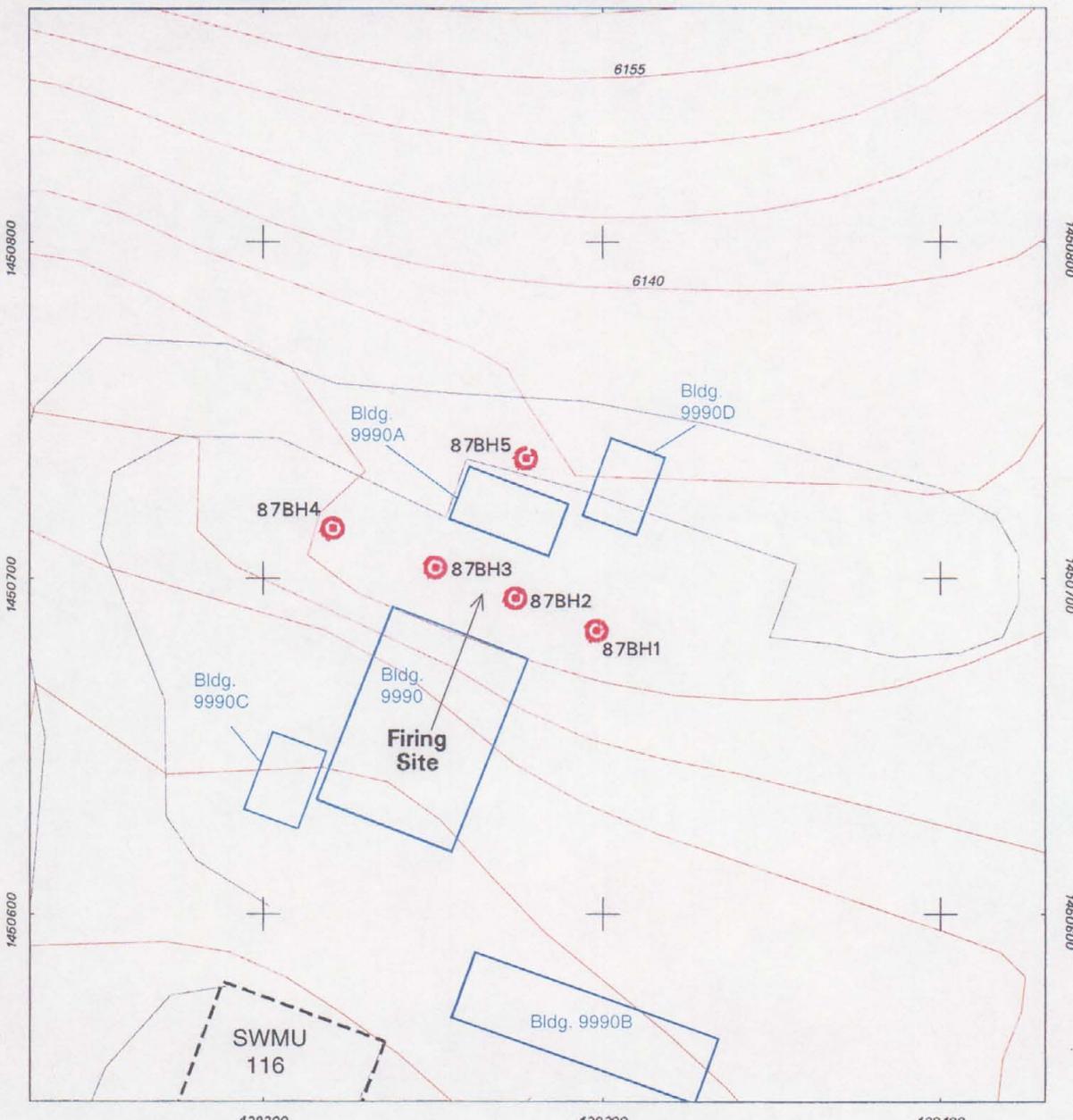
Scale in Feet

0 7.2 14.4

Scale in Meters



Sandia National Laboratories, New Mexico
 Environmental Geographic Information System



Legend

-  October 2001 Soil Boring Location
-  SWMU 116
-  Building / Structure
-  Unpaved Road / Parking
-  5-Foot Contour

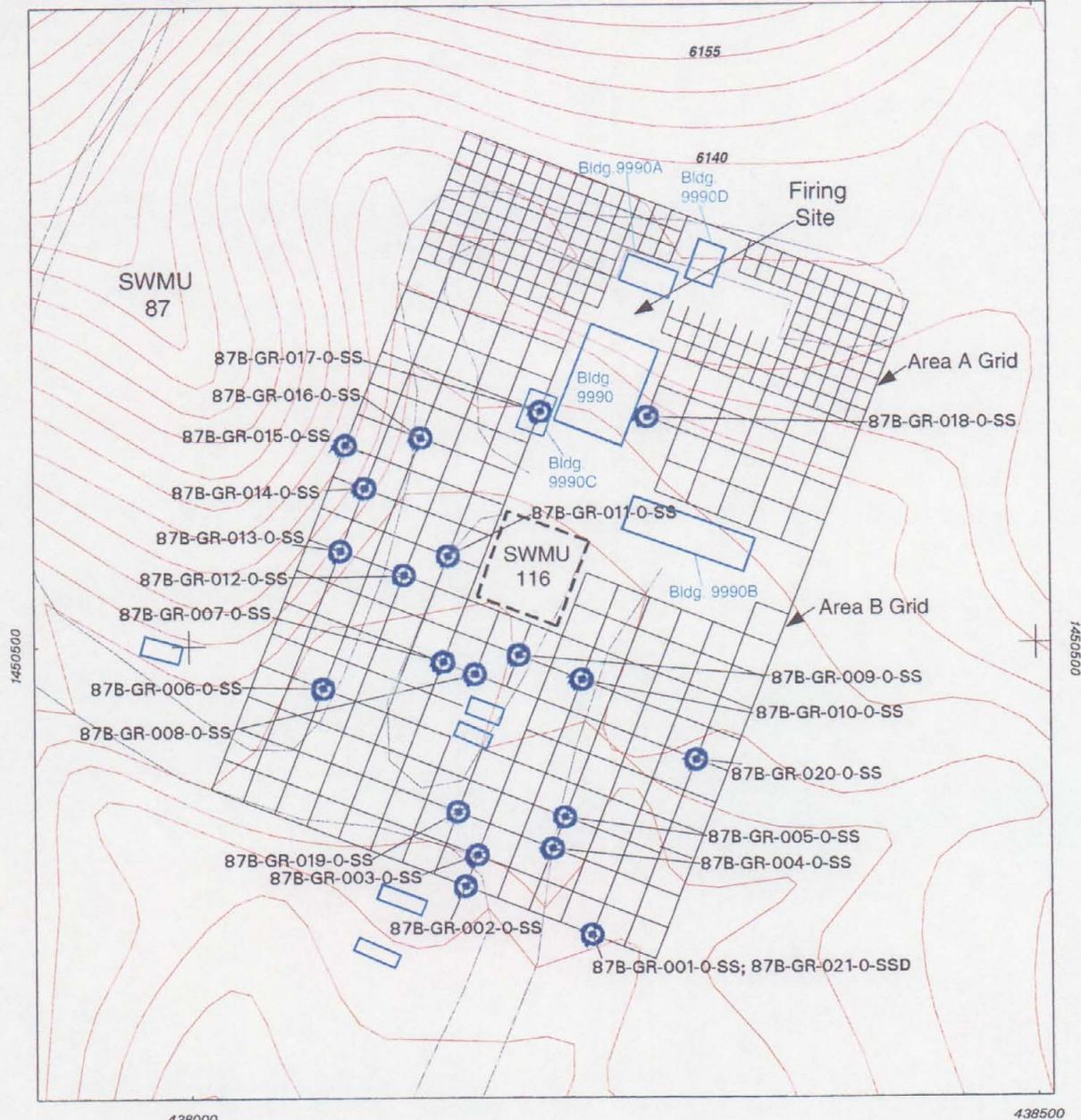
Figure 2.4.4-4
Borehole Sample Locations at Area A,
Solid Waste Management
Unit 87

0 25 50
Scale in Feet

0 6 12
Scale in Meters



Sandia National Laboratories, New Mexico
Environmental Geographic Information System



438000

438500

Legend

-  May 1996, October 1997 and September 1998 Randomly Selected Soil Sample Locations
-  SWMU 116
-  Building/Structure
-  Unpaved Road
-  5 foot Contour
-  Grid A
-  Grid B

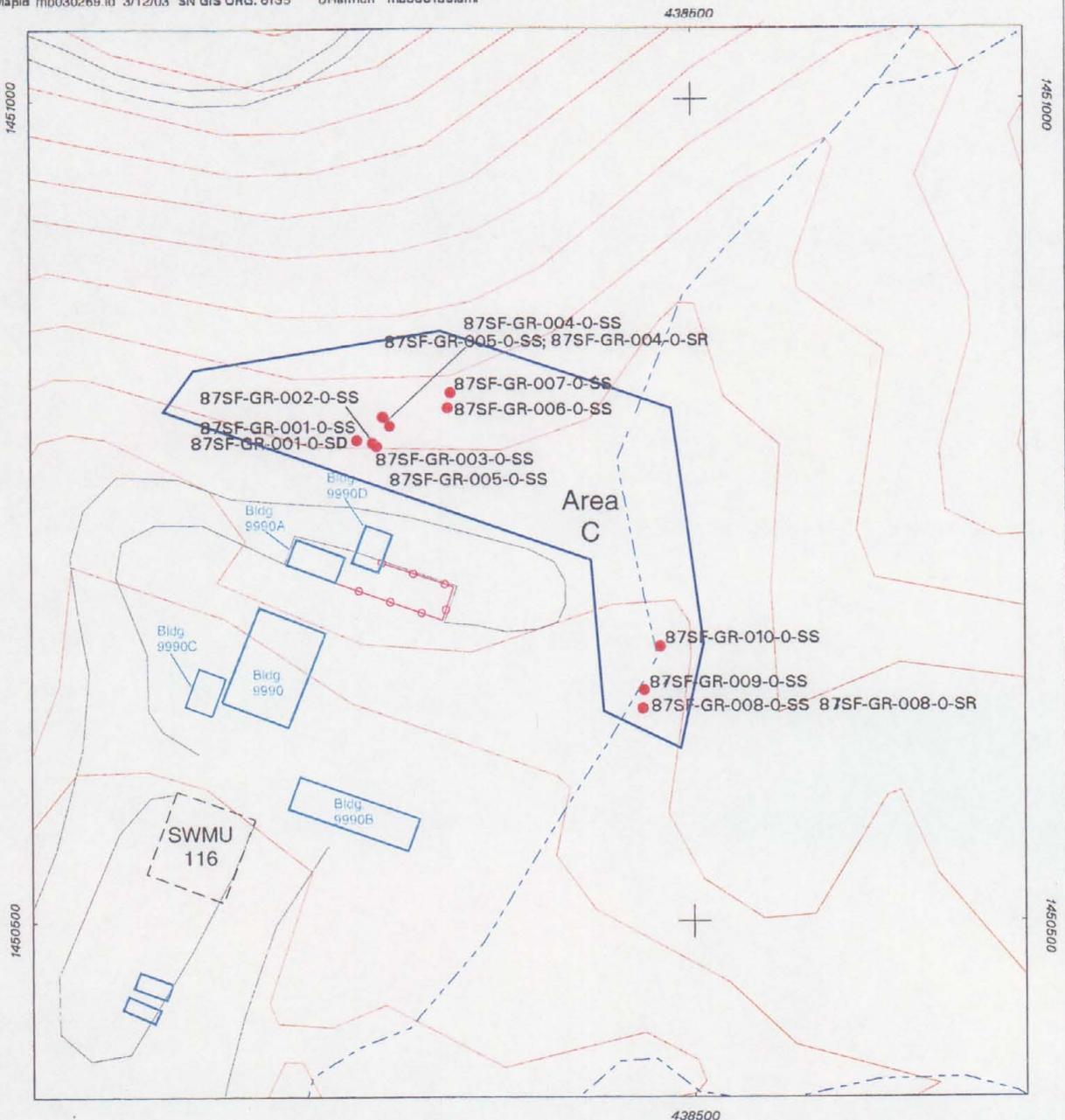
Figure 2.4.4-5
Surface Sample Locations at Area B,
Solid Waste Management
Unit 87

0 50 100
Scale in Feet

0 12 24
Scale in Meters



Sandia National Laboratories, New Mexico
Environmental Geographic Information System



Legend

- September 1996 Soil Sample Location
- Road
- Fence
- ▭ Building
- - - Surface Drainage
- 10-Foot Contour
- - - SWMU

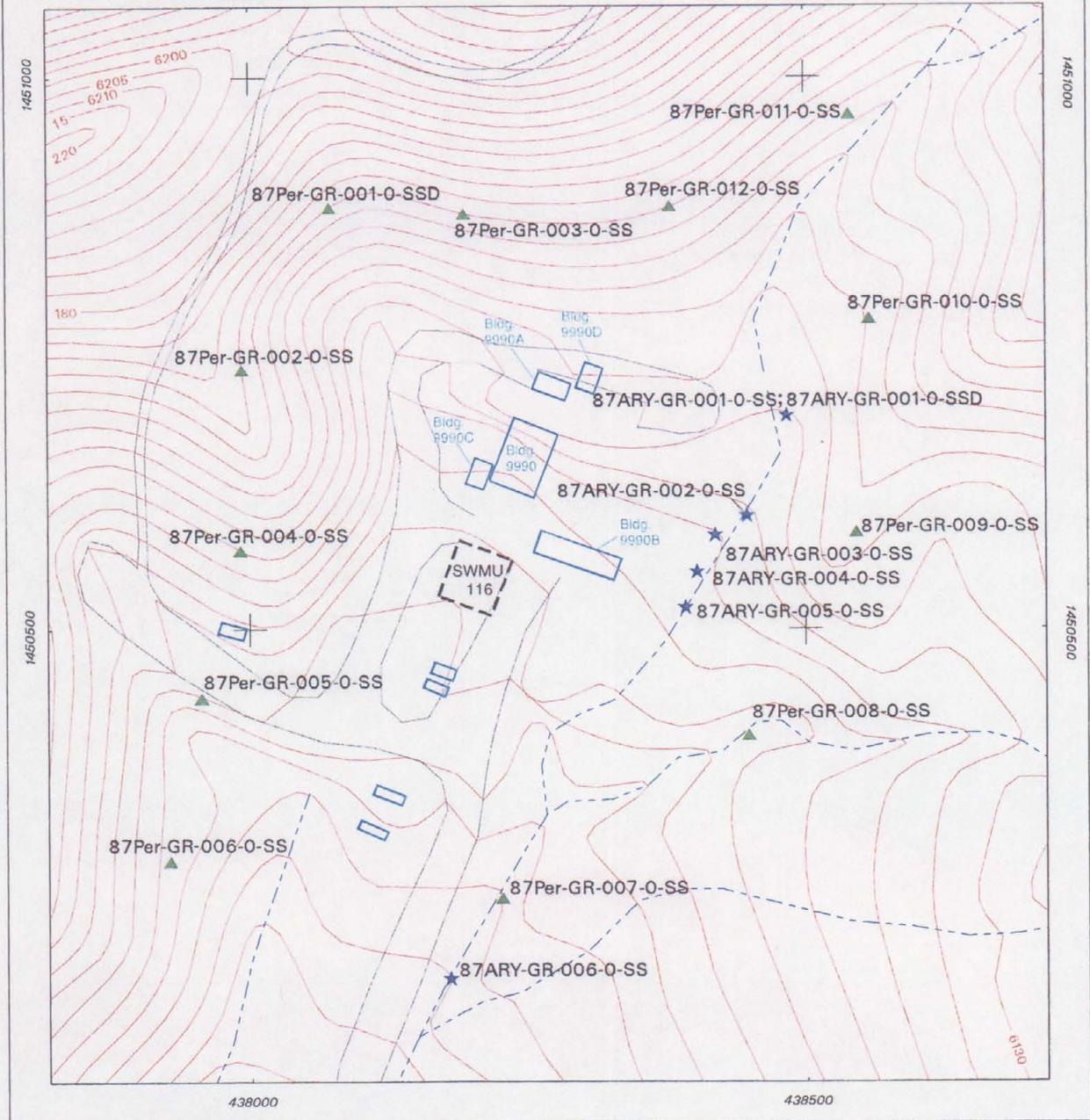
Figure 2.4.4-6
Surface Sample Locations
Beneath Metal Fragments
at Area C, Solid Waste Management
Unit 87

0 50 100
 Scale in Feet

0 12 24
 Scale in Meters



Sandia National Laboratories, New Mexico
 Environmental Geographic Information System



Legend

- ▲ May 1996, October 1997, and September 1998 Perimeter Soil Sampling Location
- ★ December 1996 and September 1998 Arroyo Sediment Sampling Location
- SWMU 116
- Building/Structure
- Unpaved Road
- 5 Foot Contour
- - - Surface Drainage

Figure 2.4.4-7
Surface Sample Locations at
Arroyo and along Perimeter of the Site
Solid Waste Management Unit 87

0 75 150
Scale in Feet

0 18 36
Scale in Meters



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Perimeter Sampling

In May 1996, October 1997, and September 1998, 12 judgmentally selected surface samples were collected along the perimeter of the site (Figure 2.4.4-7). Samples collected from all 12 locations were analyzed for metals and radionuclides by gamma spectroscopy.

2.4.4.3.5 Results and Conclusions

Table 2.4.4-4 provides a list of tables that identify the type and results of soil sampling performed at each feature within SWMU 87. Tables 2.4.4-5 through 2.4.4-10 summarize the metals analytical results for all of the RFI soil samples collected at SWMU 87. Table 2.4.4-11 summarizes the analytical results of HE compounds for samples collected at Area A. Table 2.4.4-12 provides the analytical MDLs for the TAL for HE compounds (because HE compounds were not detected at Area B or the arroyo, no analytical results tables are provided for these areas). Table 2.4.4-13 through 2.4.4-19 summarize the analytical results for radionuclides (i.e., gamma spectroscopy and tritium) for all of the RFI soil samples collected at SWMU 87. Annex 2-B contains the MDAs used during the RFI for the gamma spectroscopy analyses.

Sample numbers are coded to identify specific information regarding the samples. For example, for Sample 87A-GR-001-0-SS, 87A designates a sample collected from Area A at SWMU 87. GR-001 indicates that a grab sample was collected from Location 001, and SS designates a surface soil sample. The remainder of this section describes the results of RFI sampling at SWMU 87.

Metals

Tables 2.4.4-5 through 2.4.4-10 summarize the metals analytical results for the soil samples and duplicate samples collected from SWMU 87. For the samples collected in 1995 and 1996, the NMED-approved background concentration limits had not been established at the time of analysis. Detections of arsenic, beryllium, cadmium, mercury, selenium, and silver were above the approved background limits. However, these higher detection levels do not impact site characterization, except for arsenic, because higher levels of metals concentrations were found at other locations at SWMU 87, and these were used in the risk assessment.

Except for the 1995 samples (which were all nondetections at a detection limit slightly above the background limit), all other samples were at or below the background limit for arsenic and selenium.

One sample collected at Area C (87SF-GR-006-0-SS [Figure 2.4.4-6]) contained barium slightly above the background limit of 246 mg/kg. All other samples were at or below the background limit for barium.

Three samples from Area B (87B-GR-013-0-SS, 87B-GR-014-0-SS, and 87B-GR-015-0-SS [Figure 2.4.4-5]) contained beryllium at concentrations ranging from 0.772 to 1.21 mg/kg, compared to a background limit of 0.75 mg/kg. Except for the 1995 samples (which were all nondetections at a detection limit slightly above the background limit), all other samples were at or below the background limit for beryllium.

Table 2.4.4-4
List of Tables That Present the Results of RFI Soil Sampling for
Each Feature Sampled at SWMU 87

Table Number	Title of Table	Feature Sampled
2.4.4-5	Summary of SWMU 87 RFI Area A Soil Sampling Metals Analytical Results, August 1995 and October 1997	Area A
2.4.4-6	Summary of SWMU 87 RFI Area A Borehole Soil Sampling Metals Analytical Results, October 2001	Area A
2.4.4-11	Summary of Analytical Detections of HE Compounds in SWMU 87 RFI Soil samples (Area A), September 1998	Area A
2.4.4-13	Summary of SWMU 87 RFI Area A Soil Sampling Gamma Spectroscopy Analytical Results, August 1995	Area A
2.4.4-14	Summary of SWMU 87 RFI Area A Subsurface Soil Sampling Gamma Spectroscopy Analytical Results, October 2001	Area A
2.4.4-19	Summary of SWMU 87 RFI Area A Soil Sampling Tritium Analytical Results, March 2000	Area A
2.4.4-7	Summary of SWMU 87 RFI Area B Soil Sampling Metals Analytical Results, October 1997	Area B
2.4.4-15	Summary of SWMU 87 RFI Area B Soil Sampling Gamma Spectroscopy Analytical Results, May 1996	Area B
2.4.4-8	Summary of SWMU 87 RFI Soil Sampling Beneath Fragments at Area C Metals Analytical Results, September 1996	Area C
2.4.4-16	Summary of SWMU 87 RFI Soil Sampling Beneath Fragments at Area C Gamma Spectroscopy Analytical Results, September 1996	Area C
2.4.4-9	Summary of SWMU 87 RFI Arroyo Soil Sampling Metals Analytical Results, December 1996	Arroyo
2.4.4-17	Summary of SWMU 87 RFI Arroyo Soil Sampling Gamma Spectroscopy Analytical Results, December 1996	Arroyo
2.4.4-10	Summary of SWMU 87 RFI Perimeter Soil Sampling Metals Analytical Results, May 1996 and October 1997	Perimeter
2.4.4-18	Summary of SWMU 87 RFI Perimeter Soil Sampling Gamma Spectroscopy Analytical Results, May 1996	Perimeter
2.4.4-12	Summary of HE Compounds Analytical Method Detection Limits for SWMU 87 RFI Soil Sampling, September 1998	Area A, Area B, Arroyo

HE = High explosive(s)
 RCRA = Resource Conservation and Recovery Act.
 RFI = RCRA Facility Investigation.
 SWMU = Solid Waste Management Unit.

Table 2.4.4-5
Summary of SWMU 87 RFI Area A Soil Sampling Metals Analytical Results
August 1995 and October 1997
(On-Site and Off-Site Laboratories)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Metals (Methods 6010 and 7470/7471 ^a) (mg/kg)					
					Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper
510038	87A-GR-001-0-SS	soil	10-21-97	0-1.0	3.70	89.4	0.466 J (0.500)	0.299 J (0.500)	9.90	684
509454	87-GR-002-0-SS-02	soil	08-07-95	0-1.0	ND (50)	71	ND (3.4)	ND (10)	ND (10)	30 J (76)
510038	87A-GR-003-0-SS	soil	10-21-97	0-1.0	4.23	108	0.451 J (0.500)	0.235 J (0.500)	7.07	32.1
510038	87A-GR-004-0-SS	soil	10-21-97	0-1.0	3.51	93	0.441 J (0.485)	0.164 J (0.485)	4.03	29.3
04124	87-GR-005-0-SS-03	soil	08-07-95	0-1.0	3.8	100	ND (1.0)	ND (1.0)	7.4	180
509454	87-GR-006-0-SS-02	soil	08-07-95	0-1.0	ND (50)	78	ND (3.4)	ND (10)	ND (10)	95
509454	87-GR-007-0-SS-02	soil	08-07-95	0-1.0	ND (50)	110	ND (3.4)	ND (10)	ND (10)	58 J (76)
509454	87-GR-008-0-SS-02	soil	08-07-95	0-1.0	ND (50)	120	ND (3.4)	ND (10)	ND (10)	26 J (76)
509454	87-GR-009-0-SS-02	soil	08-07-95	0-1.0	ND (50)	130	ND (3.4)	ND (10)	ND (10)	82
04124	87-GR-010-0-SS-03	soil	08-07-95	0-1.0	4.3	110	ND (1.0)	ND (1.0)	9.6	79
509454	87-GR-011-0-SS-02	soil	08-07-95	0-1.0	ND (50)	98	ND (3.4)	ND (10)	ND (10)	160
510038	87A-GR-012-0-SS	soil	10-21-97	0-1.0	3.93	93.7	0.437 J (0.500)	0.138 J (0.500)	6.58	39.0
510038	87A-GR-013-0-SS	soil	10-21-97	0-1.0	3.16	78.6	0.375 J (0.490)	0.242 J (0.490)	6.79	59.6
509454	87-GR-014-0-SS-02	soil	08-07-95	0-1.0	ND (50)	98	ND (3.4)	ND (10)	ND (10)	52
04124	87-GR-015-0-SS-03	soil	08-07-95	0-1.0	4.9	130	ND (1.0)	ND (1.0)	12	23
509454	87-GR-016-0-SS-02	soil	08-07-95	0-1.0	ND (50)	110	ND (3.4)	ND (10)	ND (10)	45 J (76)
510038	87A-GR-017-0-SS	soil	10-21-97	0-1.0	3.72	120	0.485 J (0.500)	0.279 J (0.500)	7.22	80.6
4124	87-GR-018-0-SS-02	soil	08-07-95	0-1.0	ND (50)	62	ND (3.4)	ND (10)	ND (10)	200
509454	87-GR-019-0-SS-02	soil	08-07-95	0-1.0	ND (50)	66	ND (3.4)	ND (10)	ND (10)	25 J (76)
04124	87-GR-020-0-SS-03	soil	08-07-95	0-1.0	3.4	86	ND (0.99)	ND (0.99)	8.5	52
510038	87A-GR-018-0-SSD	soil	10-21-97	0-1.0	3.47	93	0.445 J (0.485)	0.297 J (0.485)	6.64	83.4
04124	87-GR-020-0-SS-03	soil	08-07-95	0-1.0	3.4	79	ND (0.99)	ND (0.99)	7.7	53
Quality Assurance/Quality Control Samples (mg/L)										
509454	87-GR-020-0-EB	water	08-07-95	NA	ND (0.50)	ND (0.10)	ND (0.034)	ND (0.10)	ND (0.10)	ND (0.20)
509454	87-GR-020-0-FB	water	08-07-95	NA	ND (0.50)	ND (0.10)	ND (0.034)	ND (0.10)	ND (0.10)	ND (0.20)
04124	87-GR-020-0-SS-07	water	08-07-95	NA	ND (0.010)	ND (0.20)	ND (0.0050)	ND (0.0050)	ND (0.010)	ND (0.025)
04124	87-GR-020-0-SS-08	water	08-07-95	NA	ND (0.010)	ND (0.20)	ND (0.0050)	ND (0.0050)	ND (0.010)	ND (0.025)
510038	87A-GR-019-FB	water	10-21-97	NA	ND (0.00293)	0.00039 J (0.00500)	ND (0.000223)	ND (0.000208)	ND (0.000729)	ND (0.00132)
510038	87A-GR-020-EB	water	10-21-97	NA	ND (0.00293)	0.000621 J (0.00500)	ND (0.000223)	ND (0.000208)	ND (0.000729)	ND (0.00132)
NMED-Approved Background Concentration—Lower Canyons Area ^d (mg/kg)		soil	NA	NA	9.8	246	0.75	0.64	18.8	17.1

Refer to footnotes at end of table.

Table 2.4.4-5 (Continued)
 Summary of SWMU 87 RFI Area A Soil Sampling Metals Analytical Results
 August 1995 and October 1997
 (On-Site and Off-Site Laboratories)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Metals (Methods 6010 and 7470/7471 ^a) (mg/kg)					
					Lead	Mercury	Nickel	Selenium	Silver	Zinc
510038	87A-GR-001-0-SS	soil	10-21-97	0-1.0	26.3	0.039	12.0	0.673	1.11	42.7
509454	87-GR-002-0-SS-02	soil	08-07-95	0-1.0	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	23 J (38)
510038	87A-GR-003-0-SS	soil	10-21-97	0-1.0	14.9	0.0261 J (0.0313)	7.55	0.564	0.390 J (0.500)	29
510038	87A-GR-004-0-SS	soil	10-21-97	0-1.0	14.8	0.0237 J (0.0304)	6.69	0.581	0.244 J (0.485)	18.6
04124	87-GR-005-0-SS-03	soil	08-07-95	0-1.0	31	ND (0.096)	9.4	ND (1.0)	ND (2.0)	27
509454	87-GR-006-0-SS-02	soil	08-07-95	0-1.0	38	0.06 J (0.24)	ND (4.0)	ND (50)	ND (10)	33 J (38)
509454	87-GR-007-0-SS-02	soil	08-07-95	0-1.0	13 J (38)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	31 J (38)
509454	87-GR-008-0-SS-02	soil	08-07-95	0-1.0	12 J (38)	0.06 J (0.24)	ND (4.0)	ND (50)	ND (10)	33 J (38)
509454	87-GR-009-0-SS-02	soil	08-07-95	0-1.0	19 J (38)	0.06 J (0.24)	ND (4.0)	ND (50)	ND (10)	33 J (38)
04124	87-GR-010-0-SS-03	soil	08-07-95	0-1.0	15	ND (0.10)	13	ND (1.0)	ND (2.0)	30
509454	87-GR-011-0-SS-02	soil	08-07-95	0-1.0	28 J (38)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	50
510038	87A-GR-012-0-SS	soil	10-21-97	0-1.0	23.8	0.0243 J (0.0310)	7.78	0.515	0.288 J (0.500)	24.9
510038	87A-GR-013-0-SS	soil	10-21-97	0-1.0	19.0	ND (0.0173)	7.23	1.25	0.315 J (0.490)	23.9
509454	87-GR-014-0-SS-02	soil	08-07-95	0-1.0	20 J (38)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	27 J (38)
04124	87-GR-015-0-SS-03	soil	08-07-95	0-1.0	15	ND (0.10)	12	ND (1.0)	ND (2.0)	40
509454	87-GR-016-0-SS-02	soil	08-07-95	0-1.0	11 J (38)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	26 J (38)
510038	87A-GR-017-0-SS	soil	10-21-97	0-1.0	28.7	0.0222 J (0.0310)	8.01	0.974	0.273 J (0.500)	31.0
4124	87-GR-018-0-SS-02	soil	08-07-95	0-1.0	ND (10)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	19 J (38)
509454	87-GR-019-0-SS-02	soil	08-07-95	0-1.0	14 J (38)	ND (0.06)	ND (4.0)	ND (50)	ND (10)	20 J (38)
04124	87-GR-020-0-SS-03	soil	08-07-95	0-1.0	120	ND (0.096)	ND (7.9)	ND (0.99)	ND (2.0)	26
510038	87A-GR-018-0-SSD	soil	10-21-97	0-1.0	31.1	0.0258 J (0.0331)	8.18	0.427 J (0.485)	0.353 J (0.485)	32.8
04124	87-GR-020-0-SS-03	soil	08-07-95	0-1.0	37	ND (0.096)	10	ND (0.99)	ND (2.0)	26
Quality Assurance/Quality Control Samples (mg/L)										
509454	87-GR-020-0-EB	water	08-07-95	NA	ND (0.10)	*	ND (0.04)	ND (0.50)	ND (0.10)	ND (0.10)
509454	87-GR-020-0-FB	water	08-07-95	NA	ND (0.10)	*	ND (0.04)	ND (0.50)	ND (0.10)	ND (0.10)
04124	87-GR-020-0-SS-07	water	08-07-95	NA	ND (0.0030)	ND (0.00020)	ND (0.040)	ND (0.0050)	ND (0.010)	ND (0.020)
04124	87-GR-020-0-SS-08	water	08-07-95	NA	ND (0.0030)	ND (0.00020)	ND (0.040)	ND (0.0050)	ND (0.010)	ND (0.020)
510038	87A-GR-019-FB	water	10-21-97	NA	ND (0.000678)	ND (0.00020)	ND (0.00227)	ND (0.0014)	ND (0.00062)	0.00267 J (0.00500)
510038	87A-GR-020-EB	water	10-21-97	NA	ND (0.000678)	ND (0.000104)	ND (0.00227)	ND (0.0014)	ND (0.00062)	0.00395 J (0.00500)
NMED-Approved Background Concentration—Lower Canyons Area ^d (mg/kg)		soil	NA	NA	18.9	0.055	16.6	2.7	<0.5	52.1

Refer to footnotes at end of table.

Table 2.4.4-5 (Concluded)
Summary of SWMU 87 RFI Area A Soil Sampling Metals Analytical Results
August 1995 and October 1997
(On-Site and Off-Site Laboratories)

Notes: Values in **bold** exceed background concentrations, or have MDLs that exceed background concentrations. AR/COC 509454 contains screening level data only.

^aEPA November 1986.

^bAnalysis Request/Chain-of-Custody.

^cSample numbers are coded. For Sample ID 87-GR-002-0-SS-02, 87 designates the sample was collected at SWMU 87, GR-002 indicates that the sample was collected from Sample Location No. 002, and SS designates a surface soil sample.

^dGarcia November 1998.

AR/COC = Analysis Request/Chain-of-Custody.

87A = SWMU 87 Area A.

EB = Equipment blank.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

FB = Field blank.

ft = Foot (feet).

GR = Grab sample.

ID = Identification.

J () = Analyte concentration is less than quantitation limit but greater than or equal to the MDL, shown in parentheses.

MDL = Method detection limit.

mg/kg = Milligram(s) per kilogram.

mg/L = Milligram(s) per liter.

NA = Not applicable.

ND () = Not detected at or above the MDL, shown in parentheses.

NMED = New Mexico Environment Department.

RCRA = Resource Conservation and Recovery Act.

RFI = RCRA Facility Investigation.

SS = Surface soil sample.

SSD = Soil sample duplicate.

SWMU = Solid Waste Management Unit.

* = Not analyzed for mercury.

Table 2.4.4-6
Summary of SWMU 87 RFI Area A Borehole Soil Sampling Metals Analytical Results
October 2001
(Off-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Metals (Methods 6010A and 7471 ^a) (mg/kg)					
					Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper
605073	87-BH1-GR-001-0-S	soil	10-29-01	0-1.5	1.83	60.7	0.305 J (0.500)	0.637	6.68	NA
605073	87-BH1-GR-002-3-S	soil	10-29-01	3-4.5	4.59	240	0.363 J (0.455)	0.083 J (0.455)	4.42	NA
605073	87-BH1-GR-003-6-S	soil	10-29-01	6-7.5	4.03	121	0.513	0.197 J (0.472)	12.8	NA
605073	87-BH1-GR-004-9-S	soil	10-29-01	9-10.5	3.15	186	0.312 J (0.500)	0.272 J (0.500)	14.5	NA
605073	87-BH2-GR-005-0-S	soil	10-29-01	0-1.5	3.52	65.5	0.500	0.239 J (0.476)	9.28	NA
605073	87-BH2-GR-006-3-S	soil	10-29-01	3-4.5	5.52	104	0.534	0.150 J (0.500)	8.97	NA
605073	87-BH2-GR-007-6-S	soil	10-29-01	6-7.5	2.68	94.4	0.375 J (0.485)	0.158 J (0.485)	12.3	NA
605073	87-BH2-GR-008-9-S	soil	10-29-01	9-10.5	3.21	91.9	0.402 J (0.500)	0.185 J (0.500)	19.1	NA
605073	87-BH3-GR-009-0-S	soil	10-29-01	0-1.5	1.95	76.8	0.413 J (0.490)	0.223 J (0.490)	8.23	NA
605073	87-BH3-GR-010-3-S	soil	10-29-01	3-4.5	3.14	67.2	0.414 J (0.495)	0.328 J (0.495)	18.1	NA
605073	87-BH3-GR-011-6-S	soil	10-29-01	6-7.5	4.50	141	0.689	0.189 J (0.485)	12.3	NA
605073	87-BH3-GR-012-9-S	soil	10-29-01	9-10.5	2.90	117	0.496	0.123 J (0.481)	5.04	NA
605073	87-BH4-GR-013-0-S	soil	10-30-01	0-1.5	4.29	145	0.575	0.271 J (0.490)	12.7	NA
605073	87-BH4-GR-014-3-S	soil	10-30-01	3-4.5	3.90	139	0.494	0.166 J (0.481)	13.2	NA
605073	87-BH4-GR-015-6-S	soil	10-30-01	6-7.5	4.72	163	0.739	0.265 J (0.463)	17.3	NA
605073	87-BH4-GR-016-9-S	soil	10-30-01	9-10.5	4.34	146	0.539	0.277 J (0.481)	60.1	NA
605073	87-BH5-GR-017-0-S	soil	10-30-01	0-1.5	2.67	85.2	0.389 J (0.500)	0.313 J (0.500)	9.19	NA
605073	87-BH5-GR-018-3-S	soil	10-30-01	3-4.5	3.53	96.5	0.420 J (0.467)	0.253 J (0.467)	8.85	NA
605073	87-BH5-GR-019-6-S	soil	10-30-01	6-7.5	3.01	95.8	0.471	0.238 J (0.455)	8.88	NA
605073	87-BH5-GR-020-9-S	soil	10-30-01	9-10.5	2.86	67.9	0.353 J (0.485)	0.235 J (0.485)	13.9	NA
605073	87-BH2-GR-021-6-S	soil	10-29-01	6-7.5	7.43	83.1	0.435 J (0.485)	0.167 J (0.485)	12.0	NA
Quality Assurance/Quality Control Samples (mg/L)										
605073	87-BH-GR-022-0-EB	water	10-29-01	NA	ND (0.00457)	0.000421 J (0.005)	ND (0.000203)	0.000469 J (0.005)	ND (0.000781)	NA
605073	87-BH-GR-023-0-EB	water	10-30-01	NA	ND (0.00457)	ND (0.000206)	ND (0.000206)	ND (0.000251)	0.000849 J (0.005)	NA
NMED-Approved Background Values ^d		soil	NA	NA	9.8	246	0.75	0.64	18.8	17.1

Refer to footnotes at end of table.

Table 2.4.4-6 (Continued)
 Summary of SWMU 87 RFI Area A Borehole Soil Sampling Metals Analytical Results
 October 2001
 (Off-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Metals (Methods 6010A and 7471 ^a) (mg/kg)								
					Lead	Mercury	Nickel	Selenium	Silver	Zinc			
605073	87-BH1-GR-001-0-S	soil	10-29-01	0-1.5	37.0	ND (0.00389)	5.23	ND (0.270)	ND (0.116)	NA			
605073	87-BH1-GR-002-3-S	soil	10-29-01	3-4.5	2.55	0.0077 J (0.00832)	5.42	ND (0.246)	ND (0.105)	NA			
605073	87-BH1-GR-003-6-S	soil	10-29-01	6-7.5	14.6	0.00747 J (0.00896)	8.21	ND (0.255)	ND (0.109)	NA			
605073	87-BH1-GR-004-9-S	soil	10-29-01	9-10.5	29.3	ND (0.0039)	5.82	ND (0.270)	ND (0.116)	NA			
605073	87-BH2-GR-005-0-S	soil	10-29-01	0-1.5	17.9	ND (0.00404)	9.31	ND (0.257)	ND (0.110)	NA			
605073	87-BH2-GR-006-3-S	soil	10-29-01	3-4.5	6.36	0.013	9.04	ND (0.270)	ND (0.116)	NA			
605073	87-BH2-GR-007-6-S	soil	10-29-01	6-7.5	8.07	0.00763 J (0.00875)	6.36	ND (0.262)	ND (0.112)	NA			
605073	87-BH2-GR-008-9-S	soil	10-29-01	9-10.5	8.69	0.0101	6.42	ND (0.270)	ND (0.116)	NA			
605073	87-BH3-GR-009-0-S	soil	10-29-01	0-1.5	6.51	ND (0.00396)	8.72	ND (0.265)	ND (0.113)	NA			
605073	87-BH3-GR-010-3-S	soil	10-29-01	3-4.5	12.4	ND (0.00392)	8.55	1.27	3.13	NA			
605073	87-BH3-GR-011-6-S	soil	10-29-01	6-7.5	7.03	0.010	11.6	ND (0.262)	ND (0.112)	NA			
605073	87-BH3-GR-012-9-S	soil	10-29-01	9-10.5	2.92	0.0154	5.21	ND (0.260)	ND (0.111)	NA			
605073	87-BH4-GR-013-0-S	soil	10-30-01	0-1.5	7.63	0.0132	8.47	ND (0.265)	ND (0.113)	NA			
605073	87-BH4-GR-014-3-S	soil	10-30-01	3-4.5	3.61	0.00948 J (0.00992)	6.67	ND (0.260)	ND (0.111)	NA			
605073	87-BH4-GR-015-6-S	soil	10-30-01	6-7.5	7.03	0.0165	11.1	ND (0.250)	ND (0.107)	NA			
605073	87-BH4-GR-016-9-S	soil	10-30-01	9-10.5	5.43	0.0108	11.4	ND (0.260)	ND (0.111)	NA			
605073	87-BH5-GR-017-0-S	soil	10-30-01	0-1.5	15.2	0.00446 J (0.00932)	6.86	ND (0.270)	ND (0.116)	NA			
605073	87-BH5-GR-018-3-S	soil	10-30-01	3-4.5	11.9	0.00799 J (0.00824)	6.45	ND (0.253)	ND (0.108)	NA			
605073	87-BH5-GR-019-6-S	soil	10-30-01	6-7.5	17.3	0.00545 J (0.00753)	6.99	ND (0.246)	ND (0.105)	NA			
605073	87-BH5-GR-020-9-S	soil	10-30-01	9-10.5	11.7	0.00519 J (0.00876)	7.57	ND (0.262)	ND (0.112)	NA			
605073	87-BH2-GR-021-6-S	soil	10-29-01	6-7.5	10.7	0.00973 J (0.0098)	5.95	ND (0.262)	ND (0.112)	NA			
Quality Assurance/Quality Control Samples (mg/L)													
605073	87-BH-GR-022-0-EB	water	10-29-01	NA	ND (0.00344)	ND (0.000073)	ND (0.000743)	ND (0.00618)	ND (0.000197)	NA			
605073	87-BH-GR-023-0-EB	water	10-30-01	NA	ND (0.00344)	ND (0.000073)	ND (0.000743)	ND (0.00309)	ND (0.000197)	NA			
NMED-Approved Background Values ^d					soil	NA	NA	18.9	0.055	16.6	2.7	<0.5	52.1

Refer to footnotes at end of table.

Table 2.4.4-6 (Concluded)
Summary of SWMU 87 RFI Area A Borehole Soil Sampling Metals Analytical Results
October 2001
(Off-Site Laboratory)

Note: Values in **bold** exceed background concentrations.

^aEPA November 1986.

^bAnalysis Request/Chain-of-Custody.

^cSample numbers are coded. For Sample ID 87-BH1-GR-002-3-S, 87 designates the sample was collected at SWMU 87, BH1 designates Borehole Number 1, GR-002-3 indicates that the sample is Sample Number 002 and was collected at 3 feet below grade, and S designates a subsurface soil sample.

^dGarcia November 1998.

BH = Borehole.

EB = Equipment blank.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

ft = Foot (feet).

GR = Grab sample.

ID = Identification.

J () = Analyte concentration is less than quantitation limit but greater than or equal to the MDL, shown in parentheses.

MDL = Method detection limit.

mg/kg = Milligram(s) per kilogram.

mg/L = Milligram(s) per liter.

NA = Not applicable or not analyzed.

ND () = Not detected at or above the MDL, shown in parentheses.

NMED = New Mexico Environment Department.

RCRA = Resource Conservation and Recovery Act.

RFI = RCRA Facility Investigation.

S = Subsurface soil sample.

SWMU = Solid Waste Management Unit.

Table 2.4.4-7
Summary of SWMU 87 RFI Area B Soil Sampling Metals Analytical Results
October 1997
(Off-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Metals (Methods 6010A and 7470/7471 ^a) (mg/kg)					
					Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper
06297	87B-GR-001-0-SS	soil	10-20-97	0-0.5	6.09	125	0.749	0.173 J (0.481)	12.3	11.6
06297	87B-GR-002-0-SS	soil	10-20-97	0-0.5	4.07	110	0.629	0.151 J (0.463)	10.5	11.5
06297	87B-GR-003-0-SS	soil	10-20-97	0-0.5	3.26	86.7	0.423 J (0.485)	0.150 J (0.485)	7.86	7.77
06297	87B-GR-004-0-SS	soil	10-20-97	0-0.5	3.16	69.7	0.437 J (0.481)	0.0594 J (0.481)	6.68	6.61
06297	87B-GR-005-0-SS	soil	10-20-97	0-0.5	3.16	100	0.473 J (0.476)	0.111 J (0.476)	8.61	9.34
06298	87B-GR-006-0-SS	soil	10-20-97	0-0.5	5.70	166	0.729	0.186 J (0.495)	13.2	12.1
06297	87B-GR-007-0-SS	soil	10-20-97	0-0.5	3.93	120	0.582	0.325 J (0.463)	7.86	29.4
06297	87B-GR-008-0-SS	soil	10-20-97	0-0.5	4.81	107	0.678	0.366 J (0.490)	11.6	12.9
06297	87B-GR-009-0-SS	soil	10-20-97	0-0.5	3.93	106	0.580	0.546	11.1	15.1
06297	87B-GR-010-0-SS	soil	10-20-97	0-0.5	4.21	133	0.592	0.167 J (0.467)	11.0	12.1
06297	87B-GR-011-0-SS	soil	10-20-97	0-0.5	4.75	106	0.548	0.196 J (0.485)	8.81	14.3
06297	87B-GR-012-0-SS	soil	10-20-97	0-0.5	3.57	130	0.596	0.177 J (0.485)	10.5	11.2
06297	87B-GR-013-0-SS	soil	10-20-97	0-0.5	6.39	154	0.772	0.0716 J (0.481)	19.5	6.01
06297	87B-GR-014-0-SS	soil	10-20-97	0-0.5	7.74	213	1.21	0.181 J (0.495)	12.8	15.6
06297	87B-GR-015-0-SS	soil	10-20-97	0-0.5	5.39	183	0.877	0.217 J (0.500)	11.9	15.3
06297	87B-GR-016-0-SS	soil	10-20-97	0-0.5	3.77	93.3	0.523	0.0811 J (0.476)	6.55	2,040
06297	87B-GR-017-0-SS	soil	10-20-97	0-0.5	4.75	147	0.668	0.449 J (0.500)	11.0	57.4
06297	87B-GR-018-0-SS	soil	10-20-97	0-0.5	3.28	105	0.441 J (0.481)	0.174 J (0.481)	6.56	72.2
06297	87B-GR-019-0-SS	soil	10-20-97	0-0.5	3.35	128	0.600	0.266 J (0.476)	9.35	11.1
06298	87B-GR-020-0-SS	soil	10-20-97	0-0.5	4.41	140	0.675	0.129 J (0.495)	10.0	11.1
06297	87B-GR-021-0-SSD	soil	10-20-97	0-0.5	2.76	103	0.428 J (0.481)	0.555	5.34	10.7
Quality Assurance/Quality Control Samples (mg/L)										
06297	87B-GR-022-FB	water	10-20-97	NA	ND (0.00293)	ND (0.000332)	ND (0.000223)	ND (0.000208)	ND (0.000729)	ND (0.00132)
06297	87B-GR-023-EB	water	10-20-97	NA	ND (0.00293)	.000564 J (0.00500)	ND (0.000223)	ND (0.000208)	ND (0.000729)	0.00134 J (0.00500)
NMED-Approved Background Values ^d (mg/kg)		soil	NA	NA	9.8	246	0.75	0.64	18.8	17.1

Refer to footnotes at end of table.

Table 2.4.4-7 (Continued)
 Summary of SWMU 87 RFI Area B Soil Sampling Metals Analytical Results
 October 1997
 (Off-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Metals (Methods 6010A and 7470/7471 ^a) (mg/kg)					
					Lead	Mercury	Nickel	Selenium	Silver	Zinc
06297	87B-GR-001-0-SS	soil	10-20-97	0-0.5	10.2	ND (0.0173)	10.5	ND (0.07)	0.134 J (0.481)	36.4
06297	87B-GR-002-0-SS	soil	10-20-97	0-0.5	9.84	0.0290 J (0.0326)	9.93	ND (0.07)	0.122 J (0.463)	35.9
06297	87B-GR-003-0-SS	soil	10-20-97	0-0.5	8.21	ND (0.0173)	7.42	ND (0.07)	0.148 J (0.485)	26.7
06297	87B-GR-004-0-SS	soil	10-20-97	0-0.5	6.62	ND (0.0173)	7.52	ND (0.07)	0.121 J (0.481)	25.6
06297	87B-GR-005-0-SS	soil	10-20-97	0-0.5	20.2	ND (0.0173)	8.82	ND (0.07)	0.130 J (0.476)	29.9
06298	87B-GR-006-0-SS	soil	10-20-97	0-0.5	9.85	0.0338	12.1	0.388 J (0.495)	0.275 J (0.495)	40.5
06297	87B-GR-007-0-SS	soil	10-20-97	0-0.5	15.0	ND (0.0173)	9.18	ND (0.07)	0.302 J (0.463)	54.1
06297	87B-GR-008-0-SS	soil	10-20-97	0-0.5	17.4	0.0254 J (0.0319)	10.9	ND (0.07)	0.290 J (0.490)	87.6
06297	87B-GR-009-0-SS	soil	10-20-97	0-0.5	23.3	0.0296 J (0.0324)	9.62	ND (0.07)	0.177 J (0.476)	331
06297	87B-GR-010-0-SS	soil	10-20-97	0-0.5	8.56	0.0218 J (0.0309)	10.1	ND (0.07)	0.183 J (0.467)	37.5
06297	87B-GR-011-0-SS	soil	10-20-97	0-0.5	23.6	0.0299 J (0.0313)	9.90	ND (0.07)	0.104 J (0.485)	38.2
06297	87B-GR-012-0-SS	soil	10-20-97	0-0.5	10.8	ND (0.0173)	9.28	ND (0.07)	0.130 J (0.485)	41.3
06297	87B-GR-013-0-SS	soil	10-20-97	0-0.5	12.0	0.0318	7.19	ND (0.07)	ND (0.031)	21.7
06297	87B-GR-014-0-SS	soil	10-20-97	0-0.5	13.0	0.0543	11.7	ND (0.07)	0.0642 J (0.495)	38.6
06297	87B-GR-015-0-SS	soil	10-20-97	0-0.5	12.4	0.0434	9.96	ND (0.07)	0.162 J (0.500)	37.3
06297	87B-GR-016-0-SS	soil	10-20-97	0-0.5	20.6	0.0185 J (0.0321)	5.66	ND (0.07)	0.147 J (0.476)	18.4
06297	87B-GR-017-0-SS	soil	10-20-97	0-0.5	22.2	0.0353	11.5	ND (0.07)	0.229 J (0.500)	48.4
06297	87B-GR-018-0-SS	soil	10-20-97	0-0.5	94.3	0.0256 J (0.0330)	7.82	ND (0.07)	0.150 J (0.481)	27.7
06297	87B-GR-019-0-SS	soil	10-20-97	0-0.5	8.24	0.0255 J (0.0325)	9.46	ND (0.07)	ND (0.031)	43.4
06298	87B-GR-020-0-SS	soil	10-20-97	0-0.5	10.4	0.0285 J (0.0326)	10.0	0.182 J (0.495)	0.318 J (0.495)	35.7
06297	87B-GR-021-0-SSD	soil	10-20-97	0-0.5	16.2	0.0256 J (0.0326)	6.52	ND (0.07)	ND (0.031)	317
Quality Assurance/Quality Control Samples (mg/L)										
06297	87B-GR-022-FB	water	10-20-97	NA	ND (0.000678)	0.000198 J (0.000200)	ND (0.00227)	ND (0.0014)	ND (0.00062)	0.00326 J (0.00500)
06297	87B-GR-023-EB	water	10-20-97	NA	ND (0.000678)	0.000175 J (0.000200)	ND (0.00227)	ND (0.0014)	ND (0.00062)	0.00361 J (0.00500)
NMED-Approved Background Values ^d (mg/kg)		soil	NA	NA	18.9	0.055	16.6	2.7	<0.5	52.1

Refer to footnotes at end of table.

Table 2.4.4-7 (Concluded)
Summary of SWMU 87 RFI Area B Soil Sampling Metals Analytical Results
October 1997
(Off-Site Laboratory)

Note: Values in **bold** exceed background concentrations.

^aEPA November 1986.

^bAnalysis Request/Chain-of-Custody.

^cSample numbers are coded. For Sample ID 87B-GR-002-0-SS, 87B designates the sample was collected at SWMU 87 Area B, GR-002 indicates that the sample was collected from Sample Location No. 002, and SS designates a surface soil sample.

^dGarcla November 1998.

87B = SWMU 87 Area B.

EB = Equipment blank.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

FB = Field blank.

ft = Foot (feet).

GR = Grab sample.

ID = Identification.

J () = Analyte concentration is less than quantitation limit but greater than or equal to the MDL, shown in parentheses.

MDL = Method detection limit.

mg/kg = Milligram(s) per kilogram.

mg/L = Milligram(s) per liter.

NA = Not applicable.

ND () = Not detected at or above the MDL, shown in parentheses.

NMED = New Mexico Environment Department.

RCRA = Resource Conservation and Recovery Act.

RFI = RCRA Facility Investigation.

SS = Surface soil sample.

SSD = Soil sample duplicate.

SWMU = Solid Waste Management Unit.

Table 2.4.4-8
 Summary of SWMU 87 RFI Soil Sampling Beneath Fragments at Area C Metals Analytical Results
 September 1996
 (Off-Site and On-Site Laboratories)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Metals (Methods 6010, 7470/7471 and 8080/8081 ^a) (mg/kg)					
					Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper
05825	87SF-GR-001-0-SD	soil	09-16-96	0.1-1.0	3.18	123	0.517	0.0986 J (0.485)	6.32	52.9
05824	87SF-GR-001-0-SS	soil	09-16-96	0.1-1.0	0.95 J (1.4)	120	0.43	ND (0.54)	5.6	180
05824	87SF-GR-002-0-SS	soil	09-16-96	0.1-1.0	0.71 J (1.4)	86	0.45	ND (0.54)	5.2	94
05824	87SF-GR-003-0-SS	soil	09-16-96	0.1-1.0	1.2 J (1.4)	120	0.48	ND (0.54)	7.1	220
05825	87SF-GR-004-0-SR	soil	09-16-96	0.1-1.0	2.69	78.1	0.439 J (0.481)	0.257 J (0.481)	4.37	981
05824	87SF-GR-004-0-SS	soil	09-16-96	0.1-1.0	0.47 J (1.4)	84	0.31	ND (0.54)	4.6	46
05824	87SF-GR-005-0-SS	soil	09-16-96	0.1-1.0	1.2 J (1.4)	83	0.3	ND (0.54)	4	320
05824	87SF-GR-006-0-SS	soil	09-16-96	0.1-1.0	2	270	0.31	5.8	1.3 J (1.4)	100
05824	87SF-GR-007-0-SS	soil	09-16-96	0.1-1.0	0.41 J (1.4)	210	0.14	ND (0.54)	0.85 J (1.4)	80
05825	87SF-GR-008-0-SR	soil	09-16-96	0.1-1.0	2.26	67.4	0.290 J (0.490)	0.0658 J (0.490)	3.2	10.7
05824	87SF-GR-008-0-SS	soil	09-16-96	0.1-1.0	0.52 J (1.4)	70	0.25	ND (0.54)	3.3	14 J (16)
05824	87SF-GR-009-0-SS	soil	09-16-96	0.1-1.0	0.7 J (1.4)	76	0.27	ND (0.54)	2.9	13 J (16)
05824	87SF-GR-010-0-SS	soil	09-16-96	0.1-1.0	ND (1.4)	71	0.27	ND (0.54)	3.2	82
Quality Assurance/Quality Control Samples (mg/L)										
05825	87SF-GR-010-0-FB	water	09-16-96	NA	ND (0.00276)	0.000364 J (0.0100)	ND (0.000135)	ND (0.000209)	0.00218 J (0.0100)	ND (0.00114)
05825	87SF-GR-0100-EB	water	09-16-96	NA	ND (0.00276)	0.000600 J (0.0100)	ND (0.000135)	ND (0.000209)	0.00165 J (0.0100)	ND (0.00114)
NMED-Approved Background Value ^d (mg/kg)	NA	soil	NA	NA	9.8	246	0.75	0.64	18.8	17.1

Refer to footnotes at end of table.

Table 2.4.4-8 (Continued)
 Summary of SWMU 87 RFI Soil Sampling Beneath Fragments at Area C Metals Analytical Results
 September 1996
 (Off-Site and On-Site Laboratories)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Metals (Methods 6010, 7470/7471 and 8080/8081 ^a) (mg/kg)					
					Lead	Mercury	Nickel	Selenium	Silver	Zinc
05825	87SF-GR-001-0-SD	soil	09-16-96	0.1-1.0	55.8	0.0304	8.43	0.894	0.168 J (0.971)	20.1
05824	87SF-GR-001-0-SS	soil	09-16-96	0.1-1.0	59	ND (0.078)	14	ND (0.47)	ND (0.095)	25 J (32)
05824	87SF-GR-002-0-SS	soil	09-16-96	0.1-1.0	38	ND (0.078)	9.2	ND (0.47)	1.5	22 J (32)
05824	87SF-GR-003-0-SS	soil	09-16-96	0.1-1.0	320	ND (0.078)	12	ND (0.47)	8	29 J (32)
05825	87SF-GR-004-0-SR	soil	09-16-96	0.1-1.0	43.1	0.243	8.39	0.998	0.075 J (0.962)	17.1
05824	87SF-GR-004-0-SS	soil	09-16-96	0.1-1.0	23	ND (0.078)	8.5	ND (0.47)	ND (0.095)	16 J (32)
05824	87SF-GR-005-0-SS	soil	09-16-96	0.1-1.0	73	ND (0.078)	16	ND (0.47)	ND (0.095)	28 J (32)
05824	87SF-GR-006-0-SS	soil	09-16-96	0.1-1.0	120	ND (0.078)	59	ND (0.47)	ND (0.095)	110
05824	87SF-GR-007-0-SS	soil	09-16-96	0.1-1.0	60	ND (0.078)	45	ND (0.47)	ND (0.095)	110
05825	87SF-GR-008-0-SR	soil	09-16-96	0.1-1.0	64.8	ND (0.0322)	4.5	ND (0.114)	0.0465 J (0.980)	19.6
05824	87SF-GR-008-0-SS	soil	09-16-96	0.1-1.0	40	ND (0.078)	6.7 J (7.3)	ND (0.47)	ND (0.095)	19 J (32)
05824	87SF-GR-009-0-SS	soil	09-16-96	0.1-1.0	28	ND (0.078)	6.5 J (7.3)	ND (0.47)	1.8	18 J (32)
05824	87SF-GR-010-0-SS	soil	09-16-96	0.1-1.0	280	ND (0.078)	56	ND (0.47)	ND (0.095)	100
Quality Assurance/Quality Control Samples (mg/L)										
05825	87SF-GR-010-0-FB	water	09-16-96	NA	ND (0.00136)	ND (0.0002)	ND (0.000996)	ND (0.00228)	ND (0.000424)	ND (0.00117)
05825	87SF-GR-0100-EB	water	09-16-96	NA	0.00229 J (0.00500)	ND (0.0002)	ND (0.000996)	ND (0.00228)	ND (0.000424)	0.00360 J (0.0200)
NMED-Approved Background Value ^d (mg/kg)	NA	soil	NA	NA	18.9	0.055	16.6	2.7	<0.5	52.1

Refer to footnotes at end of table.

Table 2.4.4-8 (Concluded)
Summary of SWMU 87 RFI Soil Sampling Beneath Fragments at Area C Metals Analytical Results
September 1996
(Off-Site and On-Site Laboratories)

Note: Values in **bold** exceed background concentrations.

^aEPA November 1986

^bAnalysis Request/Chain-of-Custody.

^cSample numbers are coded. For Sample ID 87SF-GR-002-0-SS, 87SF designates the sample was collected beneath a metal fragment at SWMU 87 Area C, GR-002 indicates that the sample was collected from Sample Location No. 002, and SS designates a surface soil sample.

^dGarcia November 1998.

87SF = Soil sample beneath metal fragment at SWMU 87.

EB = Equipment blank.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

FB = Field blank.

ft = Foot (feet).

GR = Grab sample.

ID = Identification.

J () = The estimated value reported is either above the MDL and less than the practical quantitation limit or above the instrument detection limit and less than the contract-required detection limit, shown in parentheses.

MDL = Method detection limit.

mg/kg = Milligram(s) per kilogram.

mg/L = Milligram(s) per liter.

NA = Not applicable.

ND () = Not detected at or above the MDL, shown in parentheses.

NMED = New Mexico Environment Department.

RCRA = Resource Conservation and Recovery Act.

RFI = RCRA Facility Investigation.

SD = Soil sample duplicate.

SR = Soil sample replicate.

SS = Surface soil sample.

SWMU = Solid Waste Management Unit.

Table 2.4.4-9
 Summary of SWMU 87 RFI Arroyo Soil Sampling Metals Analytical Results
 December 1996
 (Off-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Metals (Methods 6010A and 7470/7471 ^a) (mg/kg)					
					Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper
06012	87ARY-GR-001-0-SS	soil	12-02-96	0-1.0	2.50	75.2	0.350 J (0.481)	0.242 J (0.481)	4.52	16.6
06012	87ARY-GR-001-0-SSD	soil	12-02-96	0-1.0	2.58	80.9	0.359 J (0.490)	0.252 J (0.490)	4.67	14.7
06012	87ARY-GR-002-0-SS	soil	12-02-96	0-1.0	2.60	79.7	0.372 J (0.500)	0.298 J (0.500)	4.58	39.7
06012	87ARY-GR-003-0-SS	soil	12-02-96	0-1.0	2.95	84.2	0.392 J (0.481)	0.218 J (0.481)	5.12	8.58
06012	87ARY-GR-004-0-SS	soil	12-02-96	0-1.0	2.19	70.0	0.307 J (0.500)	0.207 J (0.500)	3.93	19.3
06012	87ARY-GR-005-0-SS	soil	12-02-96	0-1.0	3.08	151	0.540	0.255 J (0.500)	6.95	8.77
06012	87ARY-GR-006-0-SS	soil	12-02-96	0-1.0	2.17	45.2	0.296 J (0.490)	0.217 J (0.490)	3.62	5.04
Quality Assurance/Quality Control Samples (mg/L)										
06012	87ARY-GR-006-FB	water	12-02-96	NA	ND (0.00276)	0.000534 J (0.0100)	0.000418 J (0.00500)	ND (0.000209)	ND (0.000621)	ND (0.00114)
06012	87ARY-GR-006-EB	water	12-02-96	NA	ND (0.00276)	.000353 J (0.0100)	ND (0.000135)	ND (0.000209)	ND (0.000621)	0.00124 J (0.0100)
NMED-Approved Background Values ^d (mg/kg)	NA	soil	NA	NA	9.8	246	0.75	0.64	18.8	17.1

Refer to footnotes at end of table.

Table 2.4.4-9 (Continued)
 Summary of SWMU 87 RFI Arroyo Soil Sampling Metals Analytical Results
 December 1996
 (Off-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Metals (Methods 6010A and 7470/7471 ^a) (mg/kg)					
					Lead	Mercury	Nickel	Selenium	Silver	Zinc
06012	87ARY-GR-001-0-SS	soil	12-02-96	0-1.0	12.0	ND (0.02)	6.06	ND (0.114)	ND (0.0212)	23.5
06012	87ARY-GR-001-0-SSD	soil	12-02-96	0-1.0	10.7	ND (0.02)	6.77	ND (0.114)	ND (0.0212)	23.2
06012	87ARY-GR-002-0-SS	soil	12-02-96	0-1.0	10.9	ND (0.02)	6.49	0.603	0.084 J	22.8
06012	87ARY-GR-003-0-SS	soil	12-02-96	0-1.0	7.61	ND (0.02)	6.43	ND (0.114)	ND (0.0212)	19.4
06012	87ARY-GR-004-0-SS	soil	12-02-96	0-1.0	9.28	ND (0.02)	6.21	ND (0.114)	0.145 J	17.3
06012	87ARY-GR-005-0-SS	soil	12-02-96	0-1.0	7.27	ND (0.02)	9.28	ND (0.114)	0.07 J	24.2
06012	87ARY-GR-006-0-SS	soil	12-02-96	0-1.0	4.08	ND (0.02)	7.55	ND (0.114)	ND (0.0212)	42.1
Quality Assurance/Quality Control Samples (mg/L)										
06012	87ARY-GR-006-FB	water	12-02-96	NA	ND (0.00136)	ND (0.0001)	ND (0.000996)	ND (0.00228)	0.000654 J	ND (0.00117)
06012	87ARY-GR-006-EB	water	12-02-96	NA	ND (0.00136)	ND (0.0001)	ND (0.000996)	ND (0.00228)	ND (0.000424)	ND (0.00117)
NMED-Approved Background Values ^d (mg/kg)	NA	soil	NA	NA	18.9	0.055	16.6	2.7	<0.5 ^a	52.1

Refer to footnotes at end of table.

Table 2.4.4-9 (Concluded)
 Summary of SWMU 87 RFI Arroyo Soil Sampling Metals Analytical Results
 December 1996
 (Off-Site Laboratory)

Note: Values in bold exceed background concentrations.

^aEPA November 1986.

^bAnalysis Request/Chain-of-Custody.

^cSample numbers are coded. For Sample ID 87ARY-GR-002-0-SS, 87ARY designates the sample was collected at the SWMU 87 arroyo, GR-002 indicates that the sample was collected from Sample Location No. 002, and SS designates a surface soil sample.

^dGarcia November 1988.

87ARY = SWMU 87 Arroyo.

EB = Equipment blank.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

FB = Field blank.

ft = Foot (feet).

GR = Grab sample.

ID = Identification.

J () = Analyte concentration is less than quantitation limit but greater than or equal to the MDL, shown in parentheses.

MDL = Method detection limit.

mg/kg = Milligram(s) per kilogram.

mg/L = Milligram(s) per liter.

NA = Not applicable.

ND () = Not detected at or above the MDL, shown in parentheses.

NMED = New Mexico Environment Department.

RCRA = Resource Conservation and Recovery Act.

RFI = RCRA Facility Investigation.

SS = Surface soil sample.

SSD = Soil sample duplicate.

SWMU = Solid Waste Management Unit.

Table 2.4.4-10
 Summary of SWMU 87 RFI Perimeter Soil Sampling Metals Analytical Results
 May 1996 and October 1997
 (Off-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Metals (Methods 6010A and 7470/7471 ^a) (mg/kg)					
					Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper
05125	87Per-GR-001-0-SSD	soil	05-14-96	0-1.0	7.93	101	0.460 J (0.463)	0.119 J (0.463)	7.00	13.4
510037	87Per-GR-002-0-SS	soil	10-20-97	0-1.0	4.16	118	0.736	0.227 J (0.490)	8.54	13.6
510037	87Per-GR-003-0-SS	soil	10-20-97	0-1.0	3.86	115	0.639	0.194 J (0.495)	8.66	15.4
05125	87Per-GR-004-0-SS	soil	05-14-96	0-1.0	4.35	135	0.655	0.0830 J (0.476)	9.52	9.72
510037	87Per-GR-005-0-SS	soil	10-20-97	0-1.0	3.21	158	0.530	0.216 J (0.459)	8.50	11.6
510037	87Per-GR-006-0-SS	soil	10-20-97	0-1.0	3.89	142	0.678	0.164 J (0.472)	7.84	11.6
510037	87Per-GR-007-0-SS	soil	10-20-97	0-1.0	3.07	93.4	0.482 J (0.485)	0.176 J (0.485)	5.08	16.3
05125	87Per-GR-008-0-SS	soil	05-14-96	0-1.0	5.64	120	0.686	0.148 J (0.485)	10.8	14.2
510037	87Per-GR-009-0-SS	soil	10-20-97	0-1.0	6.99	101	0.677	0.251 J (0.485)	9.67	12.6
510037	87Per-GR-010-0-SS	soil	10-20-97	0-1.0	4.03	122	0.527	0.174 J (0.485)	6.79	11.7
510037	87Per-GR-011-0-SS	soil	10-20-97	0-1.0	3.37	146	0.508	0.277 J (0.476)	9.84	16.5
05125	87Per-GR-012-0-SS	soil	05-14-96	0-1.0	4.15	135	0.565	0.0913 J (0.485)	7.94	21.0
510037	87Per-GR-012-0-SS	soil	10-20-97	0-1.0	3.17	130	0.509	0.268 J (0.476)	6.93	31.0
Quality Assurance/Quality Control Samples (mg/L)										
05125	87Per-GR-012-FB	water	05-14-96	NA	ND (0.00186)	0.000213 J (0.01)	ND (0.0000114)	ND (0.000097)	ND (0.000596)	0.00120 J (0.01)
05125	87Per-GR-012-EB	water	05-14-96	NA	ND (0.00186)	0.000434 J (0.01)	ND (0.0000114)	ND (0.000097)	ND (0.000596)	0.00214 J (0.01)
NMED-Approved Background Values ^d (mg/kg)		soil	NA	NA	9.8	246	0.75	0.64	18.8	17.1

Refer to footnotes at end of table.

Table 2.4.4-10 (Continued)
 Summary of SWMU 87 RFI Perimeter Soil Sampling Metals Analytical Results
 May 1996 and October 1997
 (Off-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Metals (Methods 6010A and 7470/7471 ^a) (mg/kg)					
					Lead	Mercury	Nickel	Selenium	Silver	Zinc
05125	87Per-GR-001-0-SSD	soil	05-14-96	0-1.0	13.5	0.0138 J (0.0324)	9.30	0.299 J (0.463)	ND (0.231)	26.4
510037	87Per-GR-002-0-SS	soil	10-20-97	0-1.0	17.8	0.0311	10.8	ND (0.07)	0.120 J (0.490)	29.9
510037	87Per-GR-003-0-SS	soil	10-20-97	0-1.0	17.1	0.0253 J (0.0292)	12.1	ND (0.07)	0.110 J (0.495)	35.0
05125	87Per-GR-004-0-SS	soil	05-14-96	0-1.0	13.3	0.0224 J (0.0318)	7.95	ND (0.136)	ND (0.237)	29.3
510037	87Per-GR-005-0-SS	soil	10-20-97	0-1.0	12.3	0.0206 J (0.0313)	8.85	ND (0.07)	0.158 J (0.459)	39.1
510037	87Per-GR-006-0-SS	soil	10-20-97	0-1.0	19.5	0.0409	8.70	ND (0.07)	0.167 J (0.472)	26.7
510037	87Per-GR-007-0-SS	soil	10-20-97	0-1.0	12.4	0.0391	5.53	ND (0.07)	0.125 J (0.485)	27.8
05125	87Per-GR-008-0-SS	soil	05-14-96	0-1.0	15.4	0.0181 J (0.032)	13.3	ND (0.139)	ND (0.242)	44.7
510037	87Per-GR-009-0-SS	soil	10-20-97	0-1.0	10.8	0.0217 J (0.0299)	11.4	ND (0.07)	0.152 J (0.465)	43.4
510037	87Per-GR-010-0-SS	soil	10-20-97	0-1.0	11.3	0.0385	7.12	ND (0.07)	0.130 J (0.485)	29.4
510037	87Per-GR-011-0-SS	soil	10-20-97	0-1.0	15.5	0.0332	11.6	ND (0.07)	0.193 J (0.476)	33.7
05125	87Per-GR-012-0-SS	soil	05-14-96	0-1.0	14.9	0.0165 J (0.0324)	9.94	ND (0.139)	ND (0.242)	23.6
510037	87Per-GR-012-0-SS	soil	10-20-97	0-1.0	30.0	0.0300 J (0.0323)	9.82	ND (0.07)	0.157 J (0.476)	28.9
Quality Assurance/Quality Control Samples (mg/L)										
05125	87Per-GR-012-FB	water	05-14-96	NA	ND (0.00113)	0.00002 J (0.0002)	ND (0.000807)	ND (0.00143)	ND (0.00249)	0.00304 J (0.02)
05125	87Per-GR-012-EB	water	05-14-96	NA	ND (0.00113)	0.0000350 J (0.0002)	ND (0.000807)	ND (0.00143)	ND (0.00249)	0.0102 J (0.02)
NMEI-Approved Background Values ^d (mg/kg)		soil	NA	NA	18.9	0.055	16.6	2.7	<0.5	52.1

Refer to footnotes at end of table.

Table 2.4.4-10 (Concluded)
Summary of SWMU 87 RFI Perimeter Soil Sampling Metals Analytical Results
May 1996 and October 1997
(Off-Site Laboratory)

Note: Values in bold exceed background concentrations.

^aEPA November 1986.

^bAnalysis Request/Chain-of-Custody.

^cSample numbers are coded. For Sample ID 87Per-GR-002-0-SS, 87Per designates the sample was collected at SWMU 87 Perimeter, GR-002 indicates that the sample was collected from Sample Location No. 002, and SS designates a surface soil sample.

^dGarcia November 1998

87Per = SWMU 87 Perimeter.

EB = Equipment blank.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

FB = Field blank.

ft = Foot (feet).

GR = Grab sample.

ID = Identification.

J () = Analyte concentration is less than quantitation limit but greater than or equal to the MDL, shown in parentheses.

MDL = Method detection limit.

mg/kg = Milligram(s) per kilogram.

mg/L = Milligram(s) per liter.

NA = Not applicable.

ND () = Not detected at or above the MDL, shown in parentheses.

NMED = New Mexico Environment Department.

RCRA = Resource Conservation and Recovery Act.

RFI = RCRA Facility Investigation.

SS = Surface soil sample.

SSD = Soil sample duplicate.

SWMU = Solid Waste Management Unit.

Table 2.4.4-11
 Summary of Analytical Detections of HE Compounds in SWMU 87 RFI Soil Samples (Area A)
 September 1998
 (Off-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	High Explosives Residues (EPA 8330) ^a (µg/kg)		
					o-Nitrotoluene	HMX	m-Dinitrobenzene
600821	S87A-GR-101-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	ND (4.1)
600821	S87A-GR-102-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	ND (4.1)
600821	S87A-GR-103-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	ND (4.1)
600821	S87A-GR-104-0-SS	soil	09-09-98	0-0.5	120	ND (5.3)	ND (4.1)
600821	S87A-GR-105-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	ND (4.1)
600821	S87A-GR-106-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	ND (4.1)
600821	S87A-GR-107-0-SS	soil	09-09-98	0-0.5	ND (7.8)	110	ND (4.1)
600821	S87A-GR-108-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	ND (4.1)
600821	S87A-GR-109-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	ND (4.1)
600821	S87A-GR-110-0-SS	soil	09-09-98	0-0.5	ND (7.8)	200	ND (4.1)
600821	S87A-GR-111-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	ND (4.1)
600821	S87A-GR-112-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	ND (4.1)
600821	S87A-GR-113-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	ND (4.1)
600821	S87A-GR-114-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	ND (4.1)
600821	S87A-GR-115-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	ND (4.1)
600821	S87A-GR-116-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	140
600821	S87A-GR-117-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	ND (4.1)
600821	S87A-GR-118-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	ND (4.1)
600821	S87A-GR-119-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	140
600821	S87A-GR-120-0-SS	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	130
600824	S87A-GR-150-0-SD	soil	09-09-98	0-0.5	ND (7.8)	ND (5.3)	ND (4.1)
Quality Assurance Samples (µg/L)							
600824	S87A-GR-147-0-EB	water	09-09-98	NA	ND (0.024)	ND (0.046)	ND (0.02)

Note: Values in bold represent detected analytes.

^aEPA November 1986.

^bAnalysis Request/Chain-of-Custody.

^cSample numbers are coded. For sample ID S87A-GR-101-0-SS, S87 designates the sample was collected at SWMU 87, GR-101 indicates that the sample was collected from Sample Location No. 101, and SS designates a surface soil sample.

µg/kg = Microgram(s) per kilogram.

µg/L = Microgram(s) per liter.

S87A = SWMU 87 Area A.

EB = Equipment blank.

EPA = U.S. Environmental Protection Agency.

ER = Environmental Restoration.

ft = Foot (feet).

GR = Grab Sample.

HE = High explosive(s).

HMX = Cyclotetramethylene tetraaminine.

ID = Identification.

MDL = Method detection limit.

NA = Not applicable.

ND () = Not detected at or above the MDL,

shown in parentheses.

RCRA = Resource Conservation and Recovery Act.

RFI = RCRA Facility Investigation.

S87A = SWMU 87, Area A.

SD = Soil sample duplicate.

SS = Soil sample.

SWMU = Solid Waste Management Unit.

Table 2.4.4-12
 Summary of HE Compounds Analytical Method Detection Limits for
 SWMU 87 RFI Soil Sampling
 September 1998
 (Off-Site Laboratory)

HE Residues (EPA 8330) ^a (µg/kg)	
HE Compound	Method Detection Limit
2,4,6-Trinitrotoluene	5.7
2,4-Dinitrotoluene	6.2
2,6-Dinitrotoluene	6.5
2-Amino-4,6-dinitrotoluene	6.6
4-Amino-2,6-dinitrotoluene	5.5
HMX	5.3
Nitrobenzene	5.2
RDX	9.7
Tetryl	7.5
m-Dinitrobenzene	4.1
m-Nitrotoluene	11
o-Nitrotoluene	7.8
p-Nitrotoluene	11
sym-Trinitrobenzene	6.6

^aEPA November 1986

EPA = U.S. Environmental Protection Agency.

HE = High explosive(s).

HMX = Cyclotetramethylene tetranitramine.

µg/kg = Microgram(s) per kilogram.

RCRA = Resource Conservation and Recovery Act.

RDX = Cyclo-1,3,5-trimethylene-2,4,6-trinitramine.

RFI = RCRA facility investigation.

SWMU = Solid Waste Management Unit.

Tetryl = Trinitro-2,4,6-phenylmethylnitramine.

Table 2.4.4-13
 Summary of SWMU 87 RFI Area A Soil Sampling Gamma Spectroscopy Analytical Results
 August 1995
 (On-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Gamma Spectroscopy Activity ^a (pCi/g)			Error ^d
					Uranium-238	Thorium-232	Error ^d	
04122	87-GR-001-0-SS-01	soil	08-07-95	0.1-1.0	9.54E+00	4.73E+00	4.84E-01	1.02E+00
04267	87-GR-001-0-SS-01*	soil	08-07-95	0.1-1.0	4.33E+00	4.10E-01	*	*
04122	87-GR-002-0-SS-01	soil	08-07-95	0.1-1.0	2.12E+01	8.72E+00	6.06E-01	2.79E-01
04267	87-GR-002-0-SS-01*	soil	08-07-95	0.1-1.0	3.57E+01	2.30E+00	*	*
04122	87-GR-003-0-SS-01	soil	08-07-95	0.1-1.0	9.00E+00	7.07E+00	6.94E-01	3.71E-01
04267	87-GR-003-0-SS-01*	soil	08-07-95	0.1-1.0	7.81E+00	6.00E-01	*	*
04122	87-GR-004-0-SS-01	soil	08-07-95	0.1-1.0	ND (5.77E+00)	--	8.43E-01	3.13E-01
04125	87-GR-005-0-SS-01	soil	08-07-95	0.1-1.0	3.56E+00	1.09E+00	7.79E-01	2.92E-01
04122	87-GR-006-0-SS-01	soil	08-07-95	0.1-1.0	ND (6.58E+00)	--	7.53E-01	2.93E-01
04267	87-GR-006-0-SS-01*	soil	08-07-95	0.1-1.0	2.18E+01	1.50E+00	*	*
04122	87-GR-007-0-SS-01	soil	08-07-95	0.1-1.0	4.20E+00	4.59E+00	5.33E-01	1.97E-01
04267	87-GR-007-0-SS-01*	soil	08-07-95	0.1-1.0	1.38E+01	1.00E+00	*	*
04122	87-GR-008-0-SS-01	soil	08-07-95	0.1-1.0	ND (5.68E+00)	--	6.91E-01	2.27E-01
04122	87-GR-009-0-SS-01	soil	08-07-95	0.1-1.0	5.35E+00	3.50E+00	6.65E-01	2.31E-01
04267	87-GR-009-0-SS-01*	soil	08-07-95	0.1-1.0	7.03E+00	4.50E-01	*	*
04125	87-GR-010-0-SS-01	soil	08-07-95	0.1-1.0	ND (2.06E+00)	--	7.98E-01	2.50E-01
04122	87-GR-011-0-SS-01	soil	08-07-95	0.1-1.0	4.84E+00	2.97E+00	7.19E-01	2.59E-01
04267	87-GR-011-0-SS-01*	soil	08-07-95	0.1-1.0	9.96E+00	8.10E-01	*	*
04122	87-GR-012-0-SS-01	soil	08-07-95	0.1-1.0	ND (6.26E+00)	--	7.24E-01	2.42E-01
04122	87-GR-013-0-SS-01	soil	08-07-95	0.1-1.0	ND (5.70E+00)	--	5.15E-01	2.30E-01
04122	87-GR-014-0-SS-01	soil	08-07-95	0.1-1.0	ND (6.31E+00)	--	6.21E-01	2.88E-01
04125	87-GR-015-0-SS-01	soil	08-07-95	0.1-1.0	ND (2.08E+00)	--	6.87E-01	2.19E-01
04122	87-GR-016-0-SS-01	soil	08-07-95	0.1-1.0	ND (5.71E+00)	--	8.56E-01	3.12E-01
04122	87-GR-017-0-SS-01	soil	08-07-95	0.1-1.0	ND (5.99E+00)	--	6.62E-01	2.67E-01
04122	87-GR-018-0-SS-01	soil	08-07-95	0.1-1.0	ND (6.28E+00)	--	5.50E-01	2.08E-01
04122	87-GR-019-0-SS-01	soil	08-07-95	0.1-1.0	8.66E+00	5.14E+00	5.41E-01	1.72E-01
04267	87-GR-019-0-SS-01*	soil	08-07-95	0.1-1.0	4.91E+00	4.50E-01	*	*
04122	87-GR-020-0-SS-04	soil	08-07-95	0.1-1.0	ND (6.27E+00)	--	7.31E-01	2.30E-01
04125	87-GR-020-0-SS-01	soil	08-07-95	0.1-1.0	8.93E+00	2.34E+00	6.03E-01	2.12E-01
Quality Assurance/Quality Control Samples (pCi/mL)								
04125	014878-06	water	08-07-95	NA	ND (5.84E-01)	--	ND (1.32E-01)	--
04125	014879-05	water	08-07-95	NA	ND (5.58E-01)	--	ND (1.26E-01)	--
Background Soil Activities—Lower Canyons Area ^e (pCi/g)		soil	NA	NA	2:31	NA	1:03	NA

Refer to footnotes at end of table.

Table 2.4.4-13 (Continued)
 Summary of SWMU 87 RFI Area A Soil Sampling Gamma Spectroscopy Analytical Results
 August 1995
 (On-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Gamma Spectroscopy Activity ^a (pCi/g)		Error ^d
					Uranium-235	Cesium-137	
04122	87-GR-001-0-SS-01	soil	08-07-95	0.1-1.0	ND (3.76E-01)	ND (5.81E-02)	--
04267	87-GR-001-0-SS-01*	soil	08-07-95	0.1-1.0	1.25E-01	6.30E-02	--
04122	87-GR-002-0-SS-01	soil	08-07-95	0.1-1.0	ND (4.91E-01)	ND (6.20E-02)	--
04267	87-GR-002-0-SS-01*	soil	08-07-95	0.1-1.0	7.30E-01	2.20E-01	--
04122	87-GR-003-0-SS-01	soil	08-07-95	0.1-1.0	ND (5.31E-01)	ND (6.64E-02)	--
04267	87-GR-003-0-SS-01*	soil	08-07-95	0.1-1.0	2.00E-01	7.60E-02	--
04122	87-GR-004-0-SS-01	soil	08-07-95	0.1-1.0	ND (4.07E-01)	1.93E-02	2.40E-02
04125	87-GR-005-0-SS-01	soil	08-07-95	0.1-1.0	ND (3.41E-01)	ND (5.56E-02)	--
04122	87-GR-006-0-SS-01	soil	08-07-95	0.1-1.0	ND (3.97E-01)	ND (5.52E-02)	--
04267	87-GR-006-0-SS-01*	soil	08-07-95	0.1-1.0	3.10E-01	1.30E-01	--
04122	87-GR-007-0-SS-01	soil	08-07-95	0.1-1.0	ND (4.02E-01)	ND (5.74E-02)	--
04267	87-GR-007-0-SS-01*	soil	08-07-95	0.1-1.0	3.80E-01	1.30E-01	--
04122	87-GR-008-0-SS-01	soil	08-07-95	0.1-1.0	ND (3.94E-01)	1.78E-01	5.33E-02
04122	87-GR-009-0-SS-01	soil	08-07-95	0.1-1.0	ND (3.70E-01)	ND (5.91E-02)	--
04267	87-GR-009-0-SS-01*	soil	08-07-95	0.1-1.0	1.51E-01	4.20E-02	--
04125	87-GR-010-0-SS-01	soil	08-07-95	0.1-1.0	ND (3.62E-01)	2.55E-02	3.74E-02
04122	87-GR-011-0-SS-01	soil	08-07-95	0.1-1.0	ND (3.80E-01)	ND (6.15E-02)	--
04267	87-GR-011-0-SS-01*	soil	08-07-95	0.1-1.0	1.36E-01	7.90E-02	--
04122	87-GR-012-0-SS-01	soil	08-07-95	0.1-1.0	ND (3.99E-01)	5.29E-02	3.10E-02
04122	87-GR-013-0-SS-01	soil	08-07-95	0.1-1.0	ND (3.71E-01)	4.82E-02	2.62E-02
04122	87-GR-014-0-SS-01	soil	08-07-95	0.1-1.0	ND (4.07E-01)	ND (6.14E-01)	--
04125	87-GR-015-0-SS-01	soil	08-07-95	0.1-1.0	ND (3.62E-01)	1.49E-01	7.95E-02
04122	87-GR-016-0-SS-01	soil	08-07-95	0.1-1.0	ND (3.77E-01)	2.12E-02	2.46E-02
04122	87-GR-017-0-SS-01	soil	08-07-95	0.1-1.0	ND (3.87E-01)	ND (5.92E-02)	--
04122	87-GR-018-0-SS-01	soil	08-07-95	0.1-1.0	ND (3.48E-01)	ND (5.19E-02)	--
04122	87-GR-019-0-SS-01	soil	08-07-95	0.1-1.0	ND (3.82E-01)	ND (5.46E-02)	--
04267	87-GR-019-0-SS-01*	soil	08-07-95	0.1-1.0	1.10E-01	5.80E-02	--
04122	87-GR-020-0-SS-04	soil	08-07-95	0.1-1.0	ND (3.95E-01)	ND (5.63E-02)	--
04125	87-GR-020-0-SS-01	soil	08-07-95	0.1-1.0	ND (3.48E-01)	ND (5.58E-02)	--
Quality Assurance/Quality Control Samples (pCi/mL)							
04125	014878-06	water	08-07-95	NA	ND (1.39E-01)	ND (2.08E-02)	--
04125	014879-05	water	08-07-95	NA	ND (1.39E-01)	ND (2.15E-02)	--
Background Soil Activities—Lower Canyons Area ^e (pCi/g)				NA	0.16	NA	1.55
				NA	NA	NA	NA

Refer to footnotes at end of table.

Table 2.4.4-13 (Concluded)
 Summary of SWMU 87 RFI Area A Soil Sampling Gamma Spectroscopy Analytical Results
 August 1995
 (On-Site Laboratory)

Note: Values in **bold** exceed background activities, or have MDAs that exceed background activities.
^aUranium-238 and thorium-232 decay chain isotopes with a short half-life are not presented in this table.
^bAnalysis Request/Chain-of-Custody.
^cSample numbers are coded. For Sample ID 87-GR-002-0-SS-01, 87 designates the sample was collected at SWMU 87, GR-002 indicates that the sample was collected from Sample Location No. 002, and SS designates a surface soil sample.
^dTwo standard deviations about the MDA.
^eDinwiddie September 1997.

87 = SWMU 87.
 ER = Environmental Restoration.
 ft = Foot (feet).
 GR = Grab sample.
 ID = Identification.
 MDA = Minimum detectable activity.
 NA = Not applicable.
 ND = Not detected above the MDA, shown in parentheses.
 pCi/g = Picocurie(s) per gram.
 pCi/mL = Picocurie(s) per milliliter.
 RCRA = Resource Conservation and Recovery Act.
 RFI = RCRA Facility Investigation.
 SS = Surface soil sample.
 SWMU = Solid Waste Management Unit.
 * = Analyzed for isotopic uranium only.
 .. = Error not calculated for ND results.

Table 2.4.4-14
 Summary of SWMU 87 RFI Area A Subsurface Soil Sampling Gamma Spectroscopy Analytical Results
 October 2001
 (On-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Gamma Spectroscopy Activity ^a (pCi/g)		Error ^d	Error ^d
					Uranium-238	Thorium-232		
605074	87-BH1-GR-001-0-S	soil	10-29-01	0-1.5	2.14E+00	5.35E-01	4.46E-01	2.69E-01
605074	87-BH1-GR-002-3-S	soil	10-29-01	3-4.5	ND (5.23E-01)	6.90E-01	--	3.69E-01
605074	87-BH1-GR-003-6-S	soil	10-29-01	6-7.5	2.63E+00	7.85E-01	5.24E-01	3.71E-01
605074	87-BH1-GR-004-9-S	soil	10-29-01	9-10.5	5.00E+00	7.35E-01	8.44E-01	3.76E-01
605074	87-BH2-GR-005-0-S	soil	10-29-01	0-1.5	3.34E+00	6.83E-01	7.49E-01	3.45E-01
605074	87-BH2-GR-006-3-S	soil	10-29-01	3-4.5	1.15E+00	6.36E-01	5.56E-01	3.35E-01
605074	87-BH2-GR-007-6-S	soil	10-29-01	6-7.5	ND (5.56E-01)	1.11E+00	--	5.22E-01
605074	87-BH2-GR-008-9-S	soil	10-29-01	9-10.5	ND (5.93E-01)	1.12E+00	--	5.46E-01
605074	87-BH3-GR-009-0-S	soil	10-29-01	0-1.5	ND (5.58E-01)	7.36E-01	--	3.56E-01
605074	87-BH3-GR-010-3-S	soil	10-29-01	3-4.5	ND (7.49E-01)	8.87E-01	--	4.31E-01
605074	87-BH3-GR-011-6-S	soil	10-29-01	6-7.5	ND (5.71E-01)	9.75E-01	--	4.53E-01
605074	87-BH3-GR-012-9-S	soil	10-29-01	9-10.5	ND (5.69E-01)	9.18E-01	--	4.32E-01
605074	87-BH4-GR-013-0-S	soil	10-30-01	0-1.5	ND (7.70E-01)	8.48E-01	--	4.02E-01
605074	87-BH4-GR-014-3-S	soil	10-29-01	3-4.5	ND (7.94E-01)	8.53E-01	--	4.04E-01
605074	87-BH4-GR-015-6-S	soil	10-30-01	6-7.5	ND (6.68E-01)	7.71E-01	--	3.63E-01
605074	87-BH4-GR-016-9-S	soil	10-30-01	9-10.5	ND (7.13E-01)	8.19E-01	--	3.89E-01
605074	87-BH5-GR-017-0-S	soil	10-30-01	0-1.5	2.49E+00	9.77E-01	7.32E-01	4.53E-01
605074	87-BH5-GR-018-3-S	soil	10-30-01	3-4.5	3.04E+00	9.40E-01	6.22E-01	4.42E-01
605074	87-BH5-GR-019-6-S	soil	10-30-01	6-7.5	5.97E+00	7.43E-01	1.12E+00	3.58E-01
605074	87-BH5-GR-020-9-S	soil	10-30-01	9-10.5	3.60E+00	8.29E-01	6.82E-01	3.93E-01
Background Soil Activities—Lower Canyons Area ^e (pCi/g)		soil	NA	NA	2.31	1.03	NA	NA

Refer to footnotes at end of table.

Table 2.4.4-14 (Continued)
 Summary of SWMU 87 RFI Area A Subsurface Soil Sampling Gamma Spectroscopy Analytical Results
 October 2001
 (On-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Gamma Spectroscopy Activity ^a (pCi/g)		Error
					Uranium-235 ^d	Cesium-137 ^d	
605074	87-BH1-GR-001-0-S	soil	10-29-01	0-1.5	ND (2.09E-01)	ND (3.80E-02)	--
605074	87-BH1-GR-002-3-S	soil	10-29-01	3-4.5	1.65E-01	ND (3.97E-02)	--
605074	87-BH1-GR-003-6-S	soil	10-29-01	6-7.5	1.27E-01	2.63E-02	1.63E-02
605074	87-BH1-GR-004-9-S	soil	10-29-01	9-10.5	2.47E-01	ND (4.24E-02)	--
605074	87-BH2-GR-005-0-S	soil	10-29-01	0-1.5	2.05E-01	ND (4.10E-02)	--
605074	87-BH2-GR-006-3-S	soil	10-29-01	3-4.5	ND (2.31E-01)	7.09E-02	3.35E-02
605074	87-BH2-GR-007-6-S	soil	10-29-01	6-7.5	ND (2.17E-01)	2.43E-02	2.03E-02
605074	87-BH2-GR-008-9-S	soil	10-29-01	9-10.5	ND (2.28E-01)	2.34E-02	1.56E-02
605074	87-BH3-GR-009-0-S	soil	10-29-01	0-1.5	ND (2.05E-01)	ND (3.72E-02)	--
605074	87-BH3-GR-010-3-S	soil	10-29-01	3-4.5	ND (2.63E-01)	ND (4.83E-02)	--
605074	87-BH3-GR-011-6-S	soil	10-29-01	6-7.5	ND (2.26E-01)	2.26E-02	1.69E-02
605074	87-BH3-GR-012-9-S	soil	10-29-01	9-10.5	1.17E-01	3.09E-02	1.90E-02
605074	87-BH4-GR-013-0-S	soil	10-30-01	0-1.5	ND (2.44E-01)	1.68E-02	1.70E-02
605074	87-BH4-GR-014-3-S	soil	10-29-01	3-4.5	ND (2.37E-01)	2.45E-02	2.37E-02
605074	87-BH4-GR-015-6-S	soil	10-30-01	6-7.5	ND (2.15E-01)	3.21E-02	2.10E-02
605074	87-BH4-GR-016-9-S	soil	10-30-01	9-10.5	ND (2.19E-01)	4.06E-02	2.03E-02
605074	87-BH5-GR-017-0-S	soil	10-30-01	0-1.5	ND (2.41E-01)	1.49E-01	1.27E-01
605074	87-BH5-GR-018-3-S	soil	10-30-01	3-4.5	1.98E-01	ND (3.73E-02)	--
605074	87-BH5-GR-019-6-S	soil	10-30-01	6-7.5	1.79E-01	ND (3.15E-02)	--
605074	87-BH5-GR-020-9-S	soil	10-30-01	9-10.5	1.10E-01	1.49E-02	7.71E-03
Background Soil Activities--Lower Canyons Area ^e (pCi/g)		soil	NA	NA	0.16	1.55	NA

Refer to footnotes at end of table.

Table 2.4.4-14 (Concluded)
 Summary of SWMU 87 RFI Area A Subsurface Soil Sampling Gamma Spectroscopy Analytical Results
 October 2001
 (On-Site Laboratory)

Note: Values in bold exceed background activities.

^aUranium-238 and thorium-232 decay chain isotopes with a short half-life are not presented in this table.

^bAnalysis Request/Chain-of-Custody.

^cSample numbers are coded. For Sample ID 87-BH1-GR-002-3-S, 87 designates the sample was collected at SWMU 87, BH1 designates Borehole Number 1, GR-002-3 indicates that the sample is Sample Number 002 and was collected at 3 feet below grade, and S designates a subsurface soil sample.

^dTwo standard deviations about the mean activity.

^eDinwiddie September 1997.

BH = Borehole.

87 = SWMU 87.

ER = Environmental Restoration.

ft = Foot (feet).

GR = Grab sample.

ID = Identification.

MDA = Minimum detectable activity.

NA = Not applicable.

ND () = Not detected above the MDA, shown in parentheses.

pCi/g = Picocurie(s) per gram.

RCRA = Resource Conservation and Recovery Act.

RFI = RCRA Facility Investigation.

S = Subsurface soil sample.

SWMU = Solid Waste Management Unit.

-- = Error not calculated for ND results.

Table 2.4.4-15
 Summary of SWMU 87 RFI Area B Soil Sampling Gamma Spectroscopy Analytical Results
 May 1996
 (On-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Gamma Spectroscopy Activity ^a (pCi/g)			Error ^d
					Uranium-238	Thorium-232	Thorium-232	
05121	87B-GR-001-0-SS	soil	05-13-96	0-0.5	ND (2.99E+00)	7.44E-01	--	3.74E-01
05121	87B-GR-002-0-SS	soil	05-13-96	0-0.5	ND (3.07E+00)	9.37E-01	--	7.81E-01
05121	87B-GR-003-0-SS	soil	05-13-96	0-0.5	ND (3.39E+00)	1.17E+00	--	5.41E-01
05121	87B-GR-004-0-SS	soil	05-13-96	0-0.5	ND (2.84E+00)	8.06E-01	--	3.81E-01
05122	87B-GR-005-0-SS	soil	05-13-96	0-0.5	ND (1.38E+00)	8.63E-01	--	4.12E-01
05121	87B-GR-006-0-SS	soil	05-13-96	0-0.5	ND (2.99E+00)	7.25E-01	--	4.17E-01
05121	87B-GR-007-0-SS	soil	05-13-96	0-0.5	ND (2.94E+00)	7.95E-01	--	4.08E-01
05121	87B-GR-008-0-SS	soil	05-13-96	0-0.5	ND (2.89E+00)	7.23E-01	--	3.85E-01
05121	87B-GR-009-0-SS	soil	05-13-96	0-0.5	ND (2.95E+00)	7.01E-01	--	3.88E-01
05122	87B-GR-010-0-SS	soil	05-13-96	0-0.5	ND (1.32E+00)	8.55E-01	--	3.96E-01
05121	87B-GR-011-0-SS	soil	05-13-96	0-0.5	ND (3.10E+00)	7.35E-01	--	3.49E-01
05121	87B-GR-012-0-SS	soil	05-13-96	0-0.5	ND (2.75E+00)	6.54E-01	--	3.16E-01
05121	87B-GR-013-0-SS	soil	05-13-96	0-0.5	ND (3.30E+00)	9.66E-01	--	5.96E-01
05121	87B-GR-014-0-SS	soil	05-13-96	0-0.5	ND (2.82E+00)	7.46E-01	--	3.54E-01
05122	87B-GR-015-0-SS	soil	05-13-96	0-0.5	ND (1.18E+00)	7.34E-01	--	3.47E-01
05121	87B-GR-016-0-SS	soil	05-13-96	0-0.5	ND (3.02E+00)	8.40E-01	--	3.95E-01
05121	87B-GR-017-0-SS	soil	05-13-96	0-0.5	7.83E+00	5.61E-01	2.39E+00	2.75E-01
05121	87B-GR-018-0-SS	soil	05-13-96	0-0.5	ND (2.94E+00)	7.49E-01	--	4.04E-01
Quality Assurance/Quality Control Samples (pCi/mL)								
05121	87B-GR-019-FB	water	05-13-96	NA	ND (1.74E+00)	ND (1.32E-01)	--	--
05121	87B-GR-019-EB	water	05-13-96	NA	ND (1.69E+00)	ND (1.24E-01)	--	--
Background Soil Activities—Lower Canyons Area ^e (pCi/g)		soil	NA	NA	2.31	1.03	NA	NA

Refer to footnotes at end of table.

Table 2.4.4-15 (Continued)
 Summary of SWMU 87 RFI Area B Soil Sampling Gamma Spectroscopy Analytical Results
 May 1996
 (On-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Gamma Spectroscopy Activity ^a (pCi/g)		Error ^d	Error ^d
					Uranium-235	Cesium-137		
05121	87B-GR-001-0-SS	soil	05-13-96	0-0.5	ND (2.03E-01)	ND (3.06E-02)	--	--
05121	87B-GR-002-0-SS	soil	05-13-96	0-0.5	ND (1.27E-01)	1.82E-01	--	2.37E-01
05121	87B-GR-003-0-SS	soil	05-13-96	0-0.5	ND (2.30E-01)	1.18E-01	--	3.28E-02
05121	87B-GR-004-0-SS	soil	05-13-96	0-0.5	ND (1.99E-01)	6.68E-02	--	6.45E-02
05122	87B-GR-005-0-SS	soil	05-13-96	0-0.5	ND (1.89E-01)	1.77E-02	--	1.43E-02
05121	87B-GR-006-0-SS	soil	05-13-96	0-0.5	ND (2.10E-01)	2.52E-02	--	1.63E-02
05121	87B-GR-007-0-SS	soil	05-13-96	0-0.5	ND (2.06E-01)	4.21E-02	--	2.35E-02
05121	87B-GR-008-0-SS	soil	05-13-96	0-0.5	ND (2.02E-01)	9.72E-02	--	2.60E-02
05121	87B-GR-009-0-SS	soil	05-13-96	0-0.5	ND (2.08E-01)	5.76E-02	--	1.91E-02
05122	87B-GR-010-0-SS	soil	05-13-96	0-0.5	ND (1.73E-01)	5.14E-02	--	2.93E-02
05121	87B-GR-011-0-SS	soil	05-13-96	0-0.5	ND (2.20E-01)	3.30E-02	--	2.68E-02
05121	87B-GR-012-0-SS	soil	05-13-96	0-0.5	ND (1.92E-01)	ND (2.88E-02)	--	--
05121	87B-GR-013-0-SS	soil	05-13-96	0-0.5	ND (2.28E-01)	ND (3.45E-02)	--	--
05121	87B-GR-014-0-SS	soil	05-13-96	0-0.5	ND (2.02E-01)	ND (2.91E-02)	--	--
05122	87B-GR-015-0-SS	soil	05-13-96	0-0.5	ND (1.64E-01)	ND (3.39E-02)	--	--
05121	87B-GR-016-0-SS	soil	05-13-96	0-0.5	ND (2.18E-01)	3.60E-01	--	3.24E-01
05121	87B-GR-017-0-SS	soil	05-13-96	0-0.5	2.25E-01	4.74E-02	1.38E-01	1.76E-02
05121	87B-GR-018-0-SS	soil	05-13-96	0-0.5	ND (2.03E-01)	2.13E-02	--	3.07E-02
Quality Assurance/Quality Control Samples (pCi/mL)								
05121	87B-GR-019-FB	water	05-13-96	NA	ND (1.51E-01)	ND (2.25E-02)	--	--
05121	87B-GR-019-EB	water	05-13-96	NA	ND (1.49E-01)	ND (2.29E-02)	--	--
Background Soil Activities—Lower Canyons Area ^e (pCi/g)				NA	0.16	1.55	NA	NA

Refer to footnotes at end of table.

Table 2.4.4-15 (Concluded)
 Summary of SWMU 87 RFI Area B Soil Sampling Gamma Spectroscopy Analytical Results
 May 1996
 (On-Site Laboratory)

Note: Values in **bold** exceed background activities, or have MDAs that exceed background activities.
^aUranium-238 and thorium-232 decay chain isotopes with a short half-life are not presented in this table.
^bAnalysis Request/Chain-of-Custody.
^cSample numbers are coded. For Sample ID 87B-GR-002-0-SS, 87B designates the sample was collected at SWMU 87 Area B, GR-002 indicates that the sample was collected from Sample Location No. 002, and SS designates a surface soil sample.
^dTwo standard deviations about the mean activity.

^eDinwiddie September 1997

87B = SWMU 87 Area B.

EB = Equipment blank.

ER = Environmental Restoration.

FB = Field blank.

ft = Foot (feet).

GR = Grab sample.

ID = Identification.

MDA = Minimum detectable activity.

NA = Not applicable.

ND () = Not detected above the MDA, shown in parentheses.

pCi/g = Picocurie(s) per gram.

pCi/mL = Picocurie(s) per milliliter.

RCRA = Resource Conservation and Recovery Act.

RFI = RCRA Facility Investigation.

SS = Surface soil sample.

SWMU = Solid Waste Management Unit.

.. = Error not calculated for ND results.

Table 2.4.4-16
 Summary of SWMU 87 RFI Soil Sampling Beneath Fragments at Area C Gamma Spectroscopy Analytical Results
 September 1996
 (On-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Gamma Spectroscopy Activity ^a (pCi/g)			Error ^d
					Uranium-238	Thorium-232		
05823	87SF-GR-001-0-SS	soil	09-16-96	0.1-1.0	6.80E+00	2.29E+00	7.77E-01	3.91E-01
05823	87SF-GR-002-0-SS	soil	09-16-96	0.1-1.0	1.36E+01	3.65E+00	7.51E-01	3.73E-01
05823	87SF-GR-003-0-SS	soil	09-16-96	0.1-1.0	4.33E+00	1.69E+00	9.29E-01	4.89E-01
05823	87SF-GR-004-0-SS	soil	09-16-96	0.1-1.0	1.30E+01	3.84E+00	7.16E-01	3.61E-01
05823	87SF-GR-005-0-SS	soil	09-16-96	0.1-1.0	1.39E+01	3.86E+00	8.32E-01	4.52E-01
05823	87SF-GR-006-0-SS	soil	09-16-96	0.1-1.0	3.35E+00	2.09E+00	9.16E-01	6.07E-01
05823	87SF-GR-007-0-SS	soil	09-16-96	0.1-1.0	3.00E+00	1.17E+00	7.20E-01	6.70E-01
05823	87SF-GR-008-0-SS	soil	09-16-96	0.1-1.0	ND (1.57E+00)	--	9.36E-01	4.70E-01
05823	87SF-GR-009-0-SS	soil	09-16-96	0.1-1.0	ND (1.23E+00)	--	8.79E-01	4.35E-01
05823	87SF-GR-010-0-SS	soil	09-16-96	0.1-1.0	ND (1.42E+00)	--	8.67E-01	4.45E-01
Background Soil Activities--Lower Canyons Area ^e (pCi/g)		soil	NA	NA	2.31	NA	1.03	NA

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Gamma Spectroscopy Activity ^a (pCi/g)			Error ^d
					Uranium-235	Cesium-137		
05823	87SF-GR-001-0-SS	soil	09-16-96	0.1-1.0	ND (2.34E-01)	ND (4.18E-02)	ND (4.18E-02)	--
05823	87SF-GR-002-0-SS	soil	09-16-96	0.1-1.0	ND (1.57E-01)	ND (2.63E-02)	ND (2.63E-02)	--
05823	87SF-GR-003-0-SS	soil	09-16-96	0.1-1.0	ND (1.98E-01)	ND (4.24E-02)	ND (4.24E-02)	--
05823	87SF-GR-004-0-SS	soil	09-16-96	0.1-1.0	1.50E-01	1.10E-01	ND (4.26E-02)	--
05823	87SF-GR-005-0-SS	soil	09-16-96	0.1-1.0	1.96E-01	1.21E-01	2.80E-02	5.03E-02
05823	87SF-GR-006-0-SS	soil	09-16-96	0.1-1.0	1.43E-01	1.75E-01	3.75E-02	6.18E-02
05823	87SF-GR-007-0-SS	soil	09-16-96	0.1-1.0	ND (1.95E-01)	ND (1.95E-01)	5.30E-02	4.49E-02
05823	87SF-GR-008-0-SS	soil	09-16-96	0.1-1.0	ND (1.04E-01)	ND (1.04E-01)	2.38E-01	6.80E-02
05823	87SF-GR-009-0-SS	soil	09-16-96	0.1-1.0	ND (2.29E-01)	ND (2.29E-01)	7.35E-01	1.35E-01
05823	87SF-GR-010-0-SS	soil	09-16-96	0.1-1.0	ND (1.90E-01)	ND (1.90E-01)	4.15E-01	6.91E-02
Background Soil Activities--Lower Canyons Area ^e (pCi/g)		soil	NA	NA	0.16	NA	1.55	NA

Refer to footnotes at end of table.

Table 2.4.4-16 (Concluded)
 Summary of SWMU 87 RFI Soil Sampling Beneath Fragments at Area C Gamma Spectroscopy Analytical Results
 September 1996
 (On-Site Laboratory)

Note: Values in bold exceed background activities, or have MDAs that exceed background activities.

^aUranium-238 and thorium-232 decay chain isotopes with a short half-life are not presented in this table.

^bAnalysis Request/Chain-of-Custody.

^cSample numbers are coded. For Sample ID 87SF-GR-002-0-SS, 87SF designates the sample was collected at SWMU 87 Area C, GR-002 indicates that the sample was collected from Sample Location No. 002, and SS designates a surface soil sample.

^dTwo standard deviations about the mean activity.

^eDinwiddie September 1997.

87SF = Soil sample beneath metal fragment at SWMU 87.

ER = Environmental Restoration.

ft = Foot (feet).

ID = Identification.

MDA = Minimum detectable activity.

NA = Not applicable.

ND () = Not detected above the MDA, shown in parentheses.

pCi/g = Picocurie(s) per gram.

RCRA = Resource Conservation and Recovery Act.

RFI = RCRA Facility Investigation.

SS = Surface soil sample.

SWMU = Solid Waste Management Unit.

.. = Error not calculated for ND results.

Table 2.4.4-17
 Summary of SWMU 87 RFI Arroyo Soil Sampling Gamma Spectroscopy Analytical Results
 December 1996
 (On-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Gamma Spectroscopy Activity ^a (pCi/g)			Error ^d
					Uranium-238	Thorium-232	Uranium-235	
06066	87ARY-GR-001-0-SS	soil	12-02-96	0-1.0	ND (3.91E+00)	8.24E-01	--	3.97E-01
06066	87ARY-GR-001-0-SSD	soil	12-02-96	0-1.0	ND (2.07E+00)	8.20E-01	--	3.89E-01
06066	87ARY-GR-002-0-SS	soil	12-02-96	0-1.0	ND (3.46E+00)	7.25E-01	--	3.88E-01
06066	87ARY-GR-003-0-SS	soil	12-02-96	0-1.0	ND (3.50E+00)	7.07E-01	--	3.46E-01
06066	87ARY-GR-004-0-SS	soil	12-02-96	0-1.0	2.37E+00	6.67E-01	1.93E+00	3.23E-01
06066	87ARY-GR-005-0-SS	soil	12-02-96	0-1.0	ND (3.51E+00)	8.15E-01	--	4.07E-01
06066	87ARY-GR-006-0-SS	soil	12-02-96	0-1.0	ND (2.45E+00)	3.41E-01	--	1.83E-01
Quality Assurance/Quality Control Samples (pCi/mL)								
06066	87ARY-GR-006-FB	water	12-02-96	NA	ND (4.94E-01)	ND (1.16E-01)	--	--
06066	87ARY-GR-006-EB	water	12-02-96	NA	ND (4.99E-01)	ND (1.24E-01)	--	--
Background Soil Activities—Lower								
Canyons Area ^e (pCi/g)					2.31	1.03	NA	NA

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Gamma Spectroscopy Activity ^a (pCi/g)			Error ^d
					Uranium-235	Cesium-137	Uranium-238	
06066	87ARY-GR-001-0-SS	soil	12-02-96	0-1.0	ND (2.66E-01)	3.85E-01	--	6.87E-02
06066	87ARY-GR-001-0-SSD	soil	12-02-96	0-1.0	ND (2.39E-01)	5.14E-01	--	9.26E-02
06066	87ARY-GR-002-0-SS	soil	12-02-96	0-1.0	ND (2.35E-01)	2.02E-01	--	2.96E-02
06066	87ARY-GR-003-0-SS	soil	12-02-96	0-1.0	ND (2.43E-01)	8.63E-02	--	2.70E-02
06066	87ARY-GR-004-0-SS	soil	12-02-96	0-1.0	8.68E-02	1.46E-02	8.65E-02	1.32E-02
06066	87ARY-GR-005-0-SS	soil	12-02-96	0-1.0	ND (2.37E-01)	ND (3.61E-02)	--	--
06066	87ARY-GR-006-0-SS	soil	12-02-96	0-1.0	ND (1.68E-01)	2.40E-02	--	2.26E-02
Quality Assurance/Quality Control Samples (pCi/mL)								
06066	87ARY-GR-006-FB	water	12-02-96	NA	ND (9.99E-02)	ND (2.36E-02)	--	--
06066	87ARY-GR-006-EB	water	12-02-96	NA	ND (9.77E-02)	ND (2.45E-02)	--	--
Background Soil Activities—Lower								
Canyons Area ^e (pCi/g)					0.16	1.55	NA	NA

Refer to footnotes at end of table.

Table 2.4.4-17 (Concluded)
 Summary of SWMU 87 RFI Arroyo Soil Sampling Gamma Spectroscopy Analytical Results
 December 1996
 (On-Site Laboratory)

Note: Values in **bold** exceed background activities, or have MDAs that exceed background activities.
 aUranium-238 and thorium-232 decay chain isotopes with a short half-life are not presented in this table.
 bAnalysis Request/Chain-of-Custody.
 cSample numbers are coded. For Sample ID 87ARY-GR-002-0-SS, 87ARY designates the sample was collected at the SWMU 87 Arroyo, GR-002 indicates that the sample was collected from Sample Location No. 002, and SS designates a surface soil sample.
 dTwo standard deviations about the mean activity.
 eDinwiddle September 1997
 87ARY = SWMU 87 Arroyo.
 EB = Equipment blank.
 ER = Environmental Restoration.
 FB = Field blank.
 ft = Foot (feet).
 GR = Grab sample.
 ID = Identification.
 MDA = Minimum detectable activity.
 NA = Not applicable.
 ND () = Not detected above the MDA, shown in parentheses.
 pCi/g = Picocurie(s) per gram.
 pCi/mL = Picocurie(s) per milliliter.
 RCRA = Resource Conservation and Recovery Act.
 RFI = RCRA Facility Investigation.
 SS = Surface soil sample.
 SSD = Soil sample duplicate.
 SWMU = Solid Waste Management Unit.
 .. = Error not calculated for ND results.

Table 2.4.4-18
 Summary of SWMU 87 RFI Perimeter Soil Sampling Gamma Spectroscopy Analytical Results
 May 1996
 (On-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Gamma Spectroscopy Activity ^a (pCi/g)			Error ^d	Error ^d
					Uranium-238	Thorium-232	Uranium-238		
05123	87Per-GR-001-0-SS	soil	05-14-96	0-0.5	ND (1.33E+00)	9.02E-01	--	4.16E-01	
05123	87Per-GR-002-0-SS	soil	05-14-96	0-0.5	ND (1.29E+00)	7.77E-01	--	3.66E-01	
05123	87Per-GR-003-0-SS	soil	05-14-96	0-0.5	ND (1.22E+00)	1.05E+00	--	4.82E-01	
05123	87Per-GR-004-0-SS	soil	05-14-96	0-0.5	ND (1.43E+00)	9.39E-01	--	4.41E-01	
05124	87Per-GR-005-0-SS	soil	05-14-96	0-0.5	ND (3.02E+00)	7.88E-01	--	4.00E-01	
05123	87Per-GR-006-0-SS	soil	05-14-96	0-0.5	ND (1.45E+00)	1.21E+00	--	5.53E-01	
05123	87Per-GR-007-0-SS	soil	05-14-96	0-0.5	ND (1.08E+00)	7.69E-01	--	3.70E-01	
05123	87Per-GR-008-0-SS	soil	05-14-96	0-0.5	ND (1.29E+00)	7.58E-01	--	3.58E-01	
05123	87Per-GR-009-0-SS	soil	05-14-96	0-0.5	ND (1.53E+00)	1.45E+00	--	6.89E-01	
05124	87Per-GR-010-0-SS	soil	05-14-96	0-0.5	ND (3.19E+00)	9.19E-01	--	6.30E-01	
05123	87Per-GR-011-0-SS	soil	05-14-96	0-0.5	ND (1.37E+00)	1.05E+00	--	4.86E-01	
05124	87Per-GR-012-0-SS	soil	05-14-96	0-0.5	ND (3.06E+00)	7.83E-01	--	3.74E-01	
Quality Assurance/Quality Control Samples (pCi/mL)									
05123	87Per-GR-012-FB	water	05-14-96	NA	ND (7.36E-01)	ND (1.50E-01)	--	--	
05123	87Per-GR-012-EB	water	05-14-96	NA	ND (7.11E-01)	ND (1.51E-01)	--	--	
Background Soil Activities—Lower Canyons Area ^e (pCi/g)					2.31	1.03	NA	NA	

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Gamma Spectroscopy Activity ^a (pCi/g)			Error ^d	Error ^d
					Uranium-235	Cesium-137	Uranium-235		
05123	87Per-GR-001-0-SS	soil	05-14-96	0-0.5	ND (1.86E-01)	4.53E-01	--	7.26E-02	
05123	87Per-GR-002-0-SS	soil	05-14-96	0-0.5	ND (1.83E-01)	4.13E-01	--	6.46E-02	
05123	87Per-GR-003-0-SS	soil	05-14-96	0-0.5	ND (1.74E-01)	2.24E-01	--	3.83E-02	
05123	87Per-GR-004-0-SS	soil	05-14-96	0-0.5	ND (2.00E-01)	3.82E-01	--	6.15E-02	
05124	87Per-GR-005-0-SS	soil	05-14-96	0-0.5	ND (2.09E-01)	4.15E-02	--	1.72E-02	
05123	87Per-GR-006-0-SS	soil	05-14-96	0-0.5	ND (2.02E-01)	5.22E-02	--	3.05E-02	
05123	87Per-GR-007-0-SS	soil	05-14-96	0-0.5	ND (1.57E-01)	9.15E-02	--	3.01E-02	
05123	87Per-GR-008-0-SS	soil	05-14-96	0-0.5	ND (1.86E-01)	4.99E-01	--	7.48E-02	
05123	87Per-GR-009-0-SS	soil	05-14-96	0-0.5	ND (2.12E-01)	2.31E-01	--	4.22E-02	
05124	87Per-GR-010-0-SS	soil	05-14-96	0-0.5	6.20E-02	3.94E-01	5.53E-02	6.49E-02	
05123	87Per-GR-011-0-SS	soil	05-14-96	0-0.5	ND (1.86E-01)	3.61E-01	--	5.74E-02	
05124	87Per-GR-012-0-SS	soil	05-14-96	0-0.5	9.27E-02	4.24E-01	1.65E-01	7.08E-02	
Quality Assurance/Quality Control Samples (pCi/mL)									
05123	87Per-GR-012-FB	water	05-14-96	NA	ND (1.23E-01)	ND (2.48E-02)	--	--	
05123	87Per-GR-012-EB	water	05-14-96	NA	ND (1.24E-01)	ND (2.74E-02)	--	--	
Background Soil Activities—Lower Canyons Area ^e (pCi/g)					0.16	1.55	NA	NA	

Refer to footnotes at end of table.

Table 2.4.4-18 (Concluded)
 Summary of SWMU 87 RFI Perimeter Soil Sampling Gamma Spectroscopy Analytical Results
 May 1996
 (On-Site Laboratory)

Note: Values in bold exceed background activities, or have MDAs that exceed background activities.

^aUranium-238 and thorium-232 decay chain isotopes with a short half-life are not presented in this table.

^bAnalysis Request/Chain-of-Custody.

^cSample numbers are coded. For Sample ID 87Per-GR-002-0-SS, 87 designates the sample was collected at SWMU 87 Perimeter, GR-002 indicates that the sample was collected from Sample Location No. 002, and SS designates a surface soil sample.

^dTwo standard deviations about the mean activity.

^eDinwiddie September 1997.

87Per = SWMU 87 Perimeter.

EB = Equipment blank.

ER = Environmental Restoration.

FB = Field blank.

ft = Foot (feet).

GR = Grab sample.

ID = Identification.

MDA = Minimum detectable activity.

NA = Not applicable.

ND () = Not detected above the MDA, shown in parentheses.

pCi/g = Picocurie(s) per gram.

pCi/mL = Picocurie(s) per milliliter.

RCRA = Resource Conservation and Recovery Act.

RFI = RCRA Facility Investigation.

SS = Surface soil sample.

SWMU = Solid Waste Management Unit.

.. = Error not calculated for ND results.

Table 2.4.4-19
 Summary of SWMU 87 RFI Area A Soil Sampling Tritium Analytical Results
 March 2000
 (On-Site Laboratory)

Record Number ^b	ER Sample ID ^c	Sample Matrix	Sample Date	Sample Depth (ft)	Tritium (Method 906.0 ^a) (pCi/L)	
					Tritium	Accuracy +/-
603211	87-GR-401-0.0-SS	soil	03-29-00	0-1.0	19.5	5.01
603211	87-GR-402-0.0-SS	soil	03-29-00	0-1.0	15.3	5.33
603211	87-GR-403-0.0-SS	soil	03-29-00	0-1.0	23.4	6.23
603211	87-GR-404-0.0-SS	soil	03-29-00	0-1.0	21	5.56
603211	87-GR-405-0.0-SS	soil	03-29-00	0-1.0	18.1	5.64
603211	87-GR-406-0.0-SS	soil	03-29-00	0-1.0	3.73	2.17

^aEPA November 1986.

^bAnalysis Request/Chain-of-Custody.

^cSample numbers are coded. For Sample ID 87-GR-401-0.0-SS, 87 designates the sample was collected at SWMU 87, GR-401 indicates that the sample was collected from Sample Location No. 401, and SS designates a surface soil sample.

87 = SWMU 87.

ER = Environmental Restoration.

EPA = U.S. Environmental Protection Agency.

ft = Foot (feet).

GR = Grab sample.

ID = Identification.

pCi/L = Picocurie(s) per liter.

RCRA = Resource Conservation and Recovery Act.

RFI = RCRA Facility Investigation.

SS = Surface soil sample.

SWMU = Solid Waste Management Unit.

One sample from Area C (87SF-GR-006-0-SS [Figure 2.4.4-6]) contained cadmium slightly above the background limit of 0.64 mg/kg. Except for the 1995 samples (which were all nondetections at a detection limit slightly above the background limit), all other samples were at or below the background limit for cadmium.

Two samples from Area A (87BH2-GR-008-9-S and 87BH4-GR-016-9-S [Figure 2.4.4-4]) and one sample from Area B (87B-GR-013-0-SS [Figure 2.4.4-5]) contained chromium slightly above the background limit of 18.8 mg/kg. All other samples were at or below the background limit for chromium.

Twenty-one samples from Area A (87A-GR-001-0-SS through 87A-GR-017-0-SS, 87A-GR-018-0-SSD, 87-GR-002-0-SS-02 through 87-GR-019-0-SS-02, 87-GR-005-0-SS-03 through 87-GR-020-0-SS-03 [Figure 2.4.4-2]), four samples from Area B (87B-GR-007-0-SS, 87B-GR-016-0-SS through 87B-GR-018-0-SS [Figure 2.4.4-5]), ten samples from Area C (87SF-GR-001-0-SS through 87SF-GR-007-0-SS, 87SF-GR-010-0-SS, 87SF-GR-004-0-SR, and 87SF-GR-001-0-SD [Figure 2.4.4-6]), two samples from the arroyo (87ARY-GR-002-0-SS and 87ARY-GR-004-0-SS [Figure 2.4.4-7]), and two samples from the perimeter of the site (87Per-GR-012-0-SS [1996] and 87Per-GR-012-SS[1997] [Figure 2.4.4-7]) contained copper above the background limit of 17.1 mg/kg. The elevated levels ranged from 19.3 to 2,040 mg/kg. No subsurface samples were collected for copper analysis.

Fourteen samples from Area A (87A-GR-001-0-SS, 87A-GR-012-0-SS, 87A-GR-013-0-SS, 87A-GR-017-0-SS, 87A-GR-018-0-SSD, 87-GR-006-0-SS-02, 87-GR-009-0-SS-02, 87-GR-011-0-SS-02, 87-GR-014-0-SS-02, 87-GR-005-0-SS-03, and 87-GR-020-0-SS-03 [Figure 2.4.4-2] and (87BH1-GR-001-0-S and 87BH1-GR-004-9-S [Figure 2.4.4-4]), six samples from Area B (87B-GR-005-0-SS, 87B-GR-009-0-SS, 87B-GR-011-0-SS, 87B-GR-016-0-SS through 87B-GR-018-0-SS [Figure 2.4.4-5]), thirteen samples from Area C (87SF-GR-001-0-SS through 87SF-GR-010-0-SS, 87SF-GR-001-0-SD, 87SF-GR-004-0-SR, and 87SF-GR-008-0-SR [Figure 2.4.4-6]), and two samples from the perimeter of the site (87Per-GR-006-0-SS and 87Per-GR-012-0-SS [Figure 2.4.4-7]) contained lead above the background limit, with levels ranging from 19 to 320 mg/kg. The background limit for lead is 18.9 mg/kg.

Three samples from Area A (87-GR-006-0-SS-02 through 87-GR-009-0-SS-02 [Figure 2.4.4-2] and one sample from Area C (87SF-GR-004-0-SR [Figure 2.4.4-6]) contained mercury at levels ranging from 0.06 J to 0.243 mg/kg. Except for the 1995 and 1996 samples (which were all nondetections at a detection limit slightly above the background limit), all other samples were at or below the background limit of 0.055 mg/kg for mercury.

Three samples from the Area C (87SF0GR-006-0-SS, 87SF-GR-007-0-SS, and 87SF-GR-010-0-SS [Figure 2.4.4-6]) contained nickel at levels ranging from 45 to 59 mg/kg, compared to the background limit of 16.6 mg/kg. All other samples were at or below the background limit for nickel.

Two samples from Area A (87A-GR-001-0-SS [Figure 2.4.4-2] and 87BH3-GR-010-3-S [Figure 2.4.4-4]) and three samples from Area C (87SF-GR-002-0-SS, 87SF-GR-003-0-SS, and 87SF-GR-009-0-SS [Figure 2.4.4-6]) contained silver above the background limit of 0.5 mg/kg, with levels ranging from 1.11 to 8 mg/kg. Except for the 1995 samples (which were all nondetections at a detection limit slightly above the background limit), all other samples were at or below the background limit for silver.

Three samples from Area C (87SF-GR-006-0-SS, 87SF-GR-003-7-SS, and 87SF-GR-010-0-SS [Figure 2.4.4-6]) and four samples from Area B (87B-GR-007-0-SS through 87B-GR-009-0-SS and 87B-GR-021-0-SSD [Figure 2.4.4-5]) contained zinc above the background limit 52.1 mg/kg. The elevated levels ranged from 54.1 to 331 mg/kg. No subsurface samples were collected for zinc analysis.

HE

Soil samples collected from Area A, Area B, and the arroyo were analyzed for HE. The sample locations are exactly the same locations where samples were collected for metals analysis.

Table 2.4.4-11 summarizes the HE analysis results for the soil samples collected from Area A. One sample from Area A (S87A0GR-104-0-SS [Figure 2.4.4-2]) contained o-nitrotoluene at a concentration of 120 µg/kg. Two samples from Area A (S87A-GR-107-0-SS and S87A-GR-110-0-SS [Figure 2.4.4-2]) contained cyclotetramethylene tetranitramine (HMX) at 110 to 200 µg/kg, respectively. Four samples from Area A (S87A-GR-108-0-SS, S87A-GR-116-0-SS, S87A-GR-119-0-SS, and S87A-GR-120-0-SS [Figure 2.4.4-2]) contained m-dinitrotoluene at concentrations ranging from 110 to 140 µg/kg.

No HE compounds were detected in any of the soil samples collected from Area B or the arroyo. Table 2.4.4-12 summarizes the MDLs used for analyzing HE compounds by the off-site laboratory.

Radionuclides

Eighty-six soil samples collected from Area A, Area B, Area C, the arroyo, and the perimeter of the site were analyzed for radionuclides by gamma spectroscopy. In addition, eight samples from Area A were collected and analyzed for isotopic uranium. The sample locations are exactly the same locations where samples were collected for metals analysis.

Tables 2.4.4-13 through 2.4.4-18 summarize the on-site gamma spectroscopy analysis results for the RFI soil samples collected at SWMU 87. Sixty-five samples contained uranium-238 activities above the background limit of 2.31 picocuries (pCi)/gram (g). The highest activity was 35.7 pCi/g.

Seven samples contained thorium-232 activities above the background limit of 1.03 pCi/g. The highest activity was 1.45 pCi/g. The lithologic deposits in the vicinity of SWMU 87 have previously been shown to contain higher naturally occurring thorium activities (e.g., at SWMU 82 [SNL/NM September 2000], which is situated approximately 0.7 miles southeast of SWMU 87).

Eighty samples contained uranium-235 activities slightly above the background limit of 0.16 pCi/g, with the highest activity at 0.730 pCi/g. All cesium-137 activities were below the background limit of 1.55 pCi/g.

Annex 2-B provides a listing of the MDAs used for the gamma spectroscopy analyses.

Tritium

As recommended by the NMED, six soil samples were collected from Area A and analyzed for tritium. Table 2.4.4-19 summarizes the off-site analytical results for the RFI soil samples collected at Area A. All tritium activities were within background levels.

2.4.4.4 Exploratory Trenching in Fill Area and Mound

Exploratory trenching was conducted at SWMU 87 in May 1999 under a supplemental SAP (Annex 2-A). The purpose of the trenching was to characterize the fill area and mound situated east of the SWMU 87 building structures. These features were characterized by excavating trenches through each feature, as shown in Figure 2.4.4-8.

Four trenches were excavated through the fill area, and two trenches were excavated through the center of the mound. Each of the trenches was excavated to the bottom of fill material and the open surface of native material. All excavated soils were field-screened for organic vapors and radioactivity.

The mound consisted of soil that contained a few sand bags. The fill area consisted of soil and two soda cans, one plastic bag, one metal fragment, and one piece of wire. In accordance with the SAP, because no contamination was observed based upon field screening and no stained soil was observed, no soil sampling was required.

2.4.4.4.1 Mound/Trench Inspection

After trenching activities, the fill area and mound were inspected. No sampling or further characterization were required.

2.4.4.4.2 Site Restoration

After completing excavation activities, each trench was backfilled and restored to the original grade.

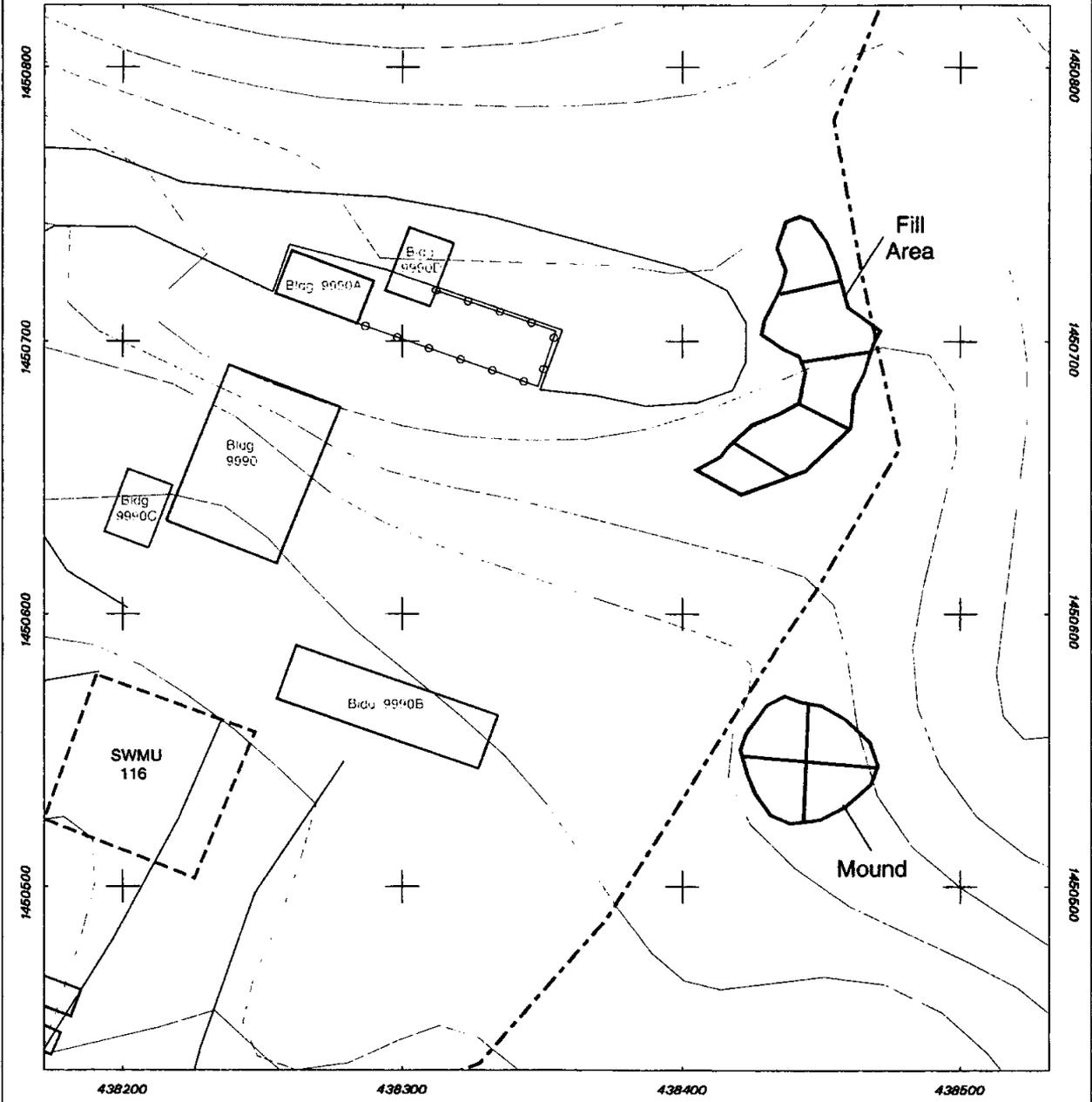
2.4.4.4.3 Conclusion

The field investigation provided the necessary information to confirm that the fill area and mound consist of clean fill, and that these features should be proposed for NFA designation as part of SWMU 87.

2.4.4.5 Data Gaps

Analytical data from RFI sampling were sufficient to determine the nature and extent of possible contamination at SWMU 87.

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Legend

-  Road
-  Fence
-  5 Foot Contour
-  Surface Drainage
-  Mound / Fill Area
-  Trench Location
-  Building / Structure

Figure 2.4.4-8
Fill Area and Mound Locations
Solid Waste Management Unit 87

0 20 80
 Scale in Feet

0 7.2 14.4
 Scale in Meters



Sandia National Laboratories, New Mexico
 Environmental Geographic Information System

2.4.5 Investigation #4—SNL/NM ER VCM/VCA and Housekeeping Activities

2.4.5.1 *Nonsampling Data Collection*

No nonsampling data collection activities were associated with Investigation #4 of SWMU 87.

2.4.5.2 *VCM/VCA Activities at SWMU 87*

The objectives of the two VCMs and one VCA conducted at SWMU 87 included:

- Removing the majority of surface depleted uranium from the site, rendering it suitable for future recreational use
- Determining whether erosion was causing additional depleted uranium to be exposed at the ground surface and, if so, removing the depleted uranium from the site

The VCMs were conducted in 1994 (Phase I VCM) and 1995 (Phase II VCM); the VCA was performed in 1998.

2.4.5.2.1 *VCM Activities*

From May 1994 through December 1995, RUST Geotech Inc. conducted two VCMs at SWMU 87 that consisted of surface gamma radiation surveys and associated remediation activities (RUST Geotech Inc. December 1994, SNL/NM September 1997). These activities are identified as Phase I and Phase II VCMs and were conducted using hand-held instruments, shovels, and rakes.

Phase I VCM

From February through May 1994, the Phase I VCM was performed encompassing a total of 44.6 acres. The gamma scan survey was performed at 10-foot centers (providing 70-percent coverage) over the surface of the site and identified 1,241 point sources and 6 area sources of gamma activity 30 percent or greater than the natural background activity (SNL/NM September 1997).

Based upon this survey, VCA activities were conducted from November 1994 through January 1995. All the point and area sources detected were removed from the site.

Phase II VCM

During the Phase II VCM, which began in March 1995, the original site boundaries were resurveyed on 6-foot centers (100-percent coverage). Then, from July 1995 through December 1995, survey boundaries were expanded on the north, east, south, and west sides of the site, and an additional 11.9 acres were surveyed on 6-foot centers (100-percent coverage). During

the Phase II resurveying (scanning) of the original site (44.6 acres) and the expanded area (11.9 acres), more than 5,000 new point sources were identified.

Because of the large number of new point and area sources, each source was immediately remediated as it was identified, and no locations were land surveyed. As in the Phase I VCM, all the point and area sources found were removed from the site. Figure 2.4.5-1 shows expanded surface radiation survey boundaries and VCM confirmatory sampling locations (post-cleanup).

During the Phase II VCM, cleanup was not performed on new sources in the graded area north of Building 9990 (Area A). The graded area contained depleted uranium ground into the soil surface from road maintenance, and it is suspected that depleted uranium fragments may be present several feet below the graded surface.

Post-Cleanup (Confirmatory) Sampling

After removal of the depleted uranium and radioactively contaminated soil, 534 post-cleanup confirmatory samples were collected from point and area sources. Figure 2.4.5-1 shows the confirmatory sampling locations (post-cleanup). Samples from point sources were collected in the immediate vicinity of the source (fragment) as well as at one in every ten locations to provide confirmation that cleanup was achieved. At area sources, samples were collected from areas exhibiting the highest residual gamma radiation measurements.

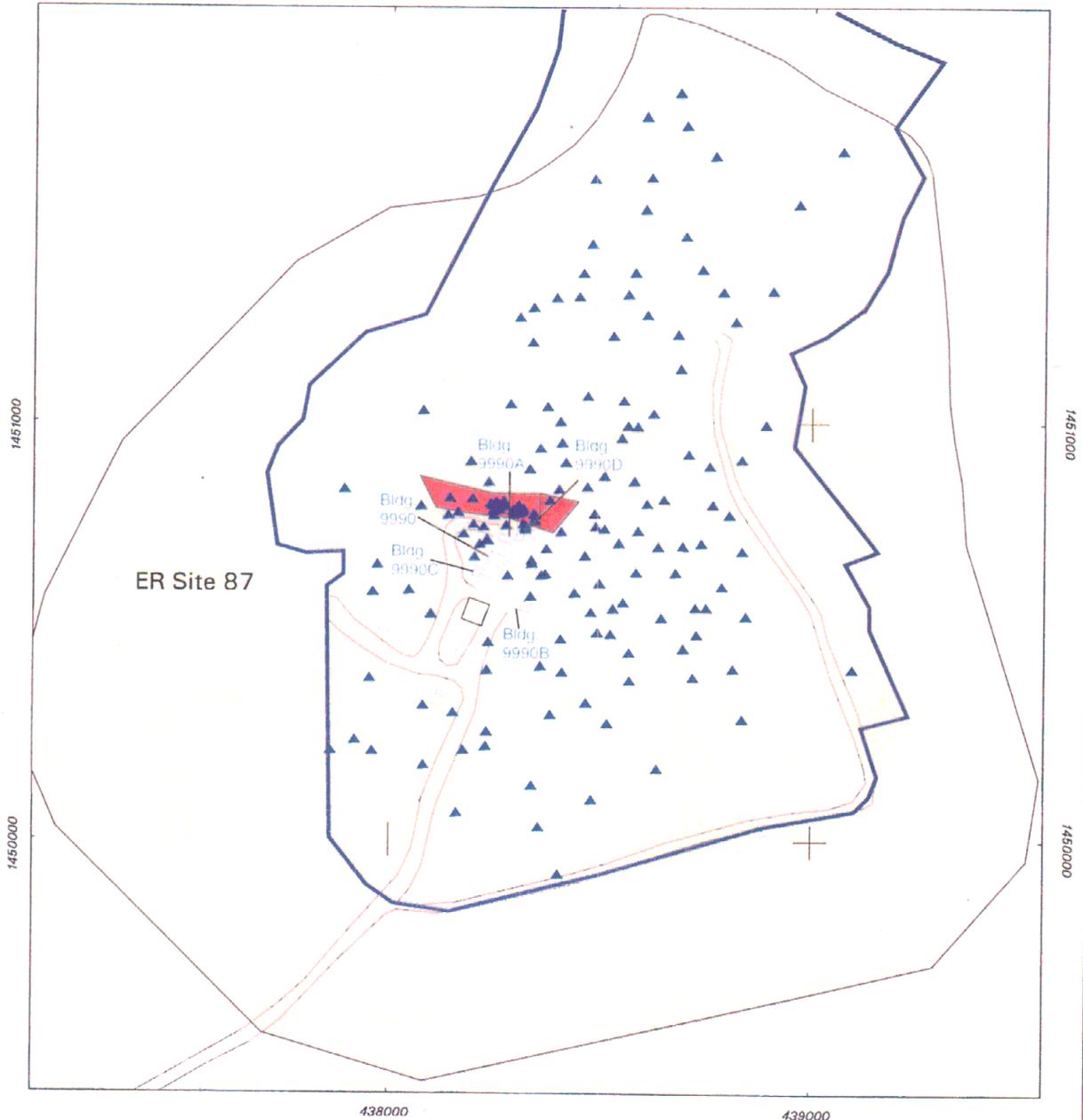
Waste Management

The cleanup activities produced contaminated metal fragments and soil. All waste was containerized in drums. The metal fragment and soil samples were analyzed for radionuclides (by gamma spectroscopy) and Toxicity Characteristic Leaching Procedure (TCLP) metals. The results indicated that the metal fragments and soil did not exhibit RCRA hazardous waste characteristics, and could be disposed of as low-level radioactive waste. The gamma spectroscopy results are provided in Annex 2-B.

2.4.5.2.2 VCA Activities

A VCA was performed at SWMU 87 during August and September 1998 and took place north of Building 9990, along the arroyo (Mignardot September 1998). The purpose of this VCA was to perform a surface radiation survey to determine whether erosion was causing additional depleted uranium to be exposed at the ground surface and, if so, to remove the depleted uranium identified and associated soil from the site. The survey was conducted on 6-foot centers (100-percent coverage), and more than 700 new point sources were identified. Figure 2.4.5-2 depicts the extent of the surface radiation survey and the approximate location of the point sources identified.

The survey was conducted using hand-held instruments, and the depleted uranium and contaminated soil were removed using shovels and rakes. All new point and area sources were remediated during this cleanup activity.



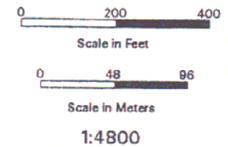
ER Site 87

Legend

-  Post-cleanup (Confirmatory) Soil Sample Location
-  Road
-  Building
-  Rad Survey Boundaries

-  SWMU 87 Firing Site
-  Area Source Gamma Radiation Anomaly (Elevated relative to site specific background)

Figure 2.4.5-1
Voluntary Correction Measure Surface Radiation
Survey Boundary and Soil Sampling Locations
at SWMU 87, 1994-1995



Sandia National Laboratories, New Mexico
Environmental Geographic Information System



Legend

-  Point Source Radiation Anomaly
-  Road
-  10 Foot Contour
-  Fence
-  Surface Drainage
-  Radiation Survey Boundary
-  Building / Structure
-  SWMU 87

Figure 2.4.5-2
Voluntary Corrective Action Surface
Radiation Survey Boundary, 1998

1:2400

0 200 400

Scale in Feet

0 40 80

Scale in Meters



Waste Management

The cleanup activities generated contaminated metal fragments and soil, which were containerized in drums and analyzed for radionuclides (by gamma spectroscopy) and TCLP metals. The results indicated that the metal fragments and soil did not exhibit RCRA hazardous waste characteristics and could be disposed of as low-level radioactive waste. The maximum values from the waste samples, used in the risk screening assessment presented in Annex 2-C, indicated that the area did not pose a significant risk to human health or the environment. The gamma spectroscopy results are provided in Annex 2-B.

2.4.5.3 Housekeeping Activities at SWMU 87

The housekeeping activities at SWMU 87, performed to remove nonradioactive metal fragments and construction debris from the site, were conducted during April and May 2000 and in March 2003. The first operation in 2000 focused on the entire site and areas beyond the site boundaries, excluding the Cultural Resources area. The second cleanup operation in March 2003 addressed the Cultural Resources area.

2.4.5.3.1 Housekeeping Activities Conducted During April and May 2000

The housekeeping activities conducted at SWMU 87 during April and May 2000 involved the removal of nonradioactive metal fragments and general construction debris throughout the entire site and beyond the site boundaries, with the exception of the Cultural Resources area. Figure 2.4.5-3 shows the approximate extent of the housekeeping activities. The Cultural Resources area, which was cleaned up in March 2003, is discussed in Section 2.4.5.3.2.

Materials Removed

The metal fragments removed from SWMU 87 consisted of various types of shrapnel and metals, including lead, cadmium, aluminum alloy and ferromagnetic metals, as well as other unidentified metals. These fragments were many different shapes and sizes and generally less than 10 inches in size. The metal fragments were scattered throughout the site up to the surrounding ridgelines.

The construction debris removed consisted of wood, wire, bricks, Styrofoam, rubber, metal, glass, cable, piping, asphalt, cans, concrete, plastic, and cardboard. Additionally, a very small amount of deteriorated batteries and electrical components were removed. The debris was largely scattered in the lower elevations along the main arroyo near Building 9990 and along the main access road. Individual pieces of debris ranged in size from several inches to several feet in diameter.

Removal Approach

Removal activities were conducted throughout the entire site of SWMU 87, with the exception of the Cultural Resources area. A walk-through survey was performed over the site, during which the larger metal fragments and construction debris identified were removed. In areas with dense surface vegetation and trees, coverage for the walk-through survey was on 10-foot

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traverse spacings. In other areas with lesser vegetation and trees, walk-through coverage was on 12- to 15-foot traverse spacings.

The metal fragments and debris were removed manually using shovels and rakes. Larger debris was loaded by a front-end loader. Prior to handling, all of the fragments and debris were field-screened to determine the presence or absence of radioactivity. If radioactive contamination was found, the metal or debris was not handled or removed.

Once field-screened, the metal fragment or debris was transported to a staging area and placed into individual piles depending upon the waste type (e.g., construction debris, aluminum alloys, lead, cadmium, etc.). An all-terrain vehicle (ATV), front-end loader, or truck was used to move the metal or debris to the staging area. After waste removal activities were completed, each waste pile was surveyed to verify the absence of radioactive contamination.

Waste Management

Table 2.4.5-1 provides a summary of nonradioactive materials removed from SWMU 87 during the housekeeping conducted in April and May 2000. All of these materials were screened for radiation prior to removal off site, and were found to be free of any radioactive contamination.

Table 2.4.5-1
Summary of Nonradioactive Materials Removed from
SWMU 87 During Housekeeping Activities
April–May 2000

Material Removed	Approximate Weight of Material
Construction debris	30 cubic yards
Lead fragments	1,000 pounds
Ferromagnetic metal fragments	2,000 pounds
Alloy metal fragments	3,000 pounds
Cadmium metal fragments	1 pound
Batteries and electrical components	20 pounds

SWMU = Solid Waste Management Unit.

2.4.5.3.2 *Housekeeping Activities Conducted in March 2003*

The housekeeping activities conducted at SWMU 87 in March 2003 were performed to remove nonradioactive metal fragments and construction debris from the Cultural Resources area. Figure 2.4.5-3 shows the approximate extent of the housekeeping activities.

Materials Removed

The metal fragments removed from within the Cultural Resources area consisted of various types of shrapnel and other metals, including lead, copper, aluminum alloy, and ferromagnetic metals. In addition, one metal shelf/cabinet was found and removed. The metal fragments, which were scattered throughout the area, consisted of different shapes and sizes, most of which were less than 10 inches in size.

The construction debris removed consisted of wood, wire, Styrofoam, metal, glass, cable, pipe, asphalt, cans, plastic, pressboard, and one plastic dish/receiver. Additionally, one UXO component was found and removed. The debris was scattered throughout the area and ranged in size from several inches to several feet in diameter.

Removal Approach

Removal activities were conducted throughout the entire Cultural Resources area, and approximately 50 feet beyond the boundary. A walk-through survey was performed over the site, and the metal fragments and construction debris identified were removed. In areas with dense surface vegetation and trees, the walk-through survey covered 10-foot traverse spacings. In areas with lesser vegetation and trees, the walk-through survey covered 12- to 15-foot traverse spacings.

The metals and debris were removed by hand. Larger pieces were loaded onto a small trailer attached to an ATV. Prior to handling, all of the metals and debris were field-screened to determine the presence or absence of radioactivity. If radioactive contamination was found, the metal or debris was not handled or removed.

Once field-screened, the metal fragment or debris was transported to a staging area and placed into individual piles depending upon the waste type (e.g., construction debris, aluminum alloys, lead, copper, etc.). An ATV was used to move the metal or debris to the staging area. After waste removal activities were completed, each waste pile was surveyed to verify the absence of radioactive contamination.

Waste Management

Table 2.4.5-2 provides a summary of nonradioactive materials removed from the Cultural Resources area during the housekeeping activities conducted in March 2003. All of these materials were screened for radiation prior to removal off site and were found to be free of radioactive contamination.

Table 2.4.5-2
Summary of Nonradioactive Materials Removed from the
Cultural Resources Area at SWMU 87 During Housekeeping Activities
March 2003

Material Removed	Approximate Weight of Material
Construction debris	0.25 cubic yards
Lead fragments	50 pounds
Ferromagnetic metal fragments	100 pounds
Aluminum alloy metal fragments	300 pounds
Copper metal fragments	200 pounds

SWMU = Solid Waste Management Unit.

Pit Features

During the housekeeping activities conducted at or near the Cultural Resources area in March 2003, several pit features were re-inspected. The ER project personnel assumed that these

features were related to former mining activities, but an archeologist that assisted in the housekeeping activities determined that the features are probably related to Sandia operations. Therefore, the pit features were investigated under the ER project in April 2003. The approach and results of this investigation are presented in Annex 2-F.

2.4.6 Data Quality

This section discusses the results of the quality assurance (QA)/quality control (QC) field samples, collected as part of both the RFI and confirmatory sampling, as well as data validation of the laboratory analytical results.

QA/QC Results

Tables 2.4.4-5 through 2.4.4-18 present the results of analyses of the QA/QC samples that were collected during the RFI at SWMU 87. The QA/QC field samples, collected as part of the 1995, 1996, 1997, 1998, and 2001 sampling events, included eleven equipment blanks (EBs), six field blanks (FBs) (metals only), and seven duplicate samples.

The EBs were collected to ensure contamination was not transferred from one sample to another via unclean sampling equipment. The EBs were analyzed off site for metals and HE. Metals concentrations in the EBs were slightly greater than the detection limits for barium, cadmium, chromium, copper, mercury, lead, and zinc. The concentrations of barium, cadmium, chromium, copper, mercury, lead, and zinc were below the practical quantitation limit, and were qualified as J (estimated value). No HE compounds were detected in the EBs. No QA/QC samples were collected for radionuclide analyses.

The FBs were collected to ensure contamination was not transferred from the surrounding area to a sample container. The FBs were analyzed off site for metals. Reported concentrations were slightly greater than the detection limits for barium, beryllium, chromium, copper, mercury, silver, and zinc. The concentrations of barium, beryllium, chromium, copper, mercury, silver, and zinc were below the practical quantitation limit, and were qualified as J (estimated value). No QA/QC samples were collected for radionuclide analyses.

To assess the precision of soil sampling procedures, soil samples were collected and analyzed in duplicate off site. Relative percent differences (RPDs) were calculated in the seven primary and duplicate samples analyzed for metals. The RPDs are presented in Tables 2.4.6-1 through 2.4.6-5. Four of the seven sample pairs exceeded the acceptable RPD limit of 25 percent for arsenic, lead, and nickel. Three of the seven sample pairs exceeded the RPD limit for chromium, copper, and mercury. Two of the seven sample pairs exceeded the RPD limit for zinc. One of the seven sample pairs exceeded the RPD limit for beryllium, cadmium, selenium, and silver. Although the RPDs presented in Tables 2.4.6-1 through 2.4.6-5 exceed the RPD limit, these values are typical of the heterogeneous soil and are, therefore, acceptable. The samples were not homogenized thoroughly in the field, which could explain the large RPD seen for some of the metals.

Duplicate samples for analysis of radionuclides were collected only from Area A and the arroyo. Of the four radionuclides examined, only cesium-137 exceeded the acceptable RPD limit of 25 percent in one sample pair (see Table 2.4.6-4). Although the RPD for cesium-137 exceeds the RPD limit, this value is typical of the heterogeneous soil and is, therefore, acceptable.

Table 2.4.6-1
Summary of SWMU 87 Area A Field Duplicate RPD
August 1995, October 1997, and October 2001
(Off-Site and On-Site Laboratories)

Sample Attributes			Metals RPD											
Record Number ^a	ER Sample ID ^b	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
04124	87-GR-020-0-SS-03 87-GR-020-0-SS-03 (duplicate)	0-1.0	0	8.48	NC	NC	9.9	1.9	105	NC	23.5	NC	NC	0
510038	87A-GR-001-0-SS 87A-GR-018-0-SSD (duplicate)	0-1.0	6.42	3.95	4.61	0.67	39.42	156.53	16.72	40.74	37.86	44.73	103.59	26.23
605073	87-BH2-GR-007-6-S 87-BH2-GR-021-6-S (duplicate)	6.0-7.5	93.97	12.73	14.8	10.73	28.88	NA	50.88	28.94	41.23	NC	NC	NA

Sample Attributes			Radionuclides ^c RPD			
Record Number ^a	ER Sample ID ^b	Sample Depth (ft)	Uranium-238	Thorium-232	Uranium-235	Cesium-137
04122	87-GR-020-0-SS-04	0-1.0	NC	19.2	NC	NC
04125	87-GR-020-0-SS-01 (duplicate)					

^aAnalysis Request/Chain-of-Custody.

^bSample numbers are coded. For sample ID 87-GR-020-0-SS-03, 87 designates the sample was collected at SWMU 87, GR-020 indicates the sample was collected at Sample Location No. 020, and SS designates a surface soil sample.

^cUranium-238 and thorium-232 decay chain isotopes with a short half-life are not presented in this table.

87 or 87A = SWMU 87.

ER = Environmental Restoration.

ft = Foot (feet).

GR = Grab sample.

ID = Identification.

NA = Not analyzed.

NC = Not calculated for nondetected results or laboratory estimated values.

RPD = Relative percent difference.

S = Subsurface soil sample.

SS = Surface soil sample.

SSD = Soil sample duplicate.

SWMU = Solid Waste Management Unit.

Table 2.4.6-2
 Summary of SWMU 87 Area B Field Duplicate RPD
 October 1997
 (Off-Site Laboratory)

Sample Attributes			Metals RPD											
Record Number ^a	ER Sample ID ^b	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
06297	87B-GR-001-0-SS 87B-GR-021-0-SSD (duplicate)	0-1.0	75.25	19.29	54.55	104.96	78.91	8.07	45.45	NC	46.77	NC	NC	159.07

^aAnalysis Request/Chain-of-Custody.

^bSample numbers are coded. For sample ID 87B-GR-001-0-SS, 87B designates the sample was collected at SWMU 87 Area B, GR-001 indicates the sample was collected at Sample Location No. 001, and SS designates a surface soil sample.

87B = SWMU 87 Area B.

ER = Environmental Restoration.

ft = Foot (feet).

GR = Grab sample.

ID = Identification.

NC = Not calculated for nondetected results or laboratory estimated values.

RPD = Relative percent difference.

SS = Surface soil sample.

SSD = Soil sample duplicate.

SWMU = Solid Waste Management Unit.

**Table 2.4.6-3
Summary of SWMU 87 Area C Field Duplicate RPD
September 1996
(On-Site and Off-Site Laboratories)**

Sample Attributes			Metals RPD											
Record Number ^a	ER Sample ID ^b	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
05824	87SF-GR-001-0-SS	0-1.0	108.15	2.47	18.37	NC	12.08	109.15	5.57	NC	49.67	NC	NC	21.73
05825	87SF-GR-001-0-SD (duplicate)													

^aAnalysis Request/Chain-of-Custody.

^bSample numbers are coded. For sample ID 87SF-GR-001-0-SS, 87SF designates the sample was collected at SWMU 87 beneath a metal fragment, GR-001 indicates the sample was collected at Sample Location No. 001, and SS designates a surface soil sample.

87SF = Soil sample beneath metal fragment at SWMU 87.

ER = Environmental Restoration.

ft = Foot (feet).

GR = Grab sample.

ID = Identification.

NC = Not calculated for nondetected results or laboratory estimated values.

RPD = Relative percent difference.

SD = Soil sample duplicate.

SS = Surface soil sample.

SWMU = Solid Waste Management Unit.

Table 2.4.6-4
 Summary of SWMU 87 Arroyo Field Duplicate RPD
 December 1996
 (Off-Site and On-Site Laboratories)

Sample Attributes			Metals RPD											
Record Number ^a	ER Sample ID ^b	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
8012	87ARY-GR-001-0-SS 87ARY-GR-001-0-SSD (duplicate)	0-1.0	3.15	7.3	2.54	4.05	3.26	12.14	11.45	NC	11.07	NC	NC	1.28

Sample Attributes			Radionuclides ^c RPD			
Record Number ^a	ER Sample ID ^b	Sample Depth (ft)	Uranium-238	Thorium-232	Uranium-235	Cesium-137
06066	87ARY-GR-001-0-SS 87ARY-GR-001-0-SSD (duplicate)	0-1.0	NC	0.49	NC	28.69

^aAnalysis Request/Chain-of-Custody.

^bSample numbers are coded. For sample ID 87ARY-GR-001-0-SS, 87ARY designates the sample was collected at the SWMU 87 Arroyo, GR-001 indicates the sample was collected at Sample Location No. 001, and SS designates a surface soil sample.

^cUranium-238 and thorium-232 decay chain isotopes with short half lives are not presented in this table.

87ARY = SWMU 87 Arroyo.

ER = Environmental Restoration.

ft = Foot (feet).

GR = Grab sample.

ID = Identification.

NC = Not calculated for nondetected results or laboratory estimated values.

SS = Surface soil sample.

SSD = Soil sample duplicate.

SWMU = Solid Waste Management Unit.

Table 2.4.6-5
 Summary of SWMU 87 Perimeter Field Duplicate RPD
 May 1996 and October 1997
 (Off-Site Laboratory)

Sample Attributes			Metals RPD											
Record Number ^a	ER Sample ID ^b	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
05125 510037	87Per-GR-012-0-SS 87Per-GR-012-0-SS (duplicate)	0-1.0	26.78	3.77	10.43	9.46	13.58	38.46	67.26	29.03	1.21	NC	NC	20.19

^aAnalysis Request/Chain-of-Custody.

^bSample numbers are coded. For sample ID 87Per-GR-012-0-SS, 87Per designates the sample was collected at SWMU 87 Perimeter, GR-012 indicates that the sample was collected from Sample Location No. 002, and SS designates a surface soil sample.

87Per = SWMU 87 Perimeter.

ER = Environmental Restoration.

ft = Foot (feet).

GR = Grab sample.

ID = Identification.

NC = Not calculated for nondetected results or laboratory estimated values.

RPD = Relative percent difference.

SS = Surface soil sample.

SWMU = Solid Waste Management Unit.

Data Validation

All off-site laboratory results were reviewed and verified/validated according to "Data Validation Procedure for Chemical and Radiochemical Data" SNL/NM ER Project Analytical Operating Procedure 00-03, Rev. 0 (SNL/NM January 2000). In addition, the SNL/NM RPSD Laboratory reviewed all gamma spectroscopy results according to "Laboratory Data Review Guidelines," Procedure No. RPSD-02-11, Issue No. 02 (SNL/NM July 1996). Annex 2-D contains the data validation reports for the off-site laboratory results. The verification/validation process confirmed that the data are acceptable for use in this NFA proposal for SWMU 87.

During data validation, qualifications were applied to some of the data. For Analysis Request/Chain-of-Custody (AR/COC) 004124, 06298, and 510037, QC measures were adequate. No sample results were qualified.

For AR/COC 05125, validation qualifications were applied to metals data for soil and aqueous sample results. Mercury and barium were detected in the method blank for the EB and FB and were qualified as "estimated" in associated samples. No other sample results were qualified.

For AR/COC 05306, validation qualifications were applied to metals data. Barium was detected in the method blank for a metal fragment sample and was qualified as "estimated." No other sample results were qualified.

For AR/COC 05825, validation qualifications were applied to metals data for soil and aqueous sample results. Chromium was detected in the method blank for the EBs and FBs and was qualified as "estimated" in associated samples. Silver was detected in the method blank for soil samples and was qualified as "estimated." No other sample results were qualified.

For AR/COC 06012, validation qualifications were applied to metals data for soil and aqueous sample results. Silver was detected in the method blank for the FB and soil samples and was qualified as "estimated." No other sample results were qualified.

For AR/COC 510038, validation qualifications were applied to metals data. Zinc was detected in the method blank for the EBs and FBs and was qualified as "estimated" in associated samples. No other sample results were qualified.

For AR/COC 600822, validation qualifications were applied to HE data for aqueous sample results. The laboratory control sample (LCS)/laboratory control sample duplicate (LCSD) percent recoveries were outside the QC limits, and nitrobenzene, Dinitrotoluene, and 2-nitrotoluene were qualified as "nondetect estimated." The LCSD RPD was high for tetryl, and was qualified as "nondetect estimated."

For AR/COC 600824, validation qualifications were applied to HE data for soil and aqueous sample results. The LCS/LCSD percent recoveries were outside the QC limits, and 2-nitrotoluene and tetryl were qualified as "nondetect estimated." No other sample results were qualified.

2.5 Site Conceptual Model

The site conceptual model for SWMU 87 is based upon the site history, hydrogeologic setting, and residual COCs identified in the soil samples collected from the site. This section summarizes the nature and extent of contamination and the environmental fate of COCs.

2.5.1 Nature and Extent of Contamination

The RFI/VCN verified that no contamination above acceptable risk-based concentrations had been released to the surrounding soil. The primary COCs at SWMU 87 are metals and radionuclides from previous testing at the former firing site. A minor estimated detection of three explosives was seen in several samples. Arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, zinc, and uranium were detected above background. Gamma activities were detected above background in some samples. Metal and radionuclide COCs were determined by comparing sample results to background concentrations and to activities established for the Lower Canyons Area (Dinwiddie September 1997, Garcia November 1998, and Tharp February 1999). Any metal or radionuclide found to exceed background in any sample is considered a potential COC for the site.

The list of metal COCs for SWMU 87 was derived by including each metal that was identified above background in one or more soil samples collected. These metals include arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, and uranium. The radionuclide COCs are uranium-238, uranium-235 and thorium-232. The HE COCs include o-nitrotoluene, HMX, and m-dinitrotoluene. The COCs that exceed background limits occurred throughout the sampling areas suggesting that, for radionuclides, some of the elevated uranium and thorium activities can be attributed to the bedrock, which contains naturally elevated uranium and thorium activities. The concentrations are slightly above background and do not represent a significant source of contamination, but may represent a remnant of the former operations in this area. Table 2.5.2-1 lists the COCs and the sample locations where they were detected.

For radionuclides, the MDA is used for comparison to background. Gamma activity attributable to uranium-238, uranium-235 and thorium-232 was detected above background in some samples. Because the MDA associated with nondetectable results for uranium-238 and uranium-235 analyses, respectively, was above background in some instances (see Tables 2.4.4-13 through 2.4.4-18), nondetection sample results are also considered in identifying potential COCs. Fifty-eight of the samples exhibited activity above background for uranium-238. Thorium-232 was reported above the background activity in seven samples, and uranium-235 was reported above the background activity in sixty-eight samples. All elevated activities are believed to be either naturally occurring at SWMU 87 due to the natural characteristics of the rock and soil in the area or remnants of the former operations at SWMU 87 (RUST Geotech Inc. December 1994, SNL/NM September 1997).

2.5.2 Environmental Fate

The primary source of COCs at SWMU 87 was from the testing operations conducted at the former firing site. The primary release mechanism of COCs to the surface soil was direct contact of the firing test debris with the native soil and rock (Figure 2.5.2-1). Because

Table 2.5.2-1
Summary of COCs for SWMU 87

COC Type	Number of Samples	COCs Detected	Maximum Background Limit/Canyon Supergroup ^a (mg/kg except where noted)	Maximum Concentration or Activity ^b (mg/kg except where noted)	Average Concentration or Activity ^c (mg/kg except where noted)	Sampling Locations Where Background Concentration or Activity is Exceeded ^d
Metals	90 environmental, 7 duplicate	Arsenic	9.8	50 ND	5.76	87-GR-002-0-SS-02 87-GR-006-0-SS-02 87-GR-007-0-SS-02 87-GR-008-0-SS-02 87-GR-009-0-SS-02 87-GR-011-0-SS-02 87-GR-014-0-SS-02 87-GR-016-0-SS-02 87-GR-018-0-SS-02 87-GR-019-0-SS-02
		Barium Beryllium	246 0.75	270 3.4 ND	111.31 0.62	87SF-GR-006-0-SS 87-GR-002-0-SS-02 87-GR-005-0-SS-03 87-GR-006-0-SS-02 87-GR-007-0-SS-02 87-GR-008-0-SS-02 87-GR-009-0-SS-02 87-GR-010-0-SS-03 87-GR-011-0-SS-02 87-GR-014-0-SS-02 87-GR-015-0-SS-03 87-GR-016-0-SS-02 87-GR-018-0-SS-02 87-GR-019-0-SS-02 87-GR-020-0-SS-03 87B-GR-013-0-SS 87B-GR-014-0-SS 87B-GR-015-0-SS

Refer to footnotes at end of table.

Table 2.5.2-1 (Continued)
Summary of COCs for SWMU 87

COC Type	Number of Samples	COCs Detected	Maximum Background Limit/Canyons Supergroup ^a (mg/kg except where noted)	Maximum Concentration or Activity ^b (mg/kg except where noted)	Average Concentration or Activity ^c (mg/kg except where noted)	Sampling Locations Where Background Concentration or Activity is Exceeded ^d
Metals (continued)	90 environmental, 7 duplicate	Cadmium	0.64	10 ND	0.79	87-GR-002-0-SS-02 87-GR-005-0-SS-03 87-GR-006-0-SS-02 87-GR-007-0-SS-02 87-GR-008-0-SS-02 87-GR-009-0-SS-02 87-GR-010-0-SS-03 87-GR-011-0-SS-02 87-GR-014-0-SS-02 87-GR-015-0-SS-03 87-GR-016-0-SS-02 87-GR-018-0-SS-02 87-GR-019-0-SS-02 87-GR-020-0-SS-03 87SF-GR-006-0-SS
		Chromium	18.8	60.1	8.63	87BH2-GR-008-9-S 87BH4-GR-016-9-S 87B-GR-013-0-SS

Refer to footnotes at end of table.

Table 2.5.2-1 (Continued)
Summary of COCs for SWMU 87

COC Type	Number of Samples	COCs Detected	Maximum Background Limit/Canyons Supergroup ^a (mg/kg except where noted)	Maximum Concentration or Activity ^b (mg/kg except where noted)	Average Concentration or Activity ^c (mg/kg except where noted)	Sampling Locations Where Background Concentration or Activity is Exceeded ^d
Metals (continued)	90 environmental, 7 duplicate	Copper	17.1	2,040	92.98	87A-GR-001-0-SS 87-GR-002-0-SS-02 87A-GR-003-0-SS 87A-GR-004-0-SS 87-GR-005-0-SS-03 87-GR-006-0-SS-02 87-GR-007-0-SS-02 87-GR-008-0-SS-02 87-GR-009-0-SS-02 87-GR-010-0-SS-03 87-GR-011-0-SS-02 87A-GR-012-0-SS 87A-GR-013-0-SS 87-GR-014-0-SS-02 87-GR-015-0-SS-03 87-GR-016-0-SS-02 87A-GR-017-0-SS 87-GR-018-0-SS-02 87A-GR-018-0-SSD 87-GR-019-0-SS-02 87-GR-020-0-SS-03 87B-GR-007-0-SS 87B-GR-016-0-SS 87B-GR-017-0-SS 87B-GR-018-0-SS 87SF-GR-001-0-SD 87SF-GR-001-0-SS 87SF-GR-002-0-SS 87SF-GR-003-0-SS 87SF-GR-004-0-SR 87SF-GR-004-0-SS 87SF-GR-005-0-SS 87SF-GR-006-0-SS 87SF-GR-007-0-SS 87SF-GR-010-0-SS 87ARY-GR-002-0-SS 87ARY-GR-004-0-SS 87Per-GR-012-0-SS

Refer to footnotes at end of table.

Table 2.5.2-1 (Continued)
Summary of COCs for SWMU 87

COC Type	Number of Samples	COCs Detected	Maximum Background Limit/Canyons Supergroup ^a (mg/kg except where noted)	Maximum Concentration or Activity ^b (mg/kg except where noted)	Average Concentration or Activity ^c (mg/kg except where noted)	Sampling Locations Where Background Concentration or Activity is Exceeded ^d
Metals (continued)	90 environmental, 7 duplicate	Lead	18.9	320	27.09	87A-GR-001-0-SS 87-GR-005-0-SS-03 87-GR-006-0-SS-02 87-GR-009-0-SS-02 87-GR-011-0-SS-02 87A-GR-012-0-SS 87A-GR-013-0-SS 87-GR-014-0-SS-02 87A-GR-017-0-SS 87A-GR-018-0-SSD 87-GR-020-0-SS-03 87BH1-GR-001-0-S 87BH1-GR-004-9-S 87B-GR-005-0-SS 87B-GR-009-0-SS 87B-GR-011-0-SS 87B-GR-016-0-SS 87B-GR-017-0-SS 87B-GR-018-0-SS 87SF-GR-001-0-SD 87SF-GR-001-0-SS 87SF-GR-002-0-SS 87SF-GR-003-0-SS 87SF-GR-004-0-SR 87SF-GR-004-0-SS 87SF-GR-005-0-SS 87SF-GR-006-0-SS 87SF-GR-007-0-SS 87SF-GR-008-0-SR 87SF-GR-008-0-SS 87SF-GR-009-0-SS 87SF-GR-010-0-SS 87Per-GR-006-0-SS 87Per-GR-012-0-SS

Refer to footnotes at end of table.

Table 2.5.2-1 (Continued)
Summary of COCs for SWMU 87

COC Type Metals (continued)	Number of Samples 90 environmental, 7 duplicate	COCs Detected Mercury	Maximum Background Limit/Canyons Supergroups (mg/kg except where noted)	Maximum Concentration or Activity ^b (mg/kg except where noted)	Average Concentration or Activity ^c (mg/kg except where noted)	Sampling Locations Where Background Concentration or Activity is Exceeded ^d
			0.055	0.243	0.027	87-GR-002-0-SS-02 87-GR-005-0-SS-03 87-GR-006-0-SS-02 87-GR-007-0-SS-02 87-GR-008-0-SS-02 87-GR-009-0-SS-02 87-GR-010-0-SS-03 87-GR-011-0-SS-02 87-GR-014-0-SS-02 87-GR-015-0-SS-03 87-GR-016-0-SS-02 87-GR-018-0-SS-02 87-GR-019-0-SS-02 87-GR-020-0-SS-03 87SF-GR-004-0-SR 87SF-GR-006-0-SS 87SF-GR-007-0-SS 87SF-GR-010-0-SS
		Nickel	16.6	59	9.39	87-GR-002-0-SS-02 87-GR-006-0-SS-02 87-GR-007-0-SS-02 87-GR-008-0-SS-02 87-GR-009-0-SS-02 87-GR-011-0-SS-02 87-GR-014-0-SS-02 87-GR-016-0-SS-02 87-GR-018-0-SS-02 87-GR-019-0-SS-02
		Selenium	2.7	50 ND	2.769	87-GR-002-0-SS-02 87-GR-006-0-SS-02 87-GR-007-0-SS-02 87-GR-008-0-SS-02 87-GR-009-0-SS-02 87-GR-011-0-SS-02 87-GR-014-0-SS-02 87-GR-016-0-SS-02 87-GR-018-0-SS-02 87-GR-019-0-SS-02

Refer to footnotes at end of table.

Table 2.5.2-1 (Continued)
Summary of COCs for SWMU 87

COC Type	Number of Samples	COCs Detected	Maximum Background Limit/Canyons Supergroup ^a (mg/kg except where noted)	Maximum Concentration or Activity ^b (mg/kg except where noted)	Average Concentration or Activity ^c (mg/kg except where noted)	Sampling Locations Where Background Concentration or Activity is Exceeded ^d
Metals (continued)	90 environmental, 7 duplicate	Silver	<0.5	10 ND	0.819	87A-GR-001-0-SS 87-GR-002-0-SS-02 87-GR-005-0-SS-03 87-GR-006-0-SS-02 87-GR-007-0-SS-02 87-GR-008-0-SS-02 87-GR-009-0-SS-02 87-GR-010-0-SS-03 87-GR-011-0-SS-02 87-GR-014-0-SS-02 87-GR-015-0-SS-03 87-GR-016-0-SS-02 87-GR-018-0-SS-02 87-GR-019-0-SS-02 87-GR-020-0-SS-03 87BH3-GR-010-3-S 87SF-GR-002-0-SS 87SF-GR-003-0-SS 87SF-GR-009-0-SS
		Zinc	52.1	331	41.37	87B-GR-007-0-SS 87B-GR-008-0-SS 87B-GR-009-0-SS 87B-GR-021-0-SSD 87SF-GR-006-0-SS 87SF-GR-007-0-SS 87SF-GR-010-0-SS

Refer to footnotes at end of table.

Table 2.5.2-1 (Continued)
Summary of COCs for SWMU 87

COC Type	Number of Samples 46 environmental, 3 duplicate	COCs Detected	Maximum Background Limit/Canyons Supergroup ^a (mg/kg except where noted)	Maximum or Concentration or Activity ^b (mg/kg except where noted)	Average Concentration or Activity ^c (mg/kg except where noted)	Sampling Locations Where Background Concentration or Activity is Exceeded ^d
HE		o-Nitrotoluene	NA	120	Not Calculated	S87A-GR-104-0-SS
		HMX	NA	200	Not Calculated	S87A-GR-107-0-SS S87A-GR-110-0-SS
		m-Dinitrobenzene Uranium-235 ^e	NA	140	Not calculated	S87A-GR-108-0-SS S87A-GR-116-0-SS S87A-GR-119-0-SS S87A-GR-120-0-SS
Radionuclides	86 environmental, 2 duplicate		0.16 pCi/g	0.730 pCi/g	Not Calculated ^f	S87-GR-002-0-SS-01 87-GR-003-0-SS-01 87-GR-006-0-SS-01 87-GR-007-0-SS-01 87-BH1-GR-002-3-S 87-BH1-GR-004-9-S 87-BH2-GR-005-0-S 87-BH5-GR-018-3-S 87-BH5-GR-019-6-S 87B-GR-017-0-SS 87SF-GR-005-0-SS (plus 57 samples where MDA exceeds background)

Refer to footnotes at end of table.

Table 2.5.2-1 (Continued)
Summary of COCs for SWMU 87

COC Type Radionuclides (continued)	Number of Samples 86 environmental, 2 duplicate	COCs Detected Uranium-238 ^e	Maximum Background Limit/Canyons Supergroup ^a (mg/kg except where noted)	Maximum Concentration or Activity ^b (mg/kg except where noted)	Average Concentration or Activity ^c (mg/kg except where noted)	Sampling Locations Where Background Concentration or Activity is Exceeded ^d
			2.31 pCi/g	35.7 pCi/g	Not Calculated ^f	87-GR-001-0-SS-01 87-GR-002-0-SS-01 87-GR-003-0-SS-01 87-GR-005-0-SS-01 87-GR-006-0-SS-01 87-GR-007-0-SS-01 87-GR-009-0-SS-01 87-GR-011-0-SS-01 87-GR-019-0-SS-01 87-GR-020-0-SS-01 87-BH1-GR-003-6-S 87-BH1-GR-004-9-S 87-BH2-GR-005-0-S 87-BH5-GR-017-0-S 87-BH5-GR-018-3-S 87-BH5-GR-019-6-S 87-BH5-GR-020-9-S 87B-GR-017-0-SS 87SF-GR-001-0-SS 87SF-GR-002-0-SS 87SF-GR-003-0-SS 87SF-GR-004-0-SS 87SF-GR-005-0-SS 87SF-GR-006-0-SS 87SF-GR-007-0-SS 87ARY-GR-004-0-SS (32 samples where MDA exceeds background)
		Thorium-232 ^e	1.03 pCi/g	1.45 pCi/g	Not Calculated ^f	87-BH2-GR-007-6-S 87-BH2-GR-008-9-S 87B-GR-003-0-SS 87Per-GR-003-0-SS 87Per-GR-006-0-SS 87Per-GR-009-0-SS 87Per-GR-011-0-SS
		Cesium-137 ^e	1.55 pCi/g	0.735 pCi/g	Not Calculated ^f	None

Refer to footnotes at end of table.

**Table 2.5.2-1 (Concluded)
Summary of COCs for SWMU 87**

Note: Canyons Supergroup, Lower Canyons subset is used for cesium-137, while uranium-235, uranium-238, and thorium-232 had no subset within the Canyons Supergroup. ^aDinwiddie (September 1997) for radionuclides and Garcia (November 1998) for metals.

^bFor arsenic, beryllium, cadmium, selenium, and silver, the MDL was the highest value and was used as the maximum concentration.

^cAverage concentration or activity includes all samples and duplicate samples. For nondetection results, half the MDL or MDA is used in the average calculation.

^dIncludes samples with nondetection results where the MDL or MDA exceeds the approved background limit.

^eResults from waste sampling are not presented in this table since these do not reflect the activity levels for radionuclides that remain at the site. However, the results from the waste sampling are incorporated into the radionuclide calculations in the risk screening assessment (Annex 2-C), because these are considered the most conservative activities identified at the site.

^fAn average MDA is not calculated because of the variability in instrument counting error and the large number of reported nondetectable activities.

87 = SWMU 87.

87A = SWMU 87 Area A.

87ARY = SWMU 87 Arroyo.

87B = SWMU 87 Area B.

87Per = SWMU 87 Perimeter.

87SF = Soil sample beneath metal fragment at SWMU 87.

ARY = ARY

B =

BH = Borehole.

COC = Constituent of concern.

GR = Grab sample.

HE = High explosive(s).

HMX = Cyclotetramethylene tetranitramine.

MDA = Minimum detectable activity.

MDL = Minimum detection limit.

mg/kg = Milligram(s) per kilogram.

NA = Not applicable.

ND = Not detected.

ND () = Not detected at or above the MDL or MDA, shown in parentheses.

pCi/g = Picocurie(s) per gram.

Per = Perimeter.

S = Subsurface soil sample.

SD = Surface fragment sample.

SS = Surface soil sample.

SSD = Soil sample duplicate.

SWMU = Solid Waste Management Unit.

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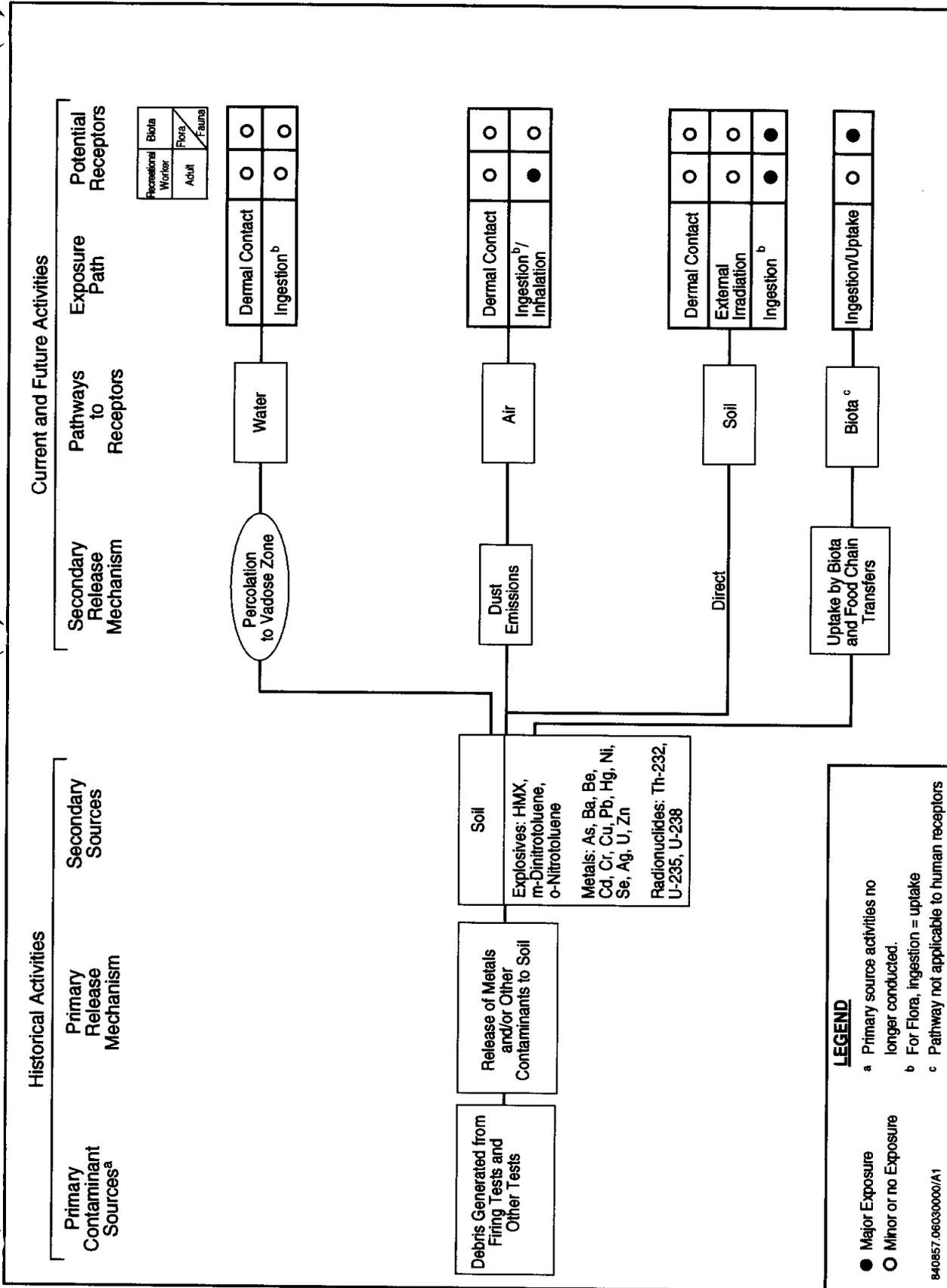


Figure 2.5.2-1
 Conceptual Model Flow Diagram for SWMU 87,
 Building 9990 (Firing Site)

SWMU 87 lies within a box canyon, during intense rainfall events, it is possible for surface runoff to erode the site. Therefore, erosion could be considered a release mechanism for COCs at the site.

Table 2.5.2-1 summarizes potential COCs for SWMU 87. Based upon the nature and extent of contamination at the site, metals, HE, and radionuclide COCs occur sporadically in surface soil at various locations within the site boundary. No distinct horizontal distribution of contamination is present. The depth to groundwater is approximately 232 feet bgs. High partitioning coefficients and low mobility of the COCs in soil media indicate that the COCs will not migrate, but will instead tend to stay fixed in the surface soil. Therefore, groundwater is not considered a viable contaminant pathway. All potential COCs were retained in the conceptual model and were evaluated in the human health and ecological risk screening assessments.

The current and future land use for SWMU 87 is recreational (DOE et al. October 1995). Therefore, the potential human receptor is considered a recreational user of the site. For all applicable pathways, the exposure routes for the recreational user are dermal contact and ingestion/inhalation. Only ingestion of soil is considered a major exposure route for the recreational user. Potential biota receptors include flora and fauna at the site. Similar to the recreational user, direct ingestion of soil is considered the major exposure route for biota, in addition to ingestion through food chain transfers or direct uptake. Annex 2-C, Section V, provides additional discussion of the exposure routes and receptors at SWMU 87.

2.6 Site Assessments

Site assessments at SWMU 87 include risk screening assessments followed by risk baseline assessments (as required) for both human health and ecological risk. The following sections summarize the site assessment results. Annex 2-C provides details of the site assessment.

2.6.1 Summary

The site assessment concludes that SWMU 87 has no significant potential to affect human health under a recreational land use scenario. After considering the uncertainties associated with the available data and modeling assumptions, ecological risks associated with SWMU 87 were found to be very low. Section 2.6.2 summarizes the site risk screening assessments, which are provided in Annex 2-C.

2.6.2 Screening Assessments

Risk screening assessments were performed for both human health and ecological risk for SWMU 87. This section briefly summarizes the risk screening assessments.

2.6.2.1 Human Health

SWMU 87 has been recommended for recreational land use (DOE et al. October 1995). Annex 2-C provides a complete discussion of the risk assessment process, results, and uncertainties. Because COCs are present in concentrations or activities greater than

background levels, it was necessary to perform a health risk assessment analysis for the site. Generally, COCs that were evaluated in this risk assessment included all detected organics and all inorganic and radiological COCs for which samples were analyzed. For conservatism, the highest activities from waste samples collected during the VCA conducted in 1998 were used in the risk assessment to provide a worst-case scenario for radiological COCs. The risk assessment process provides a quantitative evaluation of the potential adverse human health effects caused by constituents in the site's soil by calculating the hazard index (HI) and excess cancer risk for a recreational land use setting. The excess cancer risk from nonradiological COCs and radiological COCs is not additive (EPA 1989).

In summary, the HI for a recreational land use setting calculated for SWMU 87 nonradiological COCs is 0.07, which is less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). Incremental HI risk, determined by subtracting risk associated with background from potential nonradiological COC risk, is 0.07. Calculated excess cancer risk for SWMU 87 nonradiological COCs is $2\text{E-}6$. NMED guidance states that cumulative excess lifetime cancer risk must be less than $1\text{E-}5$ (NMED March 2000); thus, the excess cancer risk for this site is below the suggested acceptable risk value. Calculated incremental excess cancer risk is $1.41\text{E-}6$.

The incremental total effective dose equivalent for radionuclides for a recreational land use setting for SWMU 87 is 2.2 millirem (mrem)/year (yr), which is well below the recommended dose limit of 15 mrem/yr found in EPA's Office of Solid Waste and Emergency Response Directive No. 9200.4-18 (EPA 1997a) and reflected in a document entitled, "Sandia National Laboratories/New Mexico Environmental Restoration Project—RESRAD Input Parameter Assumptions and Justification" (SNL/NM February 1998). The incremental excess cancer risk for the recreational land use scenario for the radionuclide COCs is $2.9\text{E-}5$, which is much lower than risk values calculated from naturally occurring radiation and from intakes considered as background concentration values.

The residential land use scenarios for this site are provided only for comparison in the Risk Screening Assessment Report (Annex 2-C). The report concludes that SWMU 87 does not have potential to affect human health under a recreational land use scenario.

2.6.2.2 Ecological

An ecological screening assessment that corresponds with the screening procedures (NMED March 1998) in the EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997b) was performed as set forth by the NMED Risk-Based Decision Tree. An early step in the evaluation compared COC concentrations and identified potentially bioaccumulative constituents (see Annex 2-C, Sections III, VI, VII.2, and VII.3). This methodology also required developing a site conceptual model and a food web model as well as selecting ecological receptors. Each of these items was presented in the "Predictive Ecological Risk Assessment Methodology for SNL/NM ER Program, Sandia National Laboratories/New Mexico" (IT July 1998) and will not be duplicated here. The risk screening also includes the estimation of exposure and ecological risk.

Tables 17, 18, 19, and 20 of Annex 2-C present the results of the ecological risk screening assessment. Site-specific information was incorporated into the screening assessment when such data were available. Hazard quotients (HQs) greater than 1 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 estimating risk), the use of wildlife toxicity benchmarks based upon no-observed-adverse-effect levels, the incorporation of strict herbivorous and strict insectivorous diets for predicting the extreme HQ values for the deer mouse, and background risk. Based upon an evaluation of these uncertainties, ecological risks associated with this site are expected to be very low.

2.6.3 Baseline Risk Assessments

This section discusses the baseline risk assessments for human health and ecological risk.

2.6.3.1 Human Health

Because human health results of the screening assessment summarized in Section 2.6.2.1 indicate that SWMU 87 does not have potential to affect human health under a recreational land use setting, a baseline human health risk assessment is not required for SWMU 87.

2.6.3.2 Ecological

Because ecological results of the screening assessment summarized in Section 2.6.2.2 indicate that SWMU 87 poses very low ecological risk, a baseline ecological risk assessment is not required for SWMU 87.

2.6.4 Other Applicable Assessments

A surface-water site assessment was conducted at SWMU 87 in September 1998 (Annex 2-E) according to guidance developed jointly by Los Alamos National Laboratory and the NMED Surface-Water Quality Bureau. The assessment evaluated the potential for erosion from SWMU 87. SWMU 87 received a score of 84.3, indicating that it has relatively high erosion potential primarily due to the lack of vegetative or rock cover. The COCs detected at the site were at scattered locations (Table 2.5.2-1), indicating that surface runoff is not causing contaminant migration at SWMU 87. Additionally, as discussed in the Results and Conclusions from Investigatory Activities (Section 2.4.4.2.1) and Screening Assessments (Section 2.6.2) sections, COCs detected are not at levels that pose a threat to human health or the environment or that could adversely affect surface-water quality.

2.7 No Further Action Proposal

2.7.1 Rationale

Based upon field investigation data and the human health risk assessment analysis, an NFA decision is recommended for SWMU 87 because no COCs (metals, HE or radionuclides) were present in concentrations considered hazardous to human health for a recreational land use scenario.

2.7.2 Criterion

Based upon the evidence provided above, SWMU 87 is proposed for an NFA decision in conformance with Criterion 5 (NMED March 1998), which states, "[t]he SWMU/AOC has been characterized or remediated in accordance with current 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 2-C
Risk Screening Assessment

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SWMU 87: RISK SCREENING ASSESSMENT REPORT

I. Site Description and History

Solid Waste Management Unit (SWMU) 87, the firing site located at the former Electro-Explosives Research Facility (Building 9990), is located on U.S. Air Force (USAF) land withdrawn from the U.S. Forest Service (USFS) and permitted to the U.S. Department of Energy (DOE). The site is located off of Demolition Road approximately 1.3 miles due east of the intersection with Coyote Springs Road, and approximately 2.7 miles due east of the intersection of Coyote Springs and Lovelace Road. The site covers 97.44 acres in a box canyon that opens to the southwest. Ground elevation at the site ranges from 6,070 to 6,490 feet above mean sea level. The outer boundary of the site was defined based upon unexploded ordnance/high explosives (UXO/HE) surveys, surface gamma radiation scanning surveys, and voluntary corrective measure (VCM)/housekeeping activities.

A gravel road that branches off Demolition Road to the northeast provides access to the SWMU 87 site. Within the box canyon area, another gravel road that serves primarily as a fire barrier or fire line branches off the access road and forms a loop around the Building 9990 area. The northern portion of the site encompasses the former Electro-Explosives Research Facility, with the outdoor firing site located at the north end. The facility consists of the main concrete structure (Building 9990) and 11 associated concrete, transportainer, igloo, and metal ancillary structures.

The main building (Building 9990) is a concrete structure that was used as a control, instrumentation, and shop facility. The firing site, where detonations and tests occurred, is located on the immediate north side of Building 9990. The north-facing wall of Building 9990 is reinforced with steel plating and contains protected camera ports for filming the outdoor experiments. The surrounding canyon area and ridge slopes are littered with pieces of shrapnel.

An arroyo trends southwest across the site. Steep slopes form a U-shaped ridge that surrounds Building 9990. In the central part of the canyon where Building 9990 is located, the terrain is relatively flat, sloping gently to the southwest. Bedrock (granitic and metamorphic rocks of Precambrian age) is exposed at the surface in the surrounding ridges. A thin veneer of regolith (broken/eroded rock fragments and sand-sized material with little or no true soil) and alluvial sediment partially cover some of the ridge slopes and much of the canyon bottom near the central arroyo. This material is probably less than 1 foot thick in most areas. Vegetation in the area is spotty and primarily comprised of juniper, sagebrush, desert grasses, and cedar scrub.

Two pre-engineered metal buildings (Buildings 9990A and 9990B) used to house electromagnetic launchers for propulsion experiments were erected in late 1986. Building 9990A is situated north of Building 9990, and Building 9990B is east of Building 9990. Several smaller building structures and concrete pads are also present in the area, primarily at the northeast end of the canyon. Building 9990D was a portable test assembly building that was located north of Building 9990 before it was removed from the site in June 1994. All other building structures were used for storage.

Sandia National Laboratories/New Mexico (SNL/NM) Organization 1221, the testing group that operated the facility, has moved out of Building 9990. By July 1994, all equipment and associated materials had been removed, and the facility is currently inactive. Radiation Protection Operations (SNL/NM Organization 7714) personnel participated in the closeout activities, performing radiation release surveys on equipment and materials that were removed.

Originally constructed in 1968, the Electro-Explosives Research Facility was active from 1969 to May of 1994. Various types of outdoor tests were conducted at Building 9990:

- Explosive generator tests
- Electromagnetic launcher tests
- Contained (W45 mock warhead) tests
- Neutron generator proof tests
- Stand Off tests
- Davis Gun tests
- Box tests
- Flyer Plate tests
- Simulated lightning experiments

All of the explosive tests were conducted in the firing site area immediately north of Building 9990. No large explosive tests have been conducted at the firing site since 1986. Some of the tests dispersed shrapnel over distances greater than 1,200 feet based upon the surface radiation survey results, VCM/housekeeping activities, and visual inspections of the area. Although some shrapnel may have been propelled farther, the steep topography of the area has largely contained the distribution of fragments and/or shrapnel.

The primary purpose of the Electro-Explosives Research Facility was to conduct explosive generator and electromagnetic launcher research. The explosive generator tests involved producing large electrical currents (mega amps [amperes]) from explosions. Explosives were used to build large, short-lived electrical charges by collapsing coils with an induced electrical current. The resulting electrical current could theoretically be used to drive rail guns (launchers), lasers, or simulate electromagnetic pulses from thermonuclear devices. These tests constituted the bulk of the "hundreds of tests" performed at Building 9990 and involved high explosives but no radioactive materials. The tests did generate significant amounts of metal debris, primarily aluminum, copper, and steel (shrapnel) when various components, instruments, and fixtures were blown up during the tests. Based upon recent visual inspections and housekeeping activities at the site, the debris was scattered throughout a 500-foot radius as a result of the explosions.

Approximately 30 electromagnetic launcher tests were also conducted at the site, which involved moving projectiles using an electromagnetic force. During these tests, projectiles were accelerated up to 1 kilometer/second. However, these tests did not involve radioactive materials or generate metal shrapnel/fragments. Most projectiles were fired into some type of containment feature, such as a catch box, although up to ten of the tests were not contained and some of the projectiles were not recovered.

In addition to explosive generator and electromagnetic launcher tests, other groups at SNL/NM used the Building 9990 area to conduct weapons-related testing activities. However, these activities constituted only a very small part of the overall testing conducted at Building 9990. In

the summer or fall of 1979, contained tests (part of the W45 Tests) were conducted at Building 9990, which involved detonating mock-up warheads that contained significant quantities of depleted uranium (exact volume or mass is not known). Prior to performing these contained tests, an instrumentation test shot resulted in scattering hundreds to thousands of small depleted uranium fragments over the surrounding area and hillsides. These fragments and other metal shrapnel started fires on the hillsides.

Another series of tests that involved depleted uranium are referred to as the "Neutron Generator Proof Tests" and "Stand Off Tests." The purpose of these tests was to ensure weapon component reliability. These tests, conducted at Building 9990 from mid-1982 through 1986, involved approximately a dozen individual tests with weapons that contained depleted uranium and less than 50 pounds of HE. Although small in number, these tests, which resulted in scattering small fragments of depleted uranium (typically very thin and less than several inches in length and width) across the site, were particularly significant. These tests typically caused small, localized grass fires, probably started by small fragments of depleted uranium. Other tests also involving depleted uranium spheres were conducted at the Building 9990 site in the 1970s.

"Davis Gun" tests were also performed at the Building 9990 Electro-Explosives Research Facility. These tests were conducted in a long cylinder (the Davis gun) open at both ends with rocket propellant located mid-cylinder. An aluminum projectile was fired out of one end of the gun and an aluminum/steel counterbalance was blown out the other end. These tests did not involve radioactive materials but did result in a significant amount of aluminum and steel fragments scattered throughout the area.

"Box tests" conducted at the site also did not involve radioactive materials but resulted in a significant amount of aluminum shrapnel being dispersed over the area. In these tests, HE was packed symmetrically around a gas cylinder and placed into an aluminum box. The HE was detonated, causing instantaneous compression of the gas. The resulting explosion shattered the aluminum box and scattered the pieces.

"Flyer Plate" tests involved accelerating aluminum plates into the nose cone of a mock warhead to assess damage. The nose cone, made of carbon steel, was wired with sensors. These tests did not result in releases of radioactive material, but may have produced and dispersed metal shrapnel.

"Simulated lightning experiments," also conducted as part of the weapons components integrity tests, used the Building 9990 capacitor banks to deliver electrical pulses (three in succession) to missile carrier assemblies. No releases of radioactive or hazardous materials occurred during these tests.

During the period of 1982 to 1986, explosive generator experiments detonating up to 800 pounds of liquid nitromethane were performed north of Building 9990 (about 70 feet from the north, steel-reinforced wall). To minimize ground shock to Building 9990, the soil under the experiment area (firing site) was excavated about 10 to 12 feet below grade by 10 to 12 feet wide by 40 feet long. The excavated area was then backfilled with soil and leveled for the experiments. Constituents of concern (COCs) that may have been present in the soil may have been mixed into the subsurface during this operation.

In summary, the Electro-Explosives Research Facility has a long history of explosive and electromagnetic testing and experiments. A vast majority of the testing did not involve radioactive or hazardous materials, although the use of HE and lead was common. Lead was primarily used to anchor or hold materials in place. Most of the obvious shrapnel at the surface is aluminum, steel, or copper. Sporadic testing conducted from the late 1970s to around 1986 involved depleted uranium and possibly beryllium. The tests involving depleted uranium, although few in number, resulted in the widespread distribution of small radioactive fragments across the site, especially on the east, north, and west sides of the Electro-Explosives Research Facility. Additional detail on these tests is provided in the RCRA [Resource Conservation and Recovery Act] Facility Investigation [RFI] Work Plan for Operable Unit [OU] 1332, Foothills Test Area (SNL/NM June 1995).

Materials used or potentially used at SWMU 87 are listed in Table 1. COCs that may have been released at SWMU 87 are listed in Table 2 and were determined by the various tests known to have been conducted at the site, as well as activities related to testing, facility operation, and maintenance. Many of the tests and experiments were contained and did not result in any releases.

II. Data Quality Objectives

The Data Quality Objectives (DQOs) presented in the OU 1332 RFI work plan and its accompanying SWMU 87 Sampling and Analysis Plans (SAPs) identified the site-specific RFI sample locations, sample depths, sampling procedures, and analytical requirements. The DQOs outline the Quality Control/Quality Assurance (QA/QC) requirements necessary for producing defensible analytical data suitable for risk assessment purposes. The RFI and confirmatory sampling conducted at SWMU 87 were designed to:

- Determine whether hazardous waste or hazardous constituents were released at the site.
- Characterize the nature and extent of potential releases.
- Provide analytical data of sufficient quality to support risk screening assessments.

Table 3 summarizes the rationale for the sample locations. The source of potential COCs at SWMU 87 resulted from the tests conducted at the site and the materials used. Soil samples were collected at 90 sample locations within SWMU 87 from 0.5 foot below the ground surface (bgs) with a hand trowel and from the subsurface using a Geoprobe® drive tube. All samples were collected in accordance with the sampling procedures detailed in the OU 1332 work plan and associated SAPs.

Samples from the sampling areas outlined in Table 3 were analyzed for COCs including depleted uranium-related radionuclides (U-238, Th-232, U-235) and Cs-137, tritium, target analyte list (TAL) and RCRA metals, and HE.

The samples were submitted to Lockheed Analytical Services (LAS), General Engineering Laboratories, Inc. (GEL), and the on-site SNL/NM Environmental Restoration (ER) Chemistry Laboratory and Radiation Protection Sample Diagnostics (RPSD) Laboratory for analysis.

Table 1
Materials Used or Potentially Used at SWMU 87

Material Used or Potentially Used	Explanation
High Explosives: Comp B, tetryl, PBX 9404, nitromethane liquid, LX-04, Octol, nitrocellulose, and baratol	Tetryl used in small quantities only. PBX-9404 associated with tests involving DU. Nitromethane liquid used for big shots only. Other HE materials used in larger quantities.
Tritium	Small volumes of tritium possibly used in mock-up warheads.
DU	DU used in the Neutron Generator Proof Tests, Stand Off Tests, and Containment Tests.
Lead	Lead commonly used to anchor test objects.
Aluminum, steel, and copper	These metals used extensively in explosive generator and electromagnetic launcher tests (especially aluminum), as well as weapons tests (such as Flyer Plate Tests).
Beryllium, Barium	Some tests may have used beryllium components. Barium is a component of the explosive baratol.
Toluene, acetone, and methanol	Used to wash and clean test materials and used on the test pad.
Freon TF, TCE	Used inside Building 9990, although no known releases.
Methylene Chloride	May have been stored temporarily adjacent to Building 9990; no known releases.
Photographic waste water	Discharged to septic system only. Investigation of septic system is addressed under the SWMU 116 RFI report (IT March 1994).

DU = Depleted uranium.
 HE = High explosive(s).
 NFA = No Further Action.
 PBX = Plastic-bonded explosive.
 RCRA = Resource Conservation and Recovery Act.
 RFI = RCRA Facility Investigation.
 SNL/NM = Sandia National Laboratories/New Mexico.
 SWMU = Solid Waste Management Unit.
 TCE = Trichloroethylene.

Table 2
Potential COCs Released at SWMU 87

COC Potentially Released	Explanation
Explosives: Comp B, tetryl, PBX 9404, nitromethane liquid, LX-04, Octol, nitrocellulose, and baratol	Although unlikely, explosives could be present in the immediate vicinity of the firing pad.
DU	DU fragments (metal) are scattered across the surface of the site. A surface area greater than 52 acres has been impacted. DU could also be present in the subsurface in the immediate vicinity of the firing pad.
Tritium	It is not certain whether small amounts of tritium were present in the mock warheads tested at the site.

COC = Constituent of concern.

DU = Depleted uranium.

PBX = Plastic-bonded explosive.

SWMU = Solid Waste Management Unit.

Table 3
Summary of Sampling Performed to Meet Data Quality Objectives

SWMU 87 Sampling Area	Potential COC Source	Number of Sampling Locations	Sample Density or Pattern	Sampling Location Rationale
Area A, including the firing site.	Metals, HE, and radionuclides from tests and test debris remaining at the site or dispersed from tests at this point.	20	10-ft-grid spacing and random	Confirm that no significant levels of COCs are present in the soil that may have been affected by test operations.
Area B, including the area south of the firing site.	Metals, HE, and radionuclides from tests and test debris remaining at the site.	20	20-ft-grid spacing and random	Confirm that no significant levels of COCs are present in the soil that may have been affected by test operations.
Area C, including the area north and east of the firing site.	Metals, HE, and radionuclides from tests and test debris remaining at the site.	10	10 samples collected randomly from a 0.75-acre area	Confirm that no significant levels of COCs are present in the soil that may have been affected by test operations.
Arroyo adjacent to the facility structures.	Metals, HE, and radionuclides from tests and test debris remaining at the site.	6	6 samples collected along a 600-ft-line along the arroyo adjacent to the facility	Confirm that no significant levels of COCs are present in the soil that may have been affected by test operations.
Perimeter area surrounding the facility structures.	Metals, HE, and radionuclides from tests and test debris remaining at the site.	12	12 samples collected along the perimeter of the facility	Confirm that no significant levels of COCs are present in the soil that may have been affected by test operations.

COC = Contaminant of concern.

ft = Foot (feet).

HE = High explosive(s).

SWMU = Solid Waste Management Unit.

Table 4 summarizes the number and types of RFI sampling at SWMU 87. Table 5 provides the analytical methods, data quality level, and number of samples analyzed for each parameter.

Twenty-four QA/QC samples were collected during the RFI sampling efforts according to the ER Project Quality Assurance Project Plan, consisting of seven duplicates, eleven equipment blanks, and six field blanks. No significant problems were identified in the QA/QC samples.

All of the RFI soil sample results used in the risk assessment were verified/validated by SNL/NM. The off-site laboratory results from LAS and GEL were reviewed according to "Data Validation Procedure for Chemical and Radiochemical Data" SNL/NM Environmental Restoration Project Analytical Operating Procedure (AOP) 00-03, Rev. 0 (SNL/NM January 2000). The data validation reports are presented in the SWMU 87 proposal for no further action (NFA). The gamma spectroscopy data from the RPSD Laboratory were reviewed according to "Laboratory Data Review Guidelines," Procedure No. RPSD-02-11, Issue No. 02 (SNL/NM July 1996). The gamma spectroscopy results are presented in the NFA proposal. The reviews confirmed that the analytical data are defensible and therefore acceptable for use in the NFA proposal. Therefore, the DQOs have been fulfilled.

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

III.1 Introduction

The determination of the nature, migration rate, and extent of contamination at SWMU 87 was based upon an initial conceptual model validated with RFI sampling at the site. The initial conceptual model was developed from archival research, soil sampling, aerial photographs, and radiological surveys. The DQOs contained in the SWMU 87 SAPs identified the sample locations, sample density, sample depth, and analytical requirements. The sample data were subsequently used to develop the final conceptual model for SWMU 87, which is presented in Section 6.5 of the NFA proposal. The quality of the data specifically used to determine the nature, migration rate, and extent of contamination are described in the following sections.

III.2 Nature of Contamination

Both the nature of contamination and the potential for the degradation of COCs at SWMU 87 were evaluated using laboratory analyses of the soil samples (Section IV). The analytical requirements included analyses for depleted uranium-related radionuclides, TAL and RCRA metals, and HE compounds. The analyses characterized potential contaminants at the site. The analytes and methods listed in Tables 4 and 5 are appropriate for characterizing the COCs and potential degradation products at SWMU 87.

III.3 Rate of Contaminant Migration

SWMU 87 is an inactive site that contains residual COCs in the surface and shallow subsurface soil. The rate of COC migration from the surface and shallow subsurface soil is therefore dependent predominantly upon precipitation and occasional surface-water flow as described in

Table 4
Number of Soil Samples Collected During the
Site Characterization at SWMU 87 and Used in the Risk Assessment

Sample Type	Number of Samples	Tritium	Gamma Spectroscopy	Isotopic Uranium	TAL or RCRA Metals + Beryllium	HE
RFI	90	6	86	8	90	46
Duplicates	7	0	2	0	7	3
Equipment Blanks	11	0	0	0	8	3
Field Blanks	6	0	0	0	6	0
Total Samples	114	6	88	8	111	52
Analytical laboratory	NA	SNL/NM RPSD Laboratory	SNL/NM RPSD Laboratory	LAS	SNL/NM ERCL, LAS, GEL	GEL

Note: Sampling Dates: 08/07/95, 05/13/96, 05/14/96, 09/16/96, 12/02/96, 12/21/96, 10/20/97, 10/21/97, 09/09/98, 03/29/00, 10/29/01, 10/30/01.

Chain-of-Custody Forms: 04122, 04124, 04125, 04267, 05121, 05123, 05124, 05125, 05823, 05824, 05825, 06012, 06066, 06297, 06298, 509454, 510037, 510038, 600821, 600822, 600823, 600824, 603211, 605073, and 605074.

ERCL = Environmental Restoration Chemistry Laboratory.

GEL = General Engineering Laboratories, Inc.

HE = High explosive(s).

LAS = Lockheed Analytical Services.

NA = Not applicable.

RCRA = Resource Conservation and Recovery Act.

RFI = RCRA Facility Investigation.

RPSD = Radiation Protection Sample Diagnostics.

SNL/NM = Sandia National Laboratories/New Mexico.

SWMU = Solid Waste Management Unit.

TAL = Target Analyte List.

Table 5
Summary of Data Quality Requirements

Analytical Requirement	Data Quality Level	SNL/NM ERCL, LAS, and GEL Laboratories	RPSD Laboratory
Gamma Spectroscopy EPA Method 901.1 ^a	Definitive	Not analyzed	86 samples
Isotopic Uranium ^b	Definitive	8 samples	Not analyzed
Tritium EPA Method 906.0 ^a	Definitive	Not analyzed	6 samples
TAL and RCRA metals EPA Method 6010/7000 ^a	Definitive	90 samples	Not analyzed
HE compounds EPA Method 8330 ^a	Definitive	46 samples	Not analyzed

Note: The number of samples does not include QA/QC samples such as duplicates, equipment blanks, and field blanks.

^aEPA (November 1986).

^bLAS Standard Operating Procedure LAL-0108-26879.

EPA = U.S. Environmental Protection Agency.

ERCL = Environmental Restoration Chemistry Laboratory.

GEL = General Engineering Laboratories, Inc.

HE = High explosive(s).

LAS = Lockheed Analytical Services.

QA/QC = Quality assurance/quality control.

RCRA = Resource Conservation and Recovery Act.

RPSD = Radiation Protection Sample Diagnostics.

SNL/NM = Sandia National Laboratories/New Mexico.

TAL = Target Analyte List.

Section V. Data available from the Sandia Canyons Groundwater Investigation; numerous SNL/NM monitoring programs for air, water, and radionuclides; various biological surveys; and meteorological monitoring are adequate for characterizing the rate of COC migration at SWMU 87.

III.4 Extent of Contamination

RFI surface and subsurface soil samples were collected from the SWMU 87 site features where COCs might be present, including the former firing site, using the sampling density provided in Table 3. The subsurface soil samples were collected to a depth of 10.5 feet bgs. No significant levels of COCs that required additional characterization at depth were found in these samples. Furthermore, the vertical rate of contamination migration was expected to be extremely low for SWMU 87 because of the low precipitation, high evapotranspiration, impermeable vadose zone soil, and the relatively low solubility of the COCs. Therefore, the RFI soil samples are considered representative of the soil potentially contaminated with the COCs and sufficient to determine the vertical extent, if any, of COCs.

In summary, the design of the RFI sampling was appropriate and adequate to determine the nature, migration rate, and extent of residual COCs in soil at SWMU 87.

IV. Comparison of COCs to Background Screening Levels

Site history and characterization activities are used to identify potential COCs. The SWMU 87 NFA proposal describes the identification of COCs and the sampling that was conducted in order to determine the concentration levels of those COCs across the site. Generally, COCs that were evaluated in this risk assessment included all detected organics, and all inorganic and radiological COCs for which samples were analyzed. When the detection limit of an organic compound was too high (i.e., could possibly cause an adverse effect to human health or the environment), the compound was retained. Nondetected organic constituents not included in this assessment were determined to have detection limits low enough to ensure protection of human health and the environment. In order to provide conservatism in this risk assessment, the calculation used only the maximum concentration value of each COC found for the entire site. The SNL/NM maximum background concentration (Dinwiddie September 1997 and Garcia November 1998) was selected to provide the background screen listed in Tables 6 and 7. Human health nonradiological COCs also were compared to SNL/NM proposed Subpart S action levels if appropriate (IT July 1994).

Nonradiological inorganic constituents that are essential nutrients, such as iron, magnesium, calcium, potassium, and sodium, were not included in this risk assessment (EPA 1989). Both radiological and nonradiological COCs were evaluated. The nonradiological COCs evaluated included inorganic and organic compounds.

Table 6 lists the nonradiological COCs and Table 7 lists the radiological COCs for the human health and ecological risk assessments at SWMU 87. Both tables show the associated SNL/NM maximum background concentration values (Dinwiddie September 1997 and Garcia November 1998). Sections VI.4, VII.2 and VII.3 discuss the results presented in Tables 6 and 7.

V. Fate and Transport

The primary releases of COCs at SWMU 87 occurred to the surface and shallow subsurface soil. Wind, water, and biota are natural mechanisms of COC transport from the primary release point. Winds at this site, however, are moderated by the locally mountainous topography and woodland vegetation. Therefore, wind erosion is not considered a significant transport mechanism at this site.

Water at SWMU 87, received as precipitation (rain and occasionally snow), will either evaporate at or near the point of contact, infiltrate into the soil, or form runoff. Infiltration at the site is enhanced by the coarse nature of the soil (the soils in the area of the site are primarily Tesajo-Millett stony sandy loam and Salas very gravelly loam [USDA 1977]); however, surface runoff may be produced during intense rainstorms and extended periods of rainfall. Surface-water runoff from SWMU 87 will flow into the arroyo channel in the center of the site, which flows southward onto the piedmont surface. Runoff may carry surface soil particles with adsorbed COCs. The distance of transport will depend upon the size of the particles and the velocity of the water.

Water that infiltrates into the soil will continue to percolate through the soil until field capacity is reached. COCs desorbed from the soil particles into the soil solution may be leached into the subsurface soil with this percolation. The effective rooting depths of the soil at SWMU 87 is

Table 6
Nonradiological COCs for Human Health and Ecological Risk Assessments at SWMU 87 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) ^a	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (maximum aquatic)	Log K _{ow} (for organic COCs)	Bioaccumulator? ^b (BCF>40, log K _{ow} >4)
Arsenic	25 ^c	9.8	No	44 ^d	NA	Yes
Barium	270	246	No	170 ^e	NA	Yes
Beryllium	1.7 ^c	0.75	No	19 ^d	NA	No
Cadmium	5.8	0.64	No	64 ^d	NA	Yes
Chromium, total	60.1(19.5) ^f	18.8	No	16 ^d	NA	No
Copper	2040	17.1	No	6 ^d	NA	No
Lead	320	18.9	No	49 ^d	NA	Yes
Mercury	0.243	0.055	No	5500 ^d	NA	Yes
Nickel	59	16.6	No	47 ^d	NA	Yes
Selenium	25 ^c	2.7	No	800 ^g	NA	Yes
Silver	8	<0.5	No	0.5 ^d	NA	No
Uranium, total	1800	2.3 ^h	No	20 ^e	NA	No
Zinc	331	52.1	No	47 ^d	NA	Yes
HMX	0.2	NA	NA	0.49 ⁱ	0.28 ^j	No
m-Dinitrobenzene	0.14	NA	NA	8.5 ^k	1.49 ^k	No
o-Nitrotoluene	0.12	NA	NA	<100 ^k	2.3 ^k	Yes

Bold indicates the COCs that exceed the background screening values and/or are bioaccumulators.

^aFrom Garcia (November 1998) Canyons Area.

^bNMED (March 1998).

^cMaximum concentration of parameter was one-half of detection limit.

^dYanicak (March 1997).

^eNeumann (1976).

^fConcentration in parentheses for chromium applies only to the ecological risk assessment. All other concentrations apply to both the human health and ecological risk assessments.

Table 6 (Concluded)
Nonradiological COCs for Human Health and Ecological Risk Assessments at SWMU 87 with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log K_{ow}

^eCallahan et al. (1979).
^hThe Canyons Area does not have a total uranium background screening value. The subsurface total uranium background screening value from the north and southwest supergroups was used in this risk assessment (most conservative of uranium background screening values).
ⁱRosenblatt et al. (1991).
^jMaxwell and Opreko (1996).
^kMicromedex (1998).
 BCF = Bioconcentration factor.
 COC = Constituent of concern.
 HMX = Octahydro-1,3,5,7-trinitro-1,3,5,7-tetrazocine.
 K_{ow} = Octanol-water partition coefficient.
 Log = Logarithm (base 10).
 mg/kg = Milligram(s) per kilogram.
 NA = Not applicable.
 NMED = New Mexico Environment Department.
 SNL/NM = Sandia National Laboratories/New Mexico.
 SWMU = Solid Waste Management Unit.

Table 7
Radiological COCs for Human Health and Ecological Risk Assessments at SWMU 87 with Comparison to the Associated SNL/NM Background Screening Value and BCF

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)	Is COC a Bioaccumulator? ^b (BCF >40)
U-235	11.9	0.16	No	900 ^c	Yes
U-238	594	2.31	No	900 ^c	Yes

Note: **Bold** indicates COCs that exceed background screening values and/or are bioaccumulators.

^aFrom Dinwiddie (September 1997), Canyons Area.

^bNMED (March 1998).

^cBaker and Soldat (1992).

BCF = Bioconcentration factor.

COC = Constituent of concern.

NMED = New Mexico Environment Department.

pCi/g = Picocurie(s) per gram.

SNL/NM = Sandia National Laboratories/New Mexico.

SWMU = Solid Waste Management Unit.

about 60 inches (USDA 1977), indicating the depth of the system's transient water cycling zone (the dynamic balance between percolation/infiltration and evapotranspiration). Because groundwater at this site exceeds 230 feet bgs, the potential for COCs to reach groundwater through the unsaturated zone above the water table is very limited. As water from the surface evaporates, the direction of COC movement may be reversed with capillary rise of the soil water.

COCs can enter the food chain via uptake from the soil solution by plant roots. These COCs may be transported to the aboveground tissues, which can also take up constituents from direct contact with dust particles. These tissues containing COCs may then be consumed by herbivores or returned to the soil as litter. Aboveground litter is capable of being transported by wind and water until it decomposes. Constituents in plant tissues that are consumed by herbivores may be absorbed or returned to the soil in feces (at the site or transported from the site by the herbivore). COCs that are absorbed may be held in tissues or later excreted. A primary carnivore or scavenger may eat the herbivore and the constituents still held in the tissues will again be either excreted and decompose or consumed by higher predators and scavengers. The potential for transport of the constituents within the food chain is dependent upon both the mobility of the species that comprise the food chain and the potential for the constituent to be transferred across the links in the food chain.

The COCs at SWMU 87 include both inorganic and organic analytes. The inorganic COCs are elemental in form, and are therefore generally not considered to be degradable. Radiological COCs, however, undergo decay to stable isotopes or radioactive daughter elements. Other transformations of inorganic constituents may include changes in valence (oxidation/reduction reactions) or incorporation into organic forms (e.g., the conversion of selenite or selenate from soil to seleno-amino acids in plants). The rate of such processes will be limited by the arid environment at this site. 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 (i.e., transformation caused by plants, animals, and microorganisms) may occur; however, biological activity may be limited by the arid environment at this site.

Table 8 summarizes the fate and transport processes that may occur at SWMU 87. COCs at this site include both inorganic (metals and radionuclides) and organic constituents (HE) in surface and shallow subsurface soil. Because of the local mountainous topography and woodland vegetation, the potential for transport of COCs by wind is low. The potential for transport by surface-water runoff is moderate for COCs currently at or near the soil surface. Significant leaching of COCs into the subsurface soil is unlikely and leaching into the groundwater at this site is highly unlikely. The potential for uptake into the food chain is considered moderate to low due to the terrestrial nature of the habitat and the arid climate. For inorganic COCs, the potential for degradation is low. Due to long half-lives, decay of radiological COCs is insignificant. Degradation and/or biotransformation of HE, however, may be significant. The COC, m-dinitrobenzene, is readily metabolized by plants, animals, and microorganisms (Talmage and Opresko 1996). Octahydro-1,3,5,7-trinitro-1,3,5,7-tetrazocine (HMX) may persist in soil and leach into the subsurface soil with percolation; however, HMX is readily metabolized and excreted by animals, making the potential for food chain uptake of these COCs low (Maxwell and Opresko 1996).

Table 8
Summary of Fate and Transport at SWMU 87

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

SWMU = Solid Waste Management Unit.

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 the following:

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 SNL/NM maximum background screening value. COCs that are not eliminated during the first screening procedure are subjected to a second screening procedure, if applicable, 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 estimated 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 applies only when a radiological COC occurs as contamination and exists as a natural background radionuclide.
Step 6.	These values are compared with guidelines established by the U.S. Environmental Protection Agency (EPA), New Mexico Environment Department (NMED), and the DOE to determine whether further evaluation and potential site cleanup are required. Nonradiological COC risk values also are compared to background risk so that an incremental risk can be calculated.
Step 7.	Uncertainties of the above steps are addressed.

VI.2 Step 1. Site Data

Section I of this risk assessment provides the description and history for SWMU 87. Section II presents a comparison of results to DQOs. Section III discusses the nature, rate, and extent of contamination.

VI.3 Step 2. Pathway Identification

SWMU 87 has been designated with a future land use scenario of recreational (DOE et al. October 1995) (see Appendix 1 for default exposure pathways and parameters). Because of the location and 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 the potential exists to inhale dust and volatiles. Soil ingestion is included for the radiological COCs as well. No water pathways to the groundwater are considered. Depth to groundwater at SWMU 87 exceeds 230 feet bgs. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is not considered to be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the recreational 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

This section discusses Step 3, which includes the two screening procedures. The first screening procedure compares the maximum COC concentration to the background screening level. The second compares maximum COC concentrations to SNL/NM proposed Subpart S action levels. This second procedure was applied only to COCs that were not eliminated during the first screening procedure.

VI.4.1 Background Screening Procedure

VI.4.1.1 Methodology

Maximum concentrations of nonradiological COCs were compared to the approved SNL/NM maximum screening levels for this area (Dinwiddie September 1997 and Garcia November 1998). The SNL/NM maximum background concentration was selected to provide the background screen in Table 6 and was used to calculate risk attributable to background in Section VI.6.2. Only the COCs that were detected above the corresponding SNL/NM maximum

background screening levels or did not have either a quantifiable or a calculated background screening level were considered in further risk assessment analyses.

For radiological COCs that exceeded the SNL/NM background screening levels, background values were subtracted from the individual maximum radionuclide concentrations. Those that did not exceed these background levels were 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 were detected above the analytical minimum detectable activity were carried through the risk assessment at their maximum levels. The resultant radiological COCs remaining after this step are referred to as background-adjusted radiological COCs.

VI.4.1.2 Results

Tables 6 and 7 show SWMU 87 maximum COC concentrations that were compared to the SNL/NM maximum background values (Dinwiddie September 1997 and Garcia November 1998) for the human health risk assessment. For the nonradiological COCs, 13 constituents were measured at concentrations greater than the corresponding background screening values. Three nonradiological COCs were organic compounds that do not have corresponding background screening values.

The maximum concentration value for lead is 320 milligrams (mg) per kilogram (/kg). The EPA intentionally does not provide human health toxicological data on lead; therefore, no risk parameter values could be calculated. However, NMED guidance for lead screening concentrations for construction and industrial land use scenarios are 750 and 1500 mg/kg, respectively (Olson and Moats March 2000). The EPA screening guidance value for a residential land use scenario is 400 mg/kg (Laws July 1994). The maximum concentration value for lead at this site is less than all the screening values; therefore, lead is eliminated from further consideration in the human health risk assessment.

For the radiological COCs, two constituents (U-235 and U-238) exhibited measured activity greater than the corresponding background values.

VI.4.2 Subpart S Screening Procedure

VI.4.2.1 Methodology

The maximum concentrations of nonradiological COCs not eliminated during the background screening process were compared with action levels (IT July 1994) calculated using methods and equations promulgated in the proposed RCRA Subpart S (EPA 1990) and Risk Assessment Guidance for Superfund (RAGS) (EPA 1989) documentation. 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 all the samples were taken from the surface and near-surface soil, this assumption is considered valid. If there were ten or fewer COCs, and each had a maximum concentration of less than 1/10 the action level, then the site was judged to pose no significant

health hazard to humans. If there were more than ten COCs, then the Subpart S screening procedure was not performed.

VI.4.2.2 Results

Because the SWMU 87 sample set contained more than ten COCs that were retained beyond the first screening level (including COCs that do not have background screening values), the proposed Subpart S screening process was not performed. All nonradiological COCs not eliminated during the background screening process for SWMU 87 were carried forward in the risk assessment process and an individual hazard quotient (HQ) and excess cancer risk value were calculated for each COC.

Because radiological COCs have no predetermined action levels analogous to proposed Subpart S levels, this step in the screening process is not performed for radiological COCs.

VI.5 Step 4. Identification of Toxicological Parameters

Tables 9 (nonradiological) and 10 (radiological) list the COCs retained in the risk assessment and the values for the available toxicological information. The toxicological values used for nonradiological COCs in Table 9 were obtained from the Integrated Risk Information System (IRIS) (EPA 1998a), the Health Effects Assessment Summary Tables (HEAST) (EPA 1997a), the EPA Region 3 (EPA 1997b), and EPA Region 9 (EPA 1996) electronic databases. Dose conversion factors (DCFs) 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 were 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 in ANL/EAIS-8, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil* (Yu et al. 1993b).

VI.6 Step 5. Exposure Assessment and Risk Characterization

Section VI.6.1 describes the exposure assessment for this risk assessment. Section VI.6.2 provides the risk characterization, including the HI and the excess cancer risk for both the potential nonradiological COCs and associated background, for the recreational and residential land use scenarios. The incremental TEDE and incremental estimated cancer risk are provided

Table 9
Toxicological Parameter Values for SWMU 87 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
Arsenic	3.0E-4 ^c	M	–	–	1.5E+0 ^c	1.5E+1 ^c	A
Barium	7.0E-2 ^c	M	1.4E-4 ^d	–	–	–	–
Beryllium	2.0E-3 ^c	L to M	5.7E-6 ^c	M	–	8.4E+0 ^c	B1
Cadmium	5.0E-4 ^c	H	5.7E-5 ^d	–	–	6.3E+0 ^c	B1
Chromium III	1.0E+0 ^c	L	5.7E-7 ^e	–	–	–	–
Chromium VI	5.0E-3 ^c	L	–	–	–	4.2E+1 ^c	A
Copper	3.7E-2 ^d	–	–	–	–	–	D
Mercury	3.0E-4 ^f	–	8.6E-5 ^c	M	–	–	D
Nickel	2.0E-2 ^c	M	–	–	–	–	–
Selenium	5.0E-3 ^c	H	–	–	–	–	D
Silver	5.0E-3 ^c	L	–	–	–	–	D
Uranium, total	3.0E-3 ^c	M	–	–	–	–	–
Zinc	3.0E-1 ^c	M	–	–	–	–	D
HMX	5.0E-2 ^c	L	5.0E-2 ^d	–	–	–	D
m-Dinitrobenzene	1.0E-4 ^c	L	1.0E-4 ^d	–	–	–	D
o-Nitrotoluene	1.0E-2 ^f	–	–	–	–	–	–

^aConfidence associated with IRIS (EPA 1998a) database values. Confidence: L = low, M = medium, H = high.

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

A = Human carcinogen.

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

D = Not classifiable as to human carcinogenicity.

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

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

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

^fToxicological parameter values from HEAST (EPA 1997a).

COC = Constituent of concern.

EPA = U.S. Environmental Protection Agency.

HEAST = Health Effects Assessment Summary Tables.

HMX = Octahydro-1,3,5,7-trinitro-1,3,5,7-tetrazocine.

IRIS = Integrated Risk Information System.

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

(mg/kg-day)⁻¹ = Per milligram per kilogram per 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 10
Radiological Toxicological Parameter Values for SWMU 87 COCs Obtained from
RESRAD Risk Coefficients^a

COC Name	SF _o (1/pCi)	SF _{inh} (1/pCi)	SF _{ev} (g/pCi-yr)	Cancer Class ^b
U-235	4.70E-11	1.30E-08	2.70E-07	A
U-238	6.20E-11	1.20E-08	6.60E-08	A

^aFrom Yu et al. (1993a).

^bEPA weight-of-evidence classification system for carcinogenicity (EPA 1989): A = Human carcinogen for high dose and high dose rate (i.e., greater than 50 rem per year). For low-level environmental exposures, the carcinogenic effect has not been observed and documented.

1/pCi = One per picocurie.

COC = Constituent of concern.

EPA = U.S. Environmental Protection Agency.

g/pCi-yr = Gram(s) per picocurie per year.

SF_{ev} = External volume exposure slope factor.

SF_{inh} = Inhalation slope factor.

SF_o = Oral (ingestion) slope factor.

SWMU = Solid Waste Management Unit.

for the background-adjusted radiological COCs for both the recreational and residential land uses.

VI.6.1 Exposure Assessment

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

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

VI.6.2 Risk Characterization

Table 11 shows an HI of 0.07 for the SWMU 87 nonradiological COCs and an estimated excess cancer risk of 2E-6 for the designated recreational land use scenario. The numbers presented

Table 11
Risk Assessment Values for SWMU 87 Nonradiological COCs

COC Name	Maximum Concentration (mg/kg)	Recreational Land Use Scenario ^a		Residential Land Use Scenario ^a	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	25 ^b	0.01	2E-6	1.43	3E-4
Barium	270	0.00	–	0.04	–
Beryllium	1.7 ^b	0.00	5E-11	0.00	1E-9
Cadmium	5.8	0.00	1E-10	4.74	3E-9
Chromium, total ^c	60.1	0.00	8E-9	0.05	2E-7
Copper	2040	0.01	–	9.88	–
Mercury	0.243	0.00	–	0.42	–
Nickel	59	0.00	–	0.09	–
Selenium	25 ^j	0.00	–	8.80	–
Silver	8	0.00	–	0.33	–
Uranium, total	1800	0.05	–	4.21	–
Zinc	331	0.00	–	0.60	–
HMX	0.2	0.00	–	0.15	–
m-Dinitrobenzene	0.14	0.00	–	0.01	–
o-Nitrotoluene	0.12	0.00	–	0.03	–
Total	NA	0.07	2E-6	31	3E-4

^aFrom EPA (1989).

^bMaximum concentration was one-half of detection limit.

^cChromium, total was considered to be chromium VI (most conservative).

COC = Constituent of concern.

EPA = U.S. Environmental Protection Agency.

HMX = Octahydro-1,3,5,7-trinitro-1,3,5,7-tetrazocine.

mg/kg = Milligram(s) per kilogram.

SWMU = Solid Waste Management Unit.

– = information not available.

include exposure from soil ingestion and dust and volatile inhalation for nonradiological COCs. Table 12 shows an HI of 0.00 and an estimated excess cancer risk of 6E-7 for the designated recreational land use scenario.

For the radiological COCs, contribution from the direct gamma exposure pathway is included. For the recreational land use scenario, a TEDE was calculated for an individual who spends four hours per week on the site. This resulted in an incremental TEDE of 2.2 millirems (mrem) per year (/yr). In accordance with EPA guidance found in Office of Solid Waste and Emergency Response Directive No. 9200.4-18 (EPA 1997c), an incremental TEDE of 15 mrem/yr is used for the probable land use scenario (recreational in this case); the calculated dose value for SWMU 87 for the recreational land use is well below this guideline. The estimated excess cancer risk is 2.9E-5.

For the residential land use scenario nonradiological COCs, the HI is 31 and the estimated excess cancer risk is 3E-4 (Table 11). The numbers in the table include exposure from soil ingestion, dust and volatile inhalation, and plant uptake. Although the EPA (EPA 1991) generally recommends that inhalation not be included in a residential land use scenario, this

Table 12
Risk Assessment Values for SWMU 87 Nonradiological Background Constituents

COC Name	Background Concentration ^a (mg/kg)	Recreational Land Use Scenario ^b		Residential Land Use Scenario ^b	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	9.8	0.00	6E-7	0.56	1E-4
Barium	246	0.00	–	0.04	–
Beryllium	0.75	0.00	2E-11	0.00	6E-10
Cadmium	0.64	0.00	1E-11	0.52	4E-10
Chromium, total ^c	18.8	0.00	–	0.01	–
Copper	17.1	0.00	–	0.08	–
Mercury	0.055	0.00	–	0.09	–
Nickel	16.6	0.00	–	0.02	–
Selenium	2.7	0.00	–	0.95	–
Silver	<0.5	–	–	–	–
Uranium, total	2.3	0.00	–	0.01	–
Zinc	52.1	0.00	–	0.09	–
Total	NA	0.00	6E-7	2	1E-4

^aFrom Garcia (November 1998), Canyons Area.

^bFrom EPA (1989).

^cChromium, total was considered to be chromium III (most conservative).

COC = Constituent of concern.

EPA = U.S. Environmental Protection Agency.

mg/kg = Milligram(s) per kilogram.

SWMU = Solid Waste Management Unit.

– = Information not available.

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 12 shows that for the SWMU 87 associated background constituents, the HI is 2 and the estimated excess cancer risk is 1E-4.

For the radiological COCs, the incremental TEDE for the residential land use scenario is 50.4 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 87 for the residential land use scenario is well below this guideline. Consequently, SWMU 87 is eligible for unrestricted radiological release as 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 6.1E-4. The excess cancer risk from the nonradiological COCs and the radiological COCs is not additive, as noted in the 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 the recreational land use scenario (the designated land use scenario for this site) and the residential land use scenario.

For the recreational land use scenario nonradiological COCs, the HI is 0.07 (less than the numerical guideline of 1 suggested in the RAGS [EPA 1989]). Excess cancer risk is estimated at $2\text{E-}6$. NMED guidance states that cumulative excess lifetime cancer risk must be less than $1\text{E-}5$ (Bearzi January 2001), thus the excess cancer risk for this site is below the suggested acceptable risk value. This assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the recreational and residential land use scenarios. Assuming the recreational land use scenario, for nonradiological COCs the HI is 0.00 and the excess cancer risk is $6\text{E-}7$. 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 to be inconsistent with numbers presented in tables and within the text. For conservatism, the background constituent that does not have a quantified background concentration (silver) is assumed to have an HQ of 0.00. Incremental HI is 0.07 and the estimated incremental cancer risk is $1.41\text{E-}6$ for the recreational land use scenario. These incremental risk calculations indicate insignificant risk to human health from nonradiological COCs under a recreational land use scenario.

For the recreational land use scenario radiological COCs, incremental TEDE is 2.2 mrem/yr, which is significantly less than EPA's numerical guideline of 15 mrem/yr. Incremental estimated excess cancer risk is $2.9\text{E-}5$.

The calculated HI for the residential land use scenario nonradiological COCs is 31, which is above the numerical guidance. The excess cancer risk is estimated to be $3\text{E-}4$. NMED guidance states that cumulative excess lifetime cancer risk must be less than $1\text{E-}5$ (Bearzi January 2001), thus the excess cancer risk for this site is above the suggested acceptable risk value. The HI for associated background for the residential land use scenario is 2; the estimated excess cancer risk is $1\text{E-}4$. The incremental HI is 28.41 and the estimated incremental cancer risk is $2.00\text{E-}4$ for the residential land use scenario. Both the incremental HI and excess cancer risk calculations are above NMED guidelines under a residential land use scenario.

The incremental TEDE for a residential land use scenario from the radiological components is 50.4 mrem/yr, which is significantly less than the numerical guideline of 75 mrem/yr suggested in the SNL/NM "RESRAD Input Parameter Assumptions and Justification" (SNL/NM February 1998). The estimated excess cancer risk is $6.1\text{E-}4$.

VI.8 Step 7. Uncertainty Discussion

The determination of the nature, rate, and extent of contamination at SWMU 87 was based upon an initial conceptual model that was validated with RFI sampling conducted at the site. The RFI sampling was implemented in accordance with the RFI work plan for OU 1332 (SNL/NM June 1995) and associated SAPs. The DQOs contained in the SAPs 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 verified/validated in accordance with SNL/NM procedures (SNL/NM January 2000 and SNL/NM July 1996). Therefore, there is no uncertainty associated with the data quality used to perform the risk screening assessment at SWMU 87.

Because of the location, history of the site, and future land use (DOE et al. October 1995), there is low uncertainty in the land use scenario and the potentially affected populations that were considered in performing the risk assessment analysis. Because the COCs are found in surface and near-surface soil 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 the parameter values in the calculations are conservative and that calculated intakes are probably overestimated. Maximum measured values of COC concentrations are used to provide conservative results.

Table 9 shows the uncertainties (confidence level) in nonradiological toxicological parameter values. There is a mixture of estimated values and values from the IRIS (EPA 1998a), HEAST (EPA 1997a), the EPA Region 9 (EPA 1996), and EPA Region 3 (EPA 1997b) electronic databases. Where values are not provided, information is not available from these sources. Because of the conservative nature of the RME approach, uncertainties in toxicological values are not expected to change the conclusion of the risk assessment analysis.

Risk assessment values for nonradiological COCs are within the human health acceptable range for the recreational 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 the recreational and residential land use scenarios are within guidelines and represent only 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 not considered to be significant with respect to the conclusion reached.

VI.9 Summary

SWMU 87 contains identified COCs consisting of some inorganic, organic, and radiological compounds. Because of the location of the site, the designated recreational land use scenario, and the nature of contamination, potential exposure pathways identified for this site included soil ingestion and dust and volatile inhalation for chemical COCs, 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 an RME approach to risk assessment, calculations for nonradiological COCs show that for the recreational land use scenario the HI (0.07) is significantly less than the accepted numerical guidance from the EPA (EPA 1989). Estimated excess cancer risk is 2E-6. Thus, excess cancer risk is also below the acceptable risk value provided by the NMED for a recreational land use scenario (Bearzi January 2001). The incremental HI is 0.07, and the incremental excess cancer risk is 1.41E-6 for the recreational land use scenario. Incremental risk calculations indicate insignificant risk to human health for the recreational land use scenario.

Incremental TEDE and corresponding estimated cancer risk from radiological COCs are much less than EPA guidance values; the estimated TEDE is 2.2 mrem/yr for the recreational land use scenario. This value is much less than the EPA's numerical guidance of 15 mrem/yr in EPA guidance (EPA 1997c). The corresponding incremental estimated cancer risk value is 2.9E-5 for the recreational land use scenario. Furthermore, the incremental TEDE for the residential land use scenario that results from a complete loss of institutional control is 50.4 mrem/yr with an associated risk of 6.1E-4. The guideline for this scenario is 75 mrem/yr (SNL/NM February 1998). Therefore, SWMU 87 is eligible for unrestricted radiological release.

Uncertainties associated with the calculations are considered small relative to the conservatism of this risk assessment analysis. Therefore, it is concluded that this site poses insignificant risk to human health under the recreational 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 the soil at SWMU 87. A component of the NMED Risk-Based Decision Tree (NMED March 1998) is to conduct an ecological screening assessment that corresponds with that presented in EPA's Ecological RAGS (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, data assessment, and evaluations of bioaccumulation and fate and transport potential) are addressed in previous sections of this report. Following the completion of the scoping assessment, a determination is made as to whether a more detailed examination of potential ecological risk is necessary. If deemed necessary, the scoping assessment proceeds to a screening assessment, whereby a more quantitative estimate of ecological risk is conducted. Although this assessment incorporates conservatisms into the estimation of ecological risks, ecological relevance and professional judgment also are used as recommended by the EPA (EPA 1998b) 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 concentrations detected to background concentrations, examination of bioaccumulation potential, and fate and transport potential. A scoping risk management decision (Section VII.2.4) involves summarizing the scoping results and determining whether further examination of potential ecological impacts is necessary.

VII.2.1 Data Assessment

As indicated in Section IV (Tables 6 and 7), inorganic constituents in soil within the 0- to 5-foot depth interval that exceeded background concentrations were as follows:

- Arsenic
- Barium
- Beryllium
- Cadmium
- Chromium
- Copper
- Lead
- Mercury
- Nickel
- Selenium
- Silver
- Uranium
- Zinc
- U-235
- U-238

Organic analytes detected in the soil were as follows:

- HMX
- m-Dinitrobenzene
- o-Nitrotoluene

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 6 and 7):

- Arsenic
- Barium
- Cadmium
- Lead
- Mercury
- Nickel
- Selenium
- Zinc
- U-235
- U-238
- o-Nitrotoluene

It should be noted, however, that as directed by the NMED (NMED March 1998), bioaccumulation for inorganic constituents is assessed exclusively based upon maximum reported bioconcentration factors (BCFs) 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 8 (Section V), wind is expected to be of low significance as a transport mechanism for COPECs at this site, and surface-water runoff is potentially of moderate significance. Migration to groundwater is not anticipated. Food chain uptake is expected to be of low significance. Degradation (decay) and transformation of the inorganic COPECs and radionuclides is expected to be of low significance, but may be of moderate significance for the organic COPECs.

VII.2.4 Scoping Risk-Management Decision

Based upon 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 posed by the site.

VII.3 Screening Assessment

As concluded in Section VII.2.4, both 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 that ecological risks are not underpredicted.

Components within the screening assessment include the following:

- 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 upon the results of the risk screening assessment.

VII.3.1 Problem Formulation

Problem formulation is the initial stage of the risk 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 July 1998) and are not duplicated here.

VII.3.1.1 Ecological Pathways and Setting

SWMU 87, approximately 90 acres in size, is located in an area dominated by woodland habitat that becomes open savannas on the slopes forming the outer boundary of the site. In the center and to the south of the site, the habitat is dominated by an arroyo with riparian scrubland vegetation. The habitat at SWMU 87 has been disturbed by the construction and use of Building 9990 and supporting roads and buildings; however, the majority of the habitat at this site is only slightly, if at all, disturbed. The site is open to use by wildlife. The more heavily wooded areas east of Building 9990 provide good habitat for wildlife, and larger animals, such as coyotes and deer, may use the arroyo as a travel corridor. A sensitive species survey of the site was conducted on June 24, 1994 (IT February 1995). Although scattered populations of visnagita cactus (*Neolloydia intertexta*), which was listed by the State of New Mexico as an endangered plant species at the time of the survey, were found throughout the site, this species has since been delisted. No other threatened, endangered, or sensitive species were found within the area of this SWMU.

Complete ecological pathways may exist at this site through the exposure of plants and wildlife to COPECs in the surface soil. It was assumed that direct uptake of COPECs from soil is the major route of exposure for plants and that exposure of plants to wind-blown soil is minor. Exposure modeling for the wildlife receptors was limited to the food and soil ingestion pathways and external radiation. 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 is not expected to be affected by COCs at this site.

VII.3.1.2 COPECs

Material scattered by explosives testing activities at Building 9990 is the source of the COPECs in the soil at SWMU 87. Inorganic and organic COPECs identified for SWMU 87 are listed in Section VII.2.1. The inorganic COPECs include both radiological and nonradiological analytes.

The inorganic analytes were screened against background concentrations and those that exceeded the approved SNL/NM background screening levels (Dinwiddie September 1997 and Garcia November 1998) for the area were considered to be COPECs. Nonradiological inorganic constituents that are essential nutrients, such as iron, magnesium, calcium, potassium, and sodium, were not included in this risk assessment as set forth by the EPA (EPA 1989). All organic analytes detected were considered to be COPECs for the site. In order to provide conservatism, this ecological risk assessment was based upon the maximum soil concentrations of the COPECs measured in the surface soil at this site. Tables 6 and 7 (Section IV) present the maximum concentrations for the COPECs.

VII.3.1.3 Ecological Receptors

A nonspecific perennial plant was selected as the receptor to represent plant species at the site (IT July 1998). Vascular plants are the principal primary producers at the site and are key to the diversity and productivity of the wildlife community associated with the site. The deer mouse (*Peromyscus maniculatus*) and the 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 to represent a top predator at this site. The burrowing owl is present at SNL/NM and is designated 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

For nonradiological COPECs, direct uptake from the soil was considered the only significant route of exposure for terrestrial plants. Exposure modeling for the wildlife receptors was limited to the food and soil ingestion pathways. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Drinking water was also considered an insignificant pathway because of the lack of surface water at this site. The deer mouse was modeled under three dietary regimes: as an herbivore (100 percent of its diet as plant material), as an omnivore (50 percent of its diet as plants and 50 percent as soil invertebrates), and as an insectivore (100 percent of its diet as soil invertebrates). The burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Because the exposure in the burrowing owl from a diet consisting of equal parts of herbivorous, omnivorous, and insectivorous mice would be equivalent to the exposure consisting of only omnivorous mice, the diet of the burrowing owl was modeled with intake of omnivorous mice only. Both species were modeled with soil ingestion comprising 2 percent of the total dietary intake. Table 13 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 July 1998).

Although home range is also included in this table, exposures for this risk assessment were modeled using an area use factor of 1.0, implying that all food items and soil ingested come from the site being investigated. The maximum COPEC concentrations measured in surface soil samples were used to conservatively estimate potential exposures and risks to plants and wildlife at this site.

Table 13
Exposure Factors for Ecological Receptors at SWMU 87

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 kg wet weight.

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

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

^dFrom Silva and Downing (1995).

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

^fFrom Dunning (1993).

^gFrom Haug et al. (1993).

EPA = U.S. Environmental Protection Agency.

kg = Kilogram(s).

kg/day = Kilogram(s) per day.

SWMU = Solid Waste Management Unit.

For the radiological dose-rate calculations, the deer mouse was modeled as an herbivore (100 percent of its diet as plants), and the burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Both were modeled with soil ingestion comprising 2 percent of the total dietary intake. Receptors are exposed to radiation both internally and externally from U-235 and U-238. Internal and external dose rates to the deer mouse and the burrowing owl are approximated using modified dose-rate models from DOE (DOE 1995) as presented in the ecological risk assessment methodology document for the SNL/NM ER Project (IT July 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 transfer only a fraction of their energy to the tissues because gamma rays interact less with matter than do beta or alpha emitters. The external and internal dose-rate results are summed to calculate a total dose rate from exposure to U-235 and U-238 in soil.

Table 14 presents the transfer factors used in modeling the concentrations of COPECs through the food chain. Table 15 presents maximum concentrations in soil and derived concentrations in tissues of the various food chain elements that are used to model dietary exposures for each of the wildlife receptors.

VII.3.3 Ecological Effects Evaluation

Table 16 provides benchmark toxicity values for the plant and wildlife receptors. For plants, the benchmark soil concentrations are based upon the lowest-observed-adverse-effect level (LOAEL). For wildlife, the toxicity benchmarks are based upon the no-observed-adverse-effect level (NOAEL) for chronic oral exposure in a taxonomically similar test species. Sufficient toxicity information was not available to estimate the LOAELs or NOAELs for some COPECs.

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 protect other groups within the terrestrial habitat of SWMU 87.

VII.3.4 Risk Characterization

Maximum concentrations in soil and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. Table 17 presents the results of these comparisons. HQs are used to quantify the comparison with benchmarks for plant and wildlife exposure.

Table 14
Transfer Factors Used in Exposure Models for
COPECs at SWMU 87

COPEC	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor
Inorganic			
Arsenic	4.0E-2 ^a	1.0E+0 ^b	2.0E-3 ^a
Barium	1.5E-1 ^a	1.0E+0 ^b	2.0E-4 ^c
Beryllium	1.0E-2 ^a	1.0E+0 ^b	1.0E-3 ^a
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
Copper	8.0E-1 ^f	2.5E-1 ^d	1.0E-2 ^a
Lead	9.0E-2 ^c	4.0E-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
Uranium	2.3E-2 ^f	1.0E+0 ^b	1.0E-2 ^c
Zinc	1.5E+0 ^a	3.0E-1 ^d	1.0E-1 ^a
Organic^g			
HMX	2.7E+1	1.4E+1	3.4E-8
m-Dinitrobenzene	5.3E+0	1.6E+1	6.4E-7
o-Nitrotoluene	1.8E+0	1.7E+1	4.4E-6

^aFrom Baes et al. (1984).

^bDefault value.

^cFrom NCRP (January 1989).

^dFrom Stafford et al. (1991).

^eFrom Ma (1982).

^fFrom IAEA (1994).

^gSoil-to-plant and food-to-muscle transfer factors from equations developed in Travis and Arms (1988). Soil-to-invertebrate transfer factors from equations developed in Connell and Markwell (1990). All three equations are based upon the relationship of the transfer factor to the log K_{ow} value of the compound.

COPEC = Constituent of potential ecological concern.

HMX = Octahydro-1,3,5,7-trinitro-1,3,5,7-tetrazocine.

IAEA = International Atomic Energy Agency.

K_{ow} = Octanol-water partition coefficient.

Log = Logarithm (base 10).

NCRP = National Council on Radiation Protection and Measurements.

SWMU = Solid Waste Management Unit.

Table 15
Media Concentrations^a for COPECs at SWMU 87

COPEC	Soil (maximum) ^a	Plant Foliage ^b	Soil Invertebrate ^b	Deer Mouse Tissues ^c
Inorganic				
Arsenic	2.5E+1 ^d	1.0E+0	2.5E+1	8.4E-2
Barium	2.7E+2	4.1E+1	2.7E+2	1.0E-1
Beryllium	1.7E+0 ^d	1.7E-2	1.7E+0	2.8E-3
Cadmium	5.8E+0	3.2E+0	3.5E+0	5.9E-3
Chromium (total)	2.0E+01	7.8E-1	2.5E+0	1.9E-1
Copper	2.0E+3	1.6E+3	5.1E+2	3.5E+1
Lead	3.2E+2	2.9E+1	1.3E+1	6.8E-2
Mercury	2.4E-1	2.4E-1	2.4E-1	1.9E-1
Nickel	5.9E+1	1.2E+1	2.2E+1	3.4E-1
Selenium	2.5E+1 ^d	1.3E+1	2.5E+1	6.0E+0
Silver	8.0E+0	8.0E+0	2.0E+0	8.1E-2
Uranium	1.8E+3	4.1E+1	1.8E+3	3.0E+1
Zinc	3.3E+2	5.0E+2	1.0E+2	9.5E+1
Organic				
HMX	2.0E-1	5.5E+0	2.7E+0	4.4E-7
<i>m</i> -Dinitrobenzene	1.4E-1	7.5E-1	2.2E+0	2.9E-6
<i>o</i> -Nitrotoluene	1.2E-1	2.2E-1	2.1E+0	1.6E-5

^aIn milligrams per kilogram. All biotic media are based upon dry weight of the media. Soil concentration measurements are assumed to have been based upon dry weight. Values have been rounded to two significant digits after calculation.

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

^cBased upon the deer mouse with an omnivorous diet. Product of the average concentration ingested in food and soil times the food-to-muscle transfer factor times a wet weight-dry weight conversion factor of 3.125 (EPA 1993).

^dMaximum concentration of parameter was one-half of detection limit.

COPEC = Constituent of potential ecological concern.

EPA = U.S. Environmental Protection Agency.

HMX = Octahydro-1,3,5,7-trinitro-1,3,5,7-tetrazocine.

SWMU = Solid Waste Management Unit.

Table 16
Toxicity Benchmarks for Ecological Receptors at SWMU 87

COPEC	Plant Benchmark ^{a,b}	Mammalian NOAELs			Avian NOAELs		
		Mammalian Test Species ^{c,d}	Test Species NOAEL ^{d,e}	Deer Mouse NOAEL ^{e,f}	Avian Test Species ^d	Test Species NOAEL ^{d,e}	Burrowing Owl NOAEL ^{e,g}
Inorganic							
Arsenic	10	mouse	0.126	0.133	mallard	5.14	5.14
Barium	500	rat ^h	5.1	10.5	chicken	20.8	20.8
Beryllium	10	rat	0.66	1.29	-	-	-
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
Copper	100	mink	11.7	29.8	chicken	47	47
Lead	50	rat	8.0	15.7	American kestrel	3.85	3.85
Mercury (Organic)	0.3	rat	0.03	0.06	mallard	0.0064	0.0064
Mercury (Inorganic)	0.3	mouse	13.2	14.0	Japanese quail	0.45	0.45
Nickel	30	rat	40	78	mallard	77.4	77.4
Selenium	1	rat	0.2	0.391	screech owl	0.44	0.44
Silver	2	rat	17.8 ^j	34.8	-	-	-
Uranium	5	mouse	3.1	3.2	black duck	16	16
Zinc	50	rat	160	313	chicken	14.5	14.5
Organic							
HMX	-	mouse ^k	3.0 ^l	2.97	-	-	-
m-Dinitrobenzene	-	rat	0.11 ^m	0.22	-	-	-
o-Nitrotoluene	-	rat	1.79 ⁿ	3.5	-	-	-

^aIn mg/kg soil dry weight.

^bFrom Efroymson et al. (1997).

^cBody weights (in kg) for the NOAEL conversion are as follows: lab mouse, 0.030; lab rat, 0.350; mink, 1.0 (except where noted).

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

^eIn mg/kg/d.

^fBased upon NOAEL conversion methodology presented in Sample et al. (1996), using a deer mouse body weight of 0.0239 kg 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.

**Table 16 (Concluded)
Toxicity Benchmarks for Ecological Receptors at SWMU 87**

- ^hBody weight: 0.435 kg.
- ⁱBody weight: 0.303 kg.
- ^jBased upon a rat lowest-observed-adverse-effect level of 89 mg/kg/d (EPA 1998a) and an uncertainty factor of 0.2.
- ^kBody weight: 0.023 kg.
- ^lFrom Maxwell and Opresko (1996).
- ^mBased upon a subchronic (16-week) NOAEL of 1.13 mg/kg/d (Talmage and Opresko 1996) and an uncertainty factor of 0.1.
- ⁿBased upon the rat NOAEL for TNT and the ratio of LD₅₀ values (891/795) (Micromedex 1998).
- COPEC = Constituent of potential ecological concern.
- EPA = U.S. Environmental Protection Agency.
- HMX = Octahydro-1,3,5,7-trinitro-1,3,5,7-tetrazocine.
- kg = Kilogram(s).
- LD₅₀ = Acute lethal dose to 50 percent of the test population.
- mg = Milligram(s).
- mg/kg/d = Milligram(s) per kilogram body weight per day.
- NOAEL = No-observed-adverse-effect level.
- SWMU = Solid Waste Management Unit.
- TNT = Trinitrotoluene.
- = Insufficient toxicity data.

Table 17
 HQs for Ecological Receptors at SWMU 87

COPEC	Plant HQ ^a	Deer Mouse HQ (Herbivorous) ^a	Deer Mouse HQ (Omnivorous) ^a	Deer Mouse HQ (Insectivorous) ^a	Burrowing Owl HQ ^a
Inorganic					
Arsenic	2.5E+0	1.8E+0	1.6E+1	3.0E+1	1.3E-2
Barium	5.4E-1	6.8E-1	2.4E+0	4.1E+0	2.9E-2
Beryllium	1.7E-1	6.1E-3	1.1E-1	2.1E-1	-
Cadmium	1.9E+0	2.7E-1	2.8E-1	3.0E-1	9.4E-3
Chromium (total)	2.0E+1	3.4E-5	6.0E-5	8.5E-5	6.5E-2
Copper	2.0E+1	8.7E+0	5.8E+0	2.9E+0	1.8E-1
Lead	6.4E+0	3.5E-1	2.7E-1	1.9E-1	1.9E-1
Mercury (Organic)	8.1E-1	6.2E-1	6.2E-1	6.2E-1	3.5E+0
Mercury (Inorganic)	8.1E-1	2.8E-3	2.8E-3	2.8E-3	4.9E-2
Nickel	2.0E+0	2.6E-2	3.6E-2	4.7E-2	2.2E-3
Selenium	2.5E+1	5.2E+0	7.7E+0	1.0E+1	1.7E+0
Silver	4.0E+0	3.6E-2	2.3E-2	9.7E-3	-
Uranium	3.6E+2	3.8E+0	4.7E+1	8.9E+1	4.6E-1
Zinc	6.6E+0	2.5E-1	1.5E-1	5.3E-2	7.8E-1
Organic					
HMX	-	2.9E-1	2.1E-1	1.4E-1	-
m-Dinitrobenzene	-	5.3E-1	1.0E+0	1.5E+0	-
o-Nitrotoluene	-	9.8E-3	5.1E-2	9.2E-2	-
H1 ^b	4.5E+2	2.3E+1	8.2E+1	1.4E+2	7.0E+0

^a Bold values indicate the HQ or HI exceeds unity.

^b The HI is the sum of individual HQs.

COPEC = Constituent of potential ecological concern.

HI = Hazard index.

HMX = Octahydro-1,3,5,7-trinitro-1,3,5,7-tetrazocine.

HQ = Hazard quotient.

SWMU = Solid Waste Management Unit.

- = Insufficient toxicity data available for risk estimation purposes.

HQs for plants exceeded unity for arsenic, cadmium, total chromium, copper, lead, nickel, selenium, silver, uranium, and zinc. Because of a lack of sufficient toxicity information, HQs for plants could not be determined for any of the organic COPECs. HQs exceeded unity for all three dietary regimes in the deer mouse for arsenic, copper, selenium, and uranium. HQs exceeded unity for the omnivorous and insectivorous deer mice for barium and for the insectivorous deer mouse for m-dinitrobenzene. For the burrowing owl, the only HQs that exceeded unity were those from exposures to selenium and mercury when the mercury is assumed to be entirely in organic form. HQs for beryllium, silver, and all organic COPECs could not be determined for the burrowing owl because of a lack of sufficient toxicity information. As directed by the NMED, HIs were calculated for each of the receptors (the HI is the sum of chemical-specific HQs for all pathways for a given receptor). For all receptors, total HIs are greater than unity, with a maximum HI of $4.5E+2$ for plants.

Tables 18 and 19 summarize the internal and external dose-rate model results for U-235 and U-238 for the deer mouse and burrowing owl, respectively. The total radiation dose rate to the deer mouse was predicted to be $9.7E-2$ rad/day and that for the burrowing owl was $9.3E-2$ rad/day. The dose rates for the deer mouse and the burrowing owl are 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 87. These uncertainties result from assumptions used in calculating risk that could overestimate or underestimate the true risk presented at the site. For this risk assessment, assumptions are made that are more likely to overestimate exposures and risk rather than to underestimate them. These conservative assumptions are used to be more protective of the ecological resources potentially affected by the site. Conservatism incorporated into this risk assessment include the use of maximum analyte concentrations measured in soil to evaluate risk, the use of wildlife toxicity benchmarks based upon NOAEL values, and the incorporation of strict herbivorous and strict insectivorous diets for predicting the extreme HQ values for the deer mouse. Each of these uncertainties, which are consistent among each of the SWMU-specific ecological risk assessments, is discussed in greater detail in the uncertainty section of the ecological risk assessment methodology document for the SNL/NM ER Project (IT July 1998).

Uncertainties associated with the estimation of risk to ecological receptors following exposure to U-235 and U-238 are primarily related to those inherent in the radionuclide-specific data. Radionuclide-dependent data are measured values that have their associated errors. 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 internal and external exposure to radionuclides in soil.

In the estimation of ecological risk, background concentrations are included as a component of maximum on-site concentrations. Conservatism in the modeling of exposure and risk can result in the prediction of risk to ecological receptors when exposed at background concentrations. As shown in Table 20, HQs associated with exposures to background are greater than 1.0 for arsenic, barium, chromium, and selenium. In the case of barium, background may account for approximately 91 percent of the HQ values. For chromium,

Table 18
Internal and External Dose Rates for
Deer Mice Exposed to Radionuclides at SWMU 87

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
U-235	1.19E+1	2.4E-5	1.9E-4	3.2E-4
U-238	5.94E+2	6.0E-3	9.0E-2	9.6E-2
Total		1.3E-4	9.0E-2	9.7E-2

pCi/g = Picocurie(s) per gram.
 SWMU = Solid Waste Management Unit.

Table 19
Internal and External Dose Rates for
Burrowing Owls Exposed to Radionuclides at SWMU 87

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
U-235	1.19E+1	5.2E-5	1.9E-4	2.5E-4
U-238	5.94E+2	2.4E-3	9.0E-2	9.3E-2
Total		2.5E-3	9.0E-2	9.3E-2

pCi/g = Picocurie(s) per gram.
 SWMU = Solid Waste Management Unit.

Table 20
 HQs for Ecological Receptors Exposed to Background Concentrations at SWMU 87

COPEC	Plant HQ ^a	Deer Mouse HQ (Herbivorous) ^a	Deer Mouse HQ (Omnivorous) ^a	Deer Mouse HQ (Insectivorous) ^a	Burrowing Owl HQ ^a
Inorganic					
Arsenic	9.8E-1	6.9E-1	6.2E+0	1.2E+1	5.0E-3
Barium	4.9E-1	6.2E-1	2.2E+0	3.7E+0	2.7E-2
Beryllium	7.5E-2	2.7E-3	4.7E-2	9.2E-2	-
Cadmium	2.1E-1	3.0E-2	3.1E-2	3.3E-2	1.0E-3
Chromium (total)	1.9E+1	3.3E-5	5.7E-5	8.2E-5	6.3E-2
Copper	1.7E-1	7.3E-2	4.9E-2	2.4E-2	1.5E-3
Lead	3.8E-1	2.1E-2	1.6E-2	1.1E-2	1.1E-2
Mercury (Organic)	1.8E-1	1.4E-1	1.4E-1	1.4E-1	7.8E-1
Nickel	5.5E-1	7.3E-3	1.0E-2	1.3E-2	6.2E-4
Selenium	2.7E+0	5.6E-1	8.3E-1	1.1E+0	1.8E-1
Silver	1.3E-1	1.1E-3	7.2E-4	3.0E-4	-
Uranium	4.6E-1	4.8E-3	6.0E-2	1.1E-1	5.9E-4
Zinc	1.0E+0	3.9E-2	2.4E-2	8.3E-3	1.2E-1
HI ^b	2.7E+1	2.1E+0	9.6E+0	1.7E+1	1.2E+0

^a Bold values indicate the HQ or HI exceeds unity.

^b The HI is the sum of individual HQs.

COPEC = Constituent of potential ecological concern.

HI = Hazard index.

HQ = Hazard quotient.

SWMU = Solid Waste Management Unit.

- = Insufficient toxicity data available for risk estimation purposes.

background may account for 96 percent of the HQs. Therefore, it is likely that the actual risks from barium and chromium at SWMU 87 are overestimated by the HQs calculated in this risk screening assessment because of conservatisms incorporated into both the exposure assessment and the toxicity benchmarks for these COPECs (e.g., the use of NOAELs for wildlife receptors).

A significant source of uncertainty associated with the prediction of ecological risks at this site is the use of the maximum concentrations measured to evaluate exposure and risk. This results in a conservative exposure scenario that does not necessarily reflect actual site conditions. To assess the potential degree of overestimation caused by using the maximum measured soil concentrations in the exposure assessment, the upper 95% confidence limit (UCL) of the mean soil concentration was calculated for each of the COPECs with HQs greater than unity to determine whether these HQs can be accounted for by the magnitude of the extreme measurement. The 95% UCLs of barium and chromium (136 and 8.2 mg/kg, respectively) were found to be less than the corresponding background screening values. Therefore, risks from exposures to these COPECs at SWMU 87 are likely to be within the background levels as shown in Table 20. Predictions of potential risk from exposures to cadmium, lead, nickel, silver, and zinc are principally based upon the exceedence of the maximum measured concentrations of these COPECs over the corresponding plant toxicity benchmarks. For cadmium and nickel, the 95% UCL concentrations (2.6 and 19.6 mg/kg, respectively) are less than the corresponding plant toxicity benchmarks, and for lead, silver, and zinc, exposure at the 95% UCL concentrations in soil (81.9, 2.8, and 102 mg/kg, respectively) result in HQs that are less than or equal to 2, indicating a low potential for risk. Similarly, the 95% UCL concentrations of mercury and m-dinitrobenzene (0.06 and 0.0643 mg/kg, respectively) are below that required to indicate potential ecological risk. Based upon these exposure concentrations, the maximum HQ for mercury would be 0.85 (for the burrowing owl) and that for m-dinitrobenzene would be 0.71 (for the insectivorous deer mouse). These results indicate that the predictions of potential risk to ecological receptors for barium, cadmium, chromium, lead, mercury, nickel, silver, zinc, and m-dinitrobenzene are primarily due to using the maximum values as the exposure point concentration for the entire site. When exposure is based upon a site-wide mean, as conservatively estimated by the 95% UCL of the mean, the potential for risk from these COPECs can be considered low.

For copper and uranium, exposures in the deer mice to the 95% UCL of the mean concentration at SWMU 87 (estimated at 442 and 17.4 mg/kg, respectively) reduces the HQs to values indicating a low potential for risk. For copper, the highest HQ among the three dietary regimes of the deer mouse based upon the 95% UCL concentration is 1.9 (for the herbivorous deer mouse). In the case of uranium, the HQs fall below unity for all three dietary regimes when exposure is based upon the 95% UCL. For plants, however, the HQs for copper and uranium are 4.4 and 3.5, respectively, indicating a higher potential for adverse effects to these receptors. It should be noted, however, that in both cases, the plant toxicity benchmarks are conservatively based upon laboratory tests using soil amendments with highly available forms of copper and uranium (copper sulfate and uranyl nitrate, respectively [Efroymsen et al. 1997]). It is likely that only a small fraction of the copper and uranium in the soil at SWMU 87 is in a form that is highly available for plant uptake, and therefore, the plant toxicity benchmarks for these metals probably overestimate risk to plants to a significant degree.

Although arsenic and selenium showed HQs greater than unity for plants and deer mice (all dietary regimes), the exposure estimates upon which these HQs are based are uncertain because they are based upon one-half detection limit values rather than actual measured

concentrations. Detections of the COPECs in the soil did not exceed the corresponding background screening values; however, because some detection limits were greater than the background screening values, it is uncertain whether these two metals actually exceed background in these samples. However, based upon the low number of samples for which this uncertainty exists and the lack of exceedences in the other samples, it is concluded that these two COPECs are unlikely to be present at levels that could potentially result in risk to these receptors.

Based upon this uncertainty analysis, ecological risks at SWMU 87 are expected to be generally low. HQs greater than unity were initially predicted; however, closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to exposure concentration and the contribution of background risk. Two potential exceptions are plant exposure to copper and uranium. However, it is likely that the bioavailability of these metals to plants at this site limits its potential as a significant risk driver.

VII.3.6 Risk Interpretation

Ecological risks associated with SWMU 87 were estimated through a screening assessment that incorporated site-specific information when available. Overall, risks to ecological receptors are expected to be low because predicted risks associated with exposure to COPECs are based upon calculations using maximum detected values. The 95% UCLs of the mean concentration of barium and chromium were found to be within background range. The 95% UCL concentrations of cadmium, lead, mercury, nickel, silver, zinc, and m-dinitrobenzene resulted in HQs that indicated a low potential for risk to ecological receptors. For copper and uranium, exposures in the deer mice to the 95% UCL concentrations also indicated a low potential for risk to these receptors; however, these concentrations still indicated that a moderate potential for risk to plants exists at this site from exposures to these metals. It is likely, however, that these predictions of potential risk are greatly overestimated by the fact that the plant toxicity benchmarks for copper and uranium are based upon exposure to highly available forms of these metals while most of the copper and uranium at SWMU 87 is unlikely to be highly available to plant uptake. Because the predictions of potential risk to deer mice and plants from exposure to arsenic and selenium were based upon one-half detection limit values, with no detections indicating concentrations that exceed background, the probability of risk from these two metal is considered to be low. Based upon this final analysis, ecological risks associated with SWMU 87 are expected to be low.

VII.3.7 Screening Assessment Scientific/Management Decision Point

After potential ecological risks associated with the site have been assessed, a decision is made regarding whether the site should be recommended for NFA or whether additional data should be collected to assess actual ecological risk at the site more thoroughly. With respect to this site, ecological risks are predicted to be low. 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

Introduction

Sandia National Laboratories/New Mexico (SNL/NM) 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/NM 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 SWMUs exist within the boundaries of the Kirtland Air Force Base (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/NM ER draft Environmental Assessment (DOE 1996) presents a summary of the hydrogeology of the sites, the biological resources present and proposed land use scenarios for the SNL/NM SWMUs. At this time, all SNL/NM SWMUs have been tentatively designated for either industrial or recreational future land use. The NMED has also requested that risk calculations be performed based upon a residential land use scenario. All three land use scenarios will be addressed in this document.

The SNL/NM ER project has screened the potential exposure routes and identified default parameter values to be used for calculating potential intake and subsequent Hazard index (HI), excess cancer risk and dose values. The 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 shellfish
- 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)
- 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/NM 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, currently no consumption of fish, shellfish, fruits, vegetables, meat, eggs, or dairy occurs for 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 shellfish
- Ingestion of contaminated fruits and vegetables
- Ingestion of contaminated meat, eggs, and dairy products
- Ingestion of contaminated surface water while swimming.

That part of the exposure pathway for radionuclides related to immersion in contaminated air or water also is 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 inorganic compounds is not considered significant and will not be included. In general, the dermal exposure pathway is generally not considered to 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.

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

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

Generic Equation for Calculation of Risk Parameter Values

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

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

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

where

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

The total risk/dose (either cancer risk or 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 constituents of concern (COC) 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 1E-6 for Class A and B carcinogens and 1E-5 for Class C carcinogens. 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 used by SNL/NM 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/NM 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/NM 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/NM ER sites, but this scenario has been requested to be considered by the NMED. For sites designated as industrial or recreational land use, SNL/NM 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 SNL/NM ER sites. 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/NM 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	8 hr/day for 250 day	4 hr/wk for 52 wk/yr	350 day/yr
Exposure duration (yr)	25 ^{a,b}	30 ^{a,b}	30 ^{a,b}
Body weight (kg)	70 ^{a,b}	70 adult ^{a,b} 15 child	70 adult ^{a,b} 15 child
Averaging Time (days) for carcinogenic compounds (= 70 y x 365 day/yr)	25,550 ^a	25,550 ^a	25,550 ^a
for noncarcinogenic compounds (= ED x 365 day/yr)	9,125	10,950	10,950
Soil Ingestion Pathway			
Ingestion rate	100 mg/day ^c	200 mg/day child 100 mg/day adult	200 mg/day child 100 mg/day adult
Inhalation Pathway			
Inhalation rate (m ³ /yr)	5,000 ^{a,b}	260 ^d	7,000 ^{a,b,d}
Volatilization factor (m ³ /kg)	Chemical specific	chemical specific	chemical specific
Particulate emission factor (m ³ /kg)	1.32E9 ^a	1.32E9 ^a	1.32E9 ^a
Water Ingestion Pathway			
Ingestion rate (liter/day)	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

^aRisk Assessment Guidance for Superfund, Vol. 1, Part B (EPA 1991).

^bExposure Factors Handbook (EPA 1989b).

^cEPA Region VI guidance.

^dFor radionuclides, RESRAD (Argonne National Laboratory, 1993. *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD*, Version 5.0, ANL/EAD/LD-2, Argonne National Laboratory, Argonne, IL, 1993) is used for human health risk calculations; default parameters are consistent with RESRAD guidance.

^eDermal Exposure Assessment (EPA 1992).

ED = Exposure duration.

EPA = U.S. Environmental Protection Agency.

hr = Hour.

kg = Kilogram(s).

m² = Square meter(s).

m³ = Cubic meter(s).

mg = Milligram(s).

NA = Not available.

wk = Week.

yr = Year.

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ADDITIONAL /SUPPORTING DATA

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