9-1-2005

Justification for Class III Permit Modification September 2005 SWMU 45 OU 1309 Liquid Discharge Tijeras Arroyo

Sandia National Laboratories/NM

This work supported by the
United States Department of Energy
under contract DE-AC04-94185000.

SWMU 45
Liquid Discharge

Environmental Restoration Project

Site History

- SWMU 45, Liquid Discharge, is located at the northeast corner of TA-IV and covers approximately 0.8 acres on the northern rim of Tijeras Arroyo.
- In February 1985, an SNL/NM employee observed the discharge of brownish water from an unmarked water truck. This single discharge was to the ground surface. The type of water was not known.

Depth to Groundwater

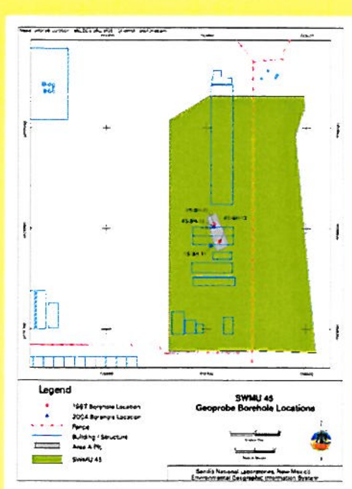
- The regional aquifer is approximately 500 ft bgs, and a perched aquifer (not a source of drinking water) is approximately 300 ft bgs.

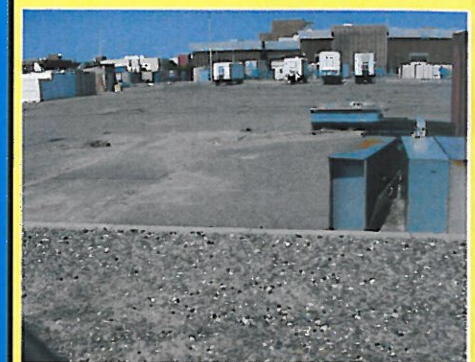
Constituents of Concern

- VOCs
- SVOCs
- HE compounds
- Metals
- Radionuclides

Investigations

- In 1993, soil sampling was conducted at a sewer-line trench located in the northern part of SWMU 45. The corresponding analytical results were presented in the SWMU 45 NFA Proposal, but were later determined to be applicable to another site, SWMU 48.
- In 1994, the ground surface at SWMU 45 was surveyed for UXO/HE and radioactive materials; no anomalies were detected. Historical aerial photographs also were reviewed. During the time when the discharge occurred, the SWMU 45 area was used as a temporary storage (borrow) area for construction related soil. For reporting purposes, the borrow area was named the Liquid Discharge Area. A separate, shallow trench shown in the aerial photographs was named the Area A Pit.
- In May 1995, a passive soil-vapor survey was conducted across SWMU 45 for scoping purposes. Twenty-one collectors were buried for 14 days at a depth of approximately 1 ft. After retrieval, the collectors were analyzed at an off-site laboratory. Very low levels of TCE, PCE, and BTEX were detected. SVOCs were eliminated from the COC list following this scoping survey.
- In May 1995, a geophysical survey was conducted across SWMU 45. Three buried magnetic anomalies were identified.
- In June 1995, scoping soil samples were collected from hand-augured boreholes to 1.5 ft bgs at the Liquid Discharge Area. The samples were analyzed for VOCs and RCRA metals and radionuclides. Three VOCs were detected at low concentrations (J qualified). One metal, barium, was above the background value. Except for lead, the other metals had MDLs that were above background values.





View of the site to the west.

View of the site to the south.

- In October 1995, the three magnetic anomalies were excavated from two trenches dug to depths of 4 and 6 ft. The buried material was found in a debris layer at approximately 3 ft bgs and consisted of non-hazardous scrap metal and concrete rubble. Soil samples were collected below the debris layer at 3 ft bgs using a backhoe bucket. The soil samples were analyzed for VOCs, RCRA metals, and radionuclides (one sample only) by on-site and off-site laboratories. Off-site laboratory results revealed two metals, barium and lead, above background values and some of the other metals had MDLs that were above background values.
- In October 1995, soil samples were collected from 10 locations at the surface and to 1.5 ft bgs at the Liquid Discharge Area. Samples were analyzed at on-site and off-site laboratories for VOCs, RCRA metals, and radionuclides (two samples only). Off-site laboratory results revealed five metals (arsenic, barium, cadmium, lead, and mercury) exceeded background values and the MDA for U-235 exceeded the background activity for one sample.
- In October 1995, two boreholes were advanced to investigate the Area A Pit. Soil samples were collected to 14 ft bgs. Samples were analyzed for VOCs, RCRA metals, and radionuclides by on-site and off-site laboratories. Off-site laboratory results revealed arsenic concentrations that exceeded the background values and some of the other metals had MDLs that were above background values.
- In November 2003, a comprehensive review of historical aerial photographs was conducted. The Area A Pit was determined to be a location where an Army tank had been parked for security purposes in the late 1950s and early 1960s. The Area A Pit was filled with soil prior to 1964.
- Also in November 2003, historical records were reviewed. Previously overlooked interviews revealed that the 1985 water discharge mostly likely occurred at the western end of the nearby SWMU 229 outfall ditch. Two sampling events (September 1994 and March 2001) were available for the SWMU 229 outfall ditch. The September 1994 soil samples were collected at the western end of the ditch to a maximum depth of 3 ft. The samples were analyzed for VOCs, SVOCs, metals, and radionuclides by on-site and off-site laboratories. Off-site laboratory results revealed five metals (antimony, arsenic, barium, cadmium, and lead) that had concentrations exceeding background values. Two VOCs and eight SVOCs were reported at low concentrations (J qualified). The MDA for Cs-137 exceeded the background activity. The March 2001 soil samples also were collected at the western end of the SWMU 229 outfall ditch to a maximum sampling depth of 19 ft bgs. One metal, barium, had a concentration that exceeded the background value.
- In February 2004, two locations at the SWMU 45 Area A pit were sampled. A Geoprobe rig was used to collect soil samples to a depth of 10 ft. The soil samples were analyzed for metals, VOCs, SVOCs, and radionuclides by an off-site laboratory. One metal, barium, exceeded the background value. Two VOCs and two SVOCs were reported at low concentrations; most were J qualified.

Summary of Data Used for NFA Justification

- A total of 54 confirmatory soil samples were used in the October 2004 risk assessment.
- The soil samples were from the (1) the Area A Pit, (2) the magnetic anomalies excavation trenches, (3) the Liquid Discharge Area, and (4) SWMU 229 outfall ditch.

Recommended Future Land Use

- Industrial land use was established for this site.

Results of Risk Analysis

- Risk assessment results for the industrial and residential land-use scenarios are calculated per NMED risk assessment guidance as presented in "Supplemental Risk Document Supporting Class 3 Permit Modification Process."
- Because COCs were present in concentrations greater than background screening levels or because constituents were present that did not have background-screening numbers, it was necessary to perform a risk assessment for the site. The risk assessment analysis evaluated the potential for adverse health effects for the industrial and residential land-use scenarios.
- The maximum concentration value for lead was 740 mg/kg. The average lead concentration was 257 mg/kg for SWMU 45. The EPA intentionally does not provide any human health toxicological data on lead; therefore, no risk parameter values could be calculated. The NMED guidance for lead screening concentrations for construction and industrial land-use scenarios are 750 and 1,500 mg/kg, respectively. The EPA screening guidance value for a residential land-use scenario is 400 mg/kg. Because the average concentration value for lead at this site is less than the screening values, lead was eliminated from further consideration in the human health risk assessment.
- The total human health HI was 1.2 for the residential land-use scenario, which is greater than the NMED guideline of 1. The total estimated excess cancer risk was 3E-5 for the residential land-use scenario, which is above the NMED guideline of 1E-5. Using the UCLs of the mean concentrations for the main contributors to risk (antimony and arsenic), the total HI was reduced to 0.56, and the total estimated excess cancer risk was reduced to 1.59E-5. The incremental HI and incremental excess cancer risk was reduced to 0.17 and 4.57E-6, respectively. The total and incremental HI, and the incremental excess cancer risks using UCLs are below NMED guidelines.
- The incremental TEDE for an industrial land-use scenario was 8.7E-2 mrem/yr, which is below the EPA numerical guideline of 15 mrem/yr. The estimated excess cancer risk is 1.2E-6. The incremental TEDE for a residential land-use scenario was 2.1E-1 mrem/yr, which is below the EPA numerical guideline of 75 mrem/yr. The estimated excess cancer risk is 3.5E-6. Therefore, SWMU 45 is eligible for unrestricted radiological release.
- Using the SNL predictive ecological risk assessment methodology, the ecological risk for SWMU 45 is predicted to be low.
- In conclusion, human health and ecological risks are acceptable per NMED guidance. Thus, the site is proposed for CAC without institutional controls.

Risk Assessment Values for SWMU 45 Nonradiological COCs

COC[a]	Maximum Concentration/UCLs (All Samples) (mg/kg)	Residential Land-Use Scenario[b] Hazard Index	Cancer Risk
Antimony	17/**5.35**	0.56/0.18	–/–
Arsenic	11/**5.43**	0.51/**0.25**	3E-5/**1E-5**
Barium	280	0.05	–
Cadmium	2.4	0.06	2E-9
Chromium VI	0.05[c]	0.00	2E-10
Mercury	2.19	0.00	–
Selenium	5[c]	0.02	–
Acetone	0.009 J	0.00	–
2-Butanone	0.006 J	0.00	–
Benzo(a)anthracene	0.071 J	0.00	1E-7
Benzo(a)pyrene	0.092 J	0.00	1E-6
Benzo(b)fluoranthene	0.16 J	0.00	3E-7
Chrysene	0.12 J	0.00	2E-9
Di-n-butyl phthalate	0.18 J	0.00	–
bis(2-Ethylhexyl) phthalate	0.17 J	0.00	4E-9
Fluoranthene	0.23 J	0.00	–
Methylene chloride	0.0011 J	0.00	1E-10
Phenanthrene	0.18 J	0.00	–
Pyrene	0.28 J	0.00	–
Total		1.20/**0.56**	3E-5/**1.59E-5**

Bold values represent UCLs and calculations with UCLs.
[a]Maximum concentration exceeded background value, where applicable, or was detected above MDL.
[b]EPA 1989.
[c]Maximum concentration is one-half of the detection limit.

For More Information Contact

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Sandia National Laboratories

Justification for Class III Permit Modification

September 2005

SWMU 45
OU 1309
LIQUID DISCHARGE TIJERAS ARROYO

NFA Submitted September 1997

RSI Submitted September 1999

RSI Submitted November 2004

Environmental
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United States Department of Energy
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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

NFA

EM/REG/MAN

Department of Energy

Field Office, Albuquerque
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P.O. Box 5400
Albuquerque New Mexico 87185-5400

SEP 26 1997

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. Benito Garcia, Bureau Chief
New Mexico Environment Department
Hazardous and Radioactive Materials Bureau
2044 Galisteo Street
P.O. Box 26110
Santa Fe, NM 87505-2100

Dear Mr. Garcia:

Enclosed are two copies of the ninth submission of No Further Action (NFA) proposals for Sandia National Laboratories/New Mexico (SNL/NM), ID Number NM5890110518-1. Fourteen SNL/NM environmental restoration sites are included in this package:

<u>OU 1303</u>

Site 1	Rad Waste Landfill/Chemical Disposal Pits
Site 3	Chemical Disposal Pit (TA-II)
Site 44A&B	Decon Site & Uranium Calibration Pits

<u>OU 1309</u>

Site 45	Liquid Discharge (Behind TA-IV)

<u>OU 1332</u>

Site 19	TRUPAK Boneyard Storage Area

<u>OU 1333</u>

Site 59	Pendulum Site
Site 63A	Balloon Test Area PDSP Site
Site 63B	Balloon Test Area Balloon/Helicopter Site
Site 64	Gun Site (Madera Canyon)

<u>OU 1334</u>

Site 11	Explosive Burial Mounds
Site 21	Metal Scrap (Coyote Springs)
Site 57B	Workman Site: Target Area
Site 88B	Firing Site: Instrumentation Pole
Site 70	Explosives Test Pit (Water Towers)

If you have any questions, please contact John Gould at (505) 845-6089, or Mark Jackson at (505) 845-6288.

Sincerely,

Michael J. Zamorski
Acting Area Manager

Enclosures

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S. Kruse, NMED

Sandia National Laboratories/New Mexico

PROPOSAL FOR RISK-BASED NO FURTHER ACTION ENVIRONMENTAL RESTORATION SITE 45 LIQUID DISCHARGE OPERABLE UNIT 1309

September 1997

Environmental
Restoration
Project

United States Department of Energy
Albuquerque Operations Office

PROPOSAL FOR
RISK-BASED NO FURTHER ACTION
ENVIRONMENTAL RESTORATION SITE 45
LIQUID DISCHARGE
OPERABLE UNIT 1309
September 1997

Prepared by
Sandia National Laboratories/New Mexico
Environmental Restoration Project
Albuquerque, New Mexico

Prepared for
the U. S. Department of Energy

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ACRONYMS AND ABBREVIATIONS

1,1,2,2-TCA	1,1,2,2-tetrachloroethane
amsl	above mean sea level
bgl	below ground level
BTEX	benzene, toluene, ethylbenzene, and xylenes
CEARP	Comprehensive Environmental Assessment and Response Program
COC	constituent(s) of concern
DOE	U.S. Department of Energy
DV	data verification/validation
EA	Environmental Assessment
EM	electromagnetic
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ERCL	Environmental Restoration Chemistry Laboratory
ft	feet
HE	high explosives
LCS	laboratory control samples
MEK	2-butanone
µg/kg	microgram(s) per kilogram
mg/kg	milligram(s) per kilogram
NFA	No Further Action
NMED	New Mexico Environment Department
OU	Operable Unit
PCE	perchloroethylene
pCi/g	picocuries per gram
PID	Photoionization Detector
ppb	parts per billion
ppm	parts per million
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
SNL/NM	Sandia National Laboratories/New Mexico
SVOC	semivolatile organic compound
TA	Technical Area
TCE	trichloroethylene
tics	total ion counts
TOP	technical operating procedure
UXO/HE	unexploded ordnance and high explosives
VOC	volatile organic compound

1.0 INTRODUCTION

Sandia National Laboratories/New Mexico (SNL/NM) is proposing No Further Action (NFA) status for Environmental Restoration (ER) Site 45 (the Liquid Discharge site), which is near the northeastern corner of Technical Area (TA) IV. ER Site 45 is listed in the Hazardous and Solid Waste Amendment Module IV (U.S. Environmental Protection Agency [EPA] 1993) of the SNL/NM Resource Conservation and Recovery Act (RCRA) Hazardous Waste Management Facility Permit #NM5890110518 (EPA 1992). The SNL/NM ER Project manages ER Site 45 under Operable Unit (OU) 1309.

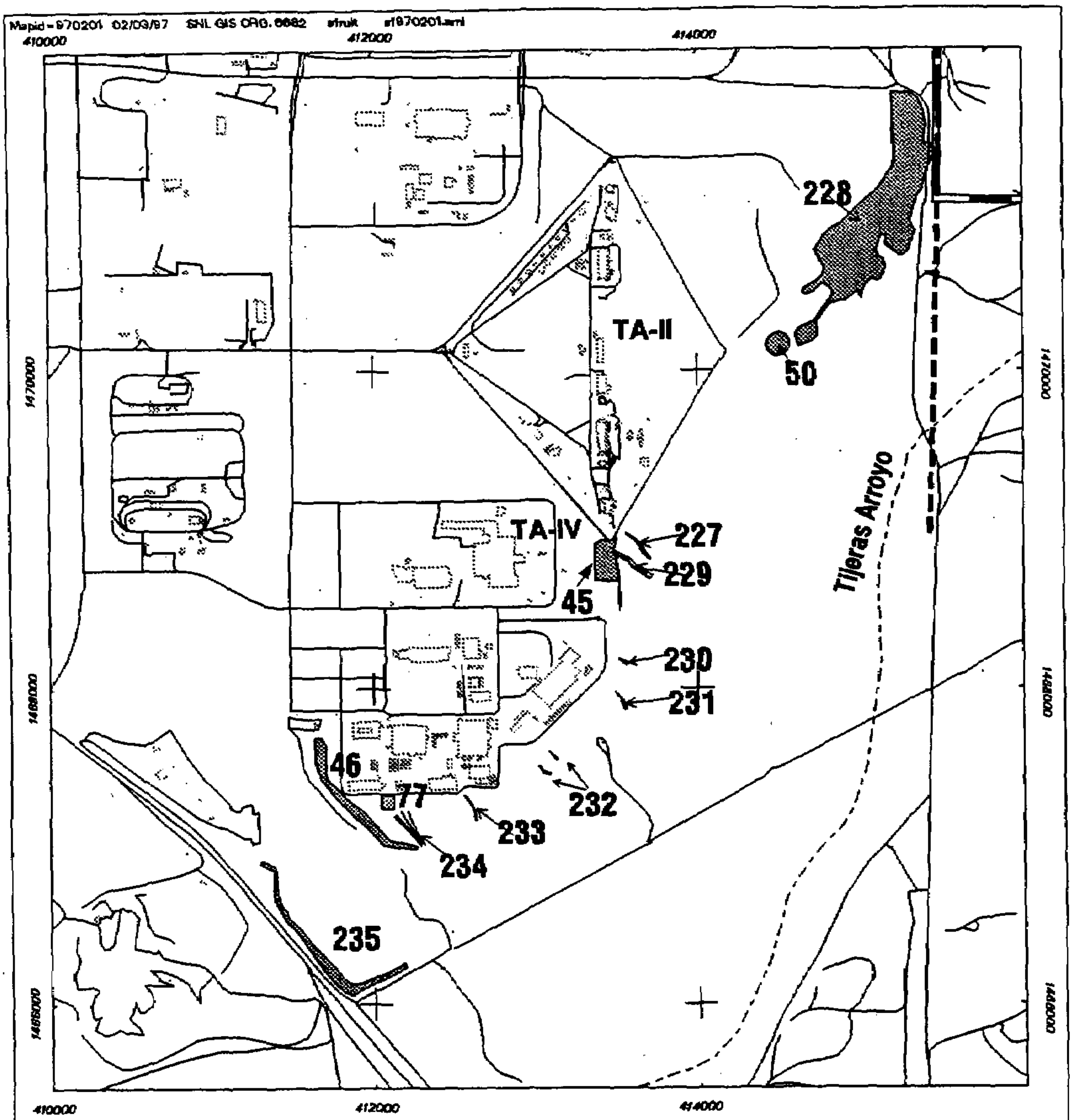
1.1 Description of ER Site 45

ER Site 45 covers 0.8 acre near the northeast corner of TA-IV and the southern apex of TA-II (Figure 1-1). ER Site 45 is located along the northern rim of Tijeras Arroyo on fenced, industrial land controlled by the U.S. Department of Energy (DOE). The topography is nearly flat, with an elevation of approximately 5,400 feet (ft) above mean sea level (amsl). The site is situated well above the 100-year floodplain. The active Tijeras Arroyo channel is located approximately 1,600 ft southeast of ER Site 45 at an elevation of about 5,350 ft amsl. No perennial surface water bodies are present near ER Site 45; Tijeras Arroyo is ephemeral and typically flows several days per year. The surficial soil at ER Site 45 consists of Pleistocene-age Embudo gravelly fine sandy loam that is underlain by Santa Fe Group sediments. ER Site 45 is defined as being within the SNL/NM North Super Group area for purposes of evaluating background levels of metals and radionuclides in soil (IT Corporation 1996). The depth to groundwater at ER Site 45 is approximately 300 ft. The vegetation consists of scattered grasses.

Environmental concern about ER Site 45 is based on the February 1985 discharge of water from a tank truck. Additional details are presented in Sections 2.0 and 3.0.

1.2 No Further Action Basis

Review and analysis of all relevant data for ER Site 45 indicate that levels for the constituents of concern (COC) at this site are less than applicable risk-assessment action levels. Thus, ER Site 45 is being proposed for an NFA decision based on confirmatory-sampling data demonstrating that COCs that may have been released from this solid waste management unit into the environment pose an acceptable level of risk under current and projected future land use, per NFA Criterion 5 of the ER Document of Understanding (New Mexico Environment Department [NMED] 1996).



Legend

- Arroyo (Active Channel)
- Road
- Building
- KAFB Boundary
- ER Site

Figure 1-1
Tijeras Arroyo OU 1309
Environmental Restoration Sites Near TA-IV

Scale in Feet: 0, 500, 1000
Scale in Meters: 0, 120, 240

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

2.0 HISTORY OF ER SITE 45

ER Site 45 was identified in the Comprehensive Environmental Assessment and Response Program (CEARP) (DOE 1987). The site was not mentioned in the RCRA Facility Assessment (EPA 1987).

2.1 Historical Operations

A single discharge of water led to the identification of ER Site 45 in the CEARP (DOE 1987). In February of 1985, a SNL/NM employee observed that a tank truck was discharging about 500 to 1,000 gallons of brownish water onto the ground surface east of TA-IV (confidential interview 1993). The employee asked the truck driver what he was doing; he replied "discharging water." The tank truck did not have SNL/NM or military markings. The location of the discharge appeared wet during February 12 to 15, 1985. No documents record that the tank truck was at the site on more than one occasion. No more water-disposal details are available in the CEARP or any other documents. The precise location of the water discharge is not known; however, the location is assumed to be within the "liquid-discharge area" as defined in Section 3.2.10.2.

No hazardous chemicals or materials are known to have been disposed of at ER Site 45. The SNL/NM ER Project has assumed that the potential COCs in soil consist of organic compounds and RCRA metals.

2.2 Previous Audits, Inspections, and Findings

Besides the CEARP, no other environmental data were compiled before the SNL/NM ER Project was established. Therefore, Section 3.0 presents the additional environmental information that has been subsequently compiled by the SNL/NM ER Project.

3.0 EVALUATION OF RELEVANT EVIDENCE

Two recent reports are relevant to ER Site 45. First, SNL/NM has prepared *Site Environmental Reports* on an annual basis since 1985; none of these 11 reports has identified environmental concerns such as chemical releases at or near ER Site 45 (SNL/NM 1996). Second, an *Environmental Assessment* (EA) *for Operation, Upgrades, and Modifications in SNL/NM Technical Area IV* was submitted to various government agencies in 1996 (SNL/NM 1996b). No environmental concerns relevant to ER Site 45 were identified in the EA.

3.1 Unit Characteristics and Operating Practices

ER Site 45 covers 0.8 acre along the northern rim of Tijeras Arroyo. The original site boundary shown on Figure 3-1 was inaccurate due to erroneous interpretation of aerial photography. Digital mapping of aerial photographs by Ebert & Associates (1994) was used to revise the site boundary. The boundary has also been modified to accommodate various construction projects for TA-II and TA-IV.

No TA-II or TA-IV disposal or testing operations have occurred at ER Site 45. The Building 904 Septic System (ER Site 48) from TA-II cuts across ER Site 45. ER Site 48 has been proposed for NFA.

Since ER Project activities began in 1993 at ER Site 45, several dozen fragments of concrete rubble and metal debris have been present on the unpaved land surface outside the TA-IV fence; no debris has been present inside the fence. No stained soil has been observed at ER Site 45. More details are discussed below.

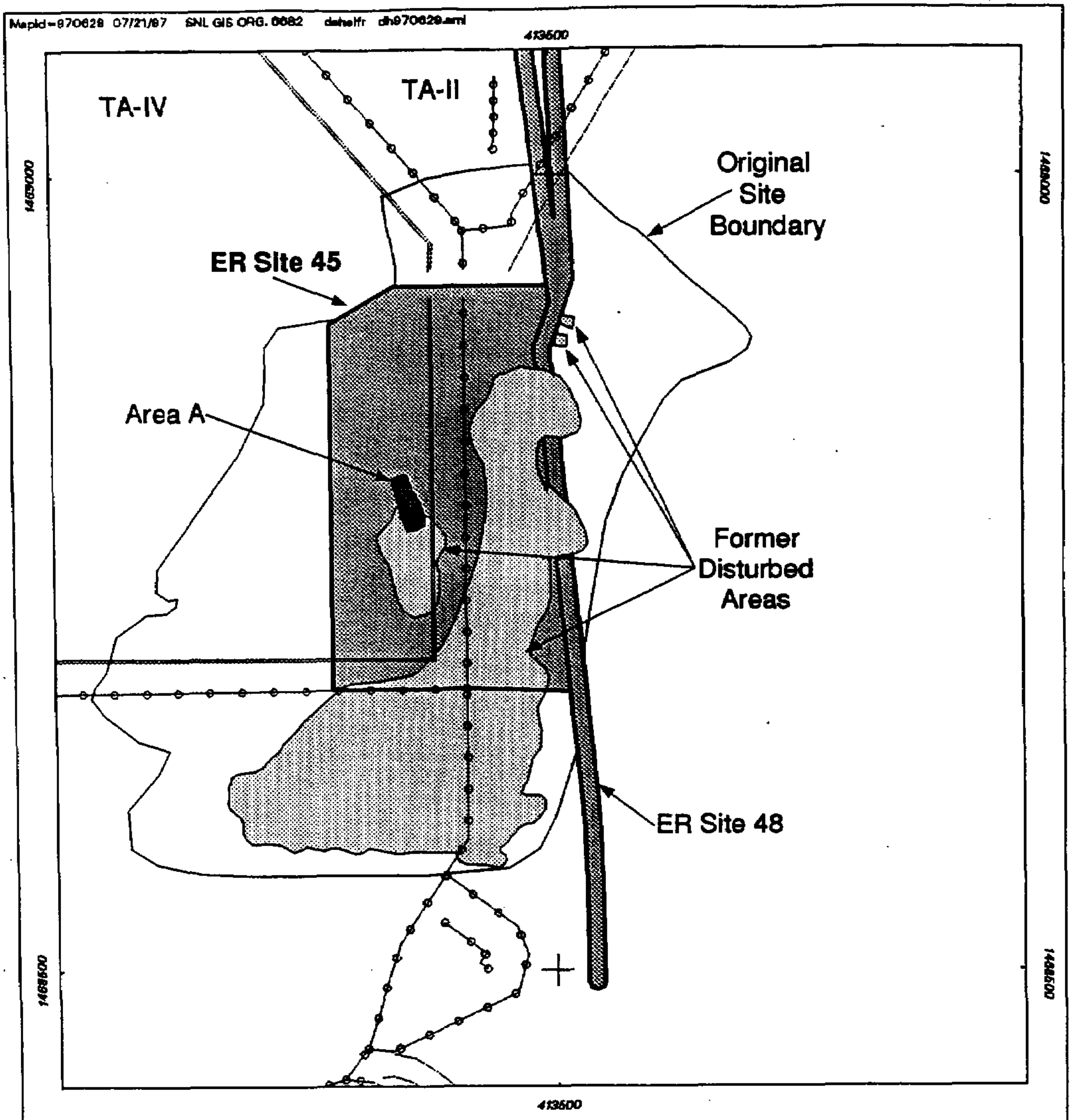
3.2 Results of SNL/NM ER Project Sampling and Surveys

This section discusses the various types of environmental investigations that have been conducted at ER Site 45.

3.2.1 Summary of Prior Investigations

The following sources of information were used to evaluate ER Site 45:

- Annual *Site Environmental Reports* from 1985 to the present
- SNL/NM Facilities Engineering drawings
- Unexploded Ordnance and High Explosives (UXO/HE) survey
- Radiological survey



Legend

- Road
- Fence
- Original Site Boundary
- ER Sites 45 & 48
- Former Disturbed Areas (Ebert & Associates, 1994)
- Area A (Ebert & Associates, 1994)

Figure 3-1
Current and Original Boundaries for ER Site 45

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

- Cultural-resources survey
- Sensitive-species survey
- Aerial photography
- Geophysical survey
- Soil-vapor survey
- Scoping sampling
- TA-IV EA
- Review of photographs and field notes collected by SNL/NM ER staff
- Confirmatory sampling at sewer-line trench
- Confirmatory sampling at liquid-discharge area
- Confirmatory sampling at Area A and magnetic-anomaly trenches.

3.2.2 UXO/HE Survey

In 1994, ER Site 45 was visually surveyed for UXO and HE material; none was found (SNL/NM 1994a).

3.2.3 Radiological Survey

In March of 1994, a surface gamma radiation survey was conducted by RUST Geotech Inc. on the liquid-discharge area site using an Eberline ESP-2 portable scaler, with an Eberline SPA-8 sodium-iodide detector. No radioactive anomalies (defined as more than 30 percent above natural background) were detected (SNL/NM 1994b).

3.2.4 Cultural-Resources Survey

A 100-percent coverage pedestrian survey was conducted by an archaeologist in 1994. No cultural resources were evident in the vicinity of the site (Butler Service Group 1994).

3.2.5 Sensitive-Species Survey

Two biological surveys have been conducted at ER Site 45 (IT Corporation 1995). ER Site 45 is located along the northern rim of Tijeras Arroyo in the vicinity of TA-I, TA-II, TA-IV, Pennsylvania Avenue, a skeet range, Kirtland Air Force Base Landfill 8, and the Albuquerque International Sunport. The vicinity of ER Site 45 has been significantly disturbed by construction activities; no undisturbed natural habitat remains. Vegetation is limited to scattered ruderal plants. Sufficient food, water, and cover are not available to support wildlife. No federally-listed endangered or threatened species (plants or animals) or state-listed endangered wildlife species (Group 1 or Group 2) are known to occur within the vicinity of TA-IV. No natural water bodies or wetlands are present, and all surface-water flows are intermittent, occurring during periods of precipitation.

3.2.6 Aerial Photographic Interpretation

In 1994, a digitally enhanced, aerial-photograph interpretation report was completed for ER Site 45 (Ebert & Associates 1994). This report evaluated the soil disturbance activities that had occurred from 1951 through 1988, as visible in sixteen sets of aerial photographs taken from 1951 to 1990. The lateral extent of the former disturbed areas is shown on Figure 3-1.

Photographic enlargements were made from the original aerial photographic negatives to an approximate scale of 1:2,400 (1 inch = 200 ft). Image processing was performed to further enhance subtle information inherent in the aerial photographs and to increase their photo-interpretive value. The ER Site 45 area on each enlargement was digitally scanned, processed, and filtered. No dumping or other activities occurred before 1951. From 1951 to 1988, soil disturbances were present. The disturbances included soil piles, blocky debris, and a rectangular pit in western part of the site. This pit was identified as Area A by Ebert & Associates (1994); Area A is now overlain by an asphalt parking lot.

To summarize, the aerial photography interpretation revealed that the site was used for cut-and-fill operations. No water or other liquids were evident in the aerial photography (Ebert & Associates 1994).

3.2.7 Geophysical Survey

In May of 1995, a geophysical (electromagnetic [EM] and magnetic) survey was conducted across the unpaved ground surface of ER Site 45 from the TA-IV fence eastward to the northern rim of the arroyo (Lamb Associates 1995). The surveyed area included the disturbed areas that were identified in the aerial photography (Section 3.2.6). A grid of parallel east-west traverses with a 5-ft spacing was used. The EM data were collected with a Geonics EM-61 at 8-inch intervals along each traverse and verified with a Schonstedt magnetic locator. The combination of the EM and magnetic data revealed two buried, magnetic anomalies that could be large enough to be buried drums and were not associated with the sewer line. The data also indicated several small anomalies that were related to surface objects, such as foundation materials and sewer manholes. A third buried, magnetic anomaly also was tentatively identified. Confirmatory sampling was subsequently conducted at the three magnetic anomalies (Section 3.2.10).

3.2.8 Soil-Vapor Sampling

In May of 1995, soil vapor at ER Site 45 was sampled using Petrex™ passive soil-vapor samplers (NERI 1995). The sample locations were based upon the aerial photography interpretation (Ebert and Associates 1994). Figure 3-2 depicts the ER Site 45 soil-vapor sampling locations including Petrex™ locations from TA-II investigations (NERI 1994). Twenty-two Petrex™ samplers were buried at a depth of approximately 1.5 ft bgl. Sampler 45-SVX-008 was used as a 3-day, time-series test. The other 21 samplers had an exposure period of 14 days. The Petrex™ samplers were subsequently analyzed for volatile organic compounds (VOC) and semivolatile organic compounds (SVOC) by Thermal Desorption - Mass Spectrometry. No SVOCs were detected. As shown in Table 3-1, background levels of trichloroethylene (TCE), perchloroethylene (PCE), and benzene, toluene, ethylbenzene, and xylenes (BTEX) were detected. No other VOCs were detected. With the Petrex™ technique, TCE and PCE values below 100,000 total ion counts (tics) and BTEX values below 200,000 tics were considered to be representative of "background" concentrations. Such "background" values normally correspond to levels that represent nondetectable concentrations by standard EPA analytical methods (NERI 1994, NERI 1995).

3.2.9 Scoping Sampling

Scoping sampling was performed at ER Site 45 in June 1995. Six hand-augered boreholes (45-GR-001 through 45-GR-006) were sampled (Figure 3-2). The sampling locations were based on the results of the surface geophysical survey (Section 3.2.7), a new aerial photographic interpretation (Section 3.2.6), and the soil-vapor sampling results (Section 3.2.8). The soil samples were analyzed for VOCs and RCRA metals by EPA Methods 8240/8260 and 6010, respectively. The purpose of the scoping-sampling effort was to obtain preliminary analytical data to support the ER project site ranking and prioritization. No quality assurance (QA)/quality control (QC) samples were collected.

Six samples (45-GR-001-1-S-5, 45-GR-002-1-S-5, 45-GR-003-1-S-5, 45-GR-004-1-S-5, 45-GR-005-1-S-5, and 45-GR-006-1-S-5) were collected at a depths of 1 to 1.5 ft below ground level (bgl). The samples were analyzed for VOCs by the on-site ER Chemistry Laboratory (ERCL) using EPA Method 8240/8260.

Estimated "J" values (above the method detection limit but below the practical quantification limit) were reported for acetone, 2-butanone (MEK), and 1,1,2,2-tetrachloroethane (1,1,2,2-TCA). The highest acetone value was 6.5 "J" micrograms per kilogram (µg/kg) (parts per billion [ppb]). The highest values for MEK and 1,1,2,2-TCA were 6.1 "J" and 1.0 "J" µg/kg (ppb), respectively. Acetone and MEK are common laboratory contaminants/artifacts (Bleyler 1988).

Twelve samples (see Table 3-2) were analyzed for RCRA metals by ERCL. Only one of the eight RCRA metals was detected in the soil samples; barium had a maximum concentration of 240 parts per million (ppm) (milligrams per kilogram [mg/kg]). Three other metals (chromium, lead, and mercury) were reported with "J" qualifiers.

Twelve samples (45-GR-001-0-S-1, 45-GR-001-1-S-4, 45-GR-002-0-S-2, 45-GR-002-1-S-4, 45-GR-003-0-S-2, 45-GR-003-1-S-4, 45-GR-004-0-S-2, 45-GR-004-1-S-4, 45-GR-005-0-S-2,

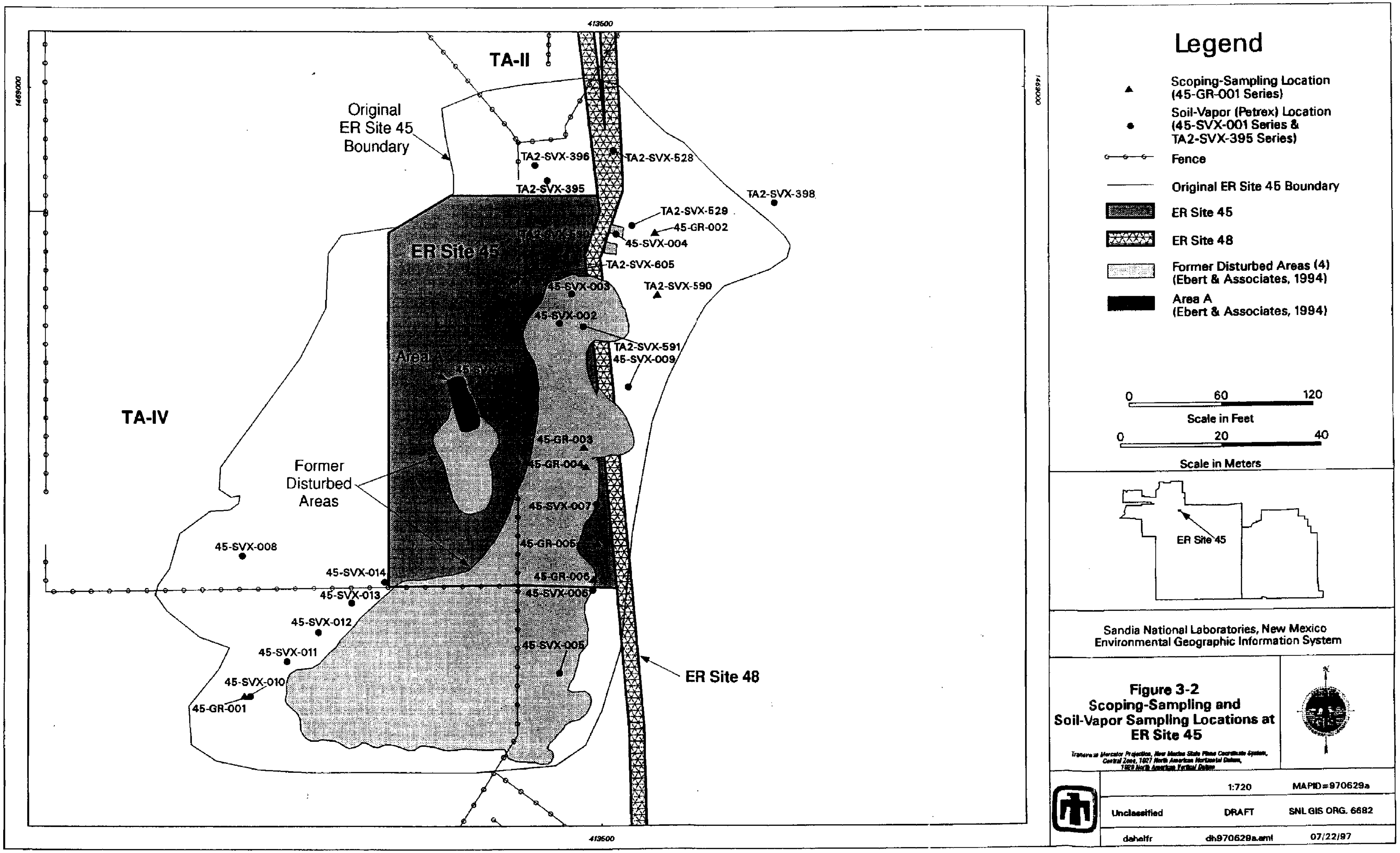


Figure 3-2
Scoping-Sampling and Soil-Vapor Sampling Locations at ER Site 45

Table 3-1
VOCs in Soil-Vapor for Petrex™ Collectors at ER Site 45

Petrex™ Soil-Vapor Sampler	TCE, tics	PCE, tics	BTEX, tics	Reference
TA2-SVX-395	112,632	4,630	48,974	NERI 1994
TA2-SVX-396	3,649	2,450	182,445	NERI 1994
TA2-SVX-398	ND	ND	25,323	NERI 1994
TA2-SVX-528	34,886	9,395	18,0840	NERI 1994
TA2-SVX-529	16,701	24,668	27,1567	NERI 1994
TA2-SVX-530	1,047	4,358	50,304	NERI 1994
TA2-SVX-590	ND	ND	14,037	NERI 1994
TA2-SVX-591	12,134	16,162	205,372	NERI 1994
TA2-SVX-605	3,872	7,405	115,613	NERI 1994
45-SVX-001	ND	ND	ND	NERI 1995
45-SVX-002	ND	ND	ND	NERI 1995
45-SVX-003	ND/ND	ND/ND	ND	NERI 1995
45-SVX-004	ND	ND	ND	NERI 1995
45-SVX-005	ND	ND	ND	NERI 1995
45-SVX-006	ND	ND	ND	NERI 1995
45-SVX-007	ND	ND	ND	NERI 1995
45-SVX-008	NA	NA	NA	NERI 1995
45-SVX-009	ND	ND	ND	NERI 1995
45-SVX-010	23,298	106,212	ND	NERI 1995
45-SVX-011	ND/ND	ND/ND	ND	NERI 1995
45-SVX-012	ND	ND	ND	NERI 1995
45-SVX-013	ND	ND	ND	NERI 1995
45-SVX-014	ND	ND	ND	NERI 1995

NA - not applicable, sampler 45-SVX-008 was a 3-day, time-series test.
ND - VOCs not detected (<1,000 tics).
ND/ND - VOCs were not detected in either the primary collector wire or the duplicate collector wire.
tics - total ion counts.

Sources: NERI 1994 and NERI 1995

Table 3-2
Scoping-Sampling Results for RCRA Metals in Soil Samples Collected at ER Site 45

			Concentration in Soil, mg/kg (ppm)							
Sample Number	Sample Date	Sample Depth (ft, BGL)	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
45-GR-001-0-S-1	6/19/95	0.5	<50	180	<10	<10	<10	0.24 J	<50	<10
45-GR-001-1-S-3	6/19/95	1	<50	130	<10	<10	<10	<0.2	<50	<10
45-GR-002-0-S-1	6/19/95	0.5	<50	76	<10	<10	<10	0.22 J	<50	<10
45-GR-002-1-S-3	6/19/95	1	<50	170	<10	14 J	16 J	<0.2	<50	<10
45-GR-003-0-S-1	6/19/95	0.5	<50	100	<10	13 J	13 J	<0.2	<50	<10
45-GR-003-1-S-3	6/19/95	1	<50	120	<10	15 J	24 J	<0.2	<50	<10
45-GR-004-0-S-1	6/19/95	0.5	<50	74	<10	<10	<10	<0.2	<50	<10
45-GR-004-1-S-3	6/19/95	1	<50	71	<10	<10	16 J	<0.2	<50	<10
45-GR-005-0-S-1	6/19/95	0.5	<50	120	<10	<10	<10	<0.2	<50	<10
45-GR-005-1-S-3	6/19/95	1	<50	130	<10	<10	<10	<0.2	<50	<10
45-GR-006-0-S-1	6/19/95	0.5	<50	180	<10	<10	<10	<0.2	<50	<10
45-GR-006-1-S-3	6/19/95	1	<50	240	<10	13 J	14 J	<0.2	<50	<10
		Maximum concentration	<50	240	<10	15 J	24 J	0.24 J	<50	<10
		Detection Limit	50	10	10	10	10	0.2	50	10
		SNL/NM North Super Group background	4.4	200	<1	NC	11.2	<0.1	<1	<1
		Tijeras Arroyo background	5.9	298	3.0	NC	23.1	NC	NC	NC

Analytical Laboratory: ERCL
Analytical Method: RCRA metals by EPA Method 6010
J - estimated value is either above the highest calibration standard or less than the practical quantification limit.
NC - Not calculated because of insufficient detections for statistical analysis.
Sampling technique: hand auger

45-GR-005-1-S-4, 45-GR-006-0-S-2, and 45-GR-006-1-S-4) were analyzed for gamma emitting radionuclides by SNL/NM Radiation Protection Sample Diagnostics Laboratory. The "0-S-1" and "0-S-2" samples were collected at depths of 0 to 0.5 ft bgl. The "1-S-4" samples were collected at 1 to 1.5 ft bgl. No anomalous gamma emitting radionuclides were identified in the samples relative to the radionuclide background activity levels for SNL/NM soil (IT Corporation 1996), as modified during verbal discussions with representatives of NMED.

3.2.10 Confirmatory Sampling

Three phases of confirmatory soil sampling have been conducted at ER Site 45:

- Confirmatory sampling at the sewer-line trench
- Confirmatory sampling at the liquid-discharge area
- Confirmatory sampling at Area A and the magnetic-anomaly trenches

As shown in Table 3-3, a total of 100 soil samples were collected at three areas (the sewer-line trench, the liquid-discharge area, and the subsurface magnetic-anomalies). The field QA/QC samples consisted of 5 duplicates, 1 soil-trip blank, and 4 rinsates.

Table 3-3
Number of ER Site 45 Confirmatory-Sampling Soil Samples Versus Analyte and Location

Analyte	Sewer-Line Trench	Liquid-Discharge Area	Area A and Magnetic-Anomaly Trenches	Totals
VOCs	3	13	13	29
SVOCs	3	--	--	3
HE compounds	3	--	--	3
RCRA metals	3	36	15	54
Tritium	3	--	--	3
Gamma-emitting radionuclides	4	2	2	8
Grand Total	19	51	30	100

HE - High explosives.
RCRA - Resource Conservation and Recovery Act.
SVOC - Semivolatile organic compound.
VOC - Volatile organic compound.

The COCs for ER Site 45 are organic compounds (VOCs and SVOCs) and RCRA metals. As a conservative measure, the samples also were analyzed for HE, tritium, and other radionuclides. Analysis for VOCs was by EPA Method 8240, SVOCs by EPA Method 8270, RCRA metals by EPA Methods 6010/7421/7471, HE compounds by EXP-USATHAMA/HPLC, tritium by EPA Method 600-906.0, and other radionuclides by gamma spectroscopy.

Approximately 75 percent of the samples were analyzed on site at the two SNL/NM analytical laboratories (the ERCL and the Radiation Protection Sample Diagnostics Laboratory). The remaining 25 percent of the samples were analyzed at off-site Contract Laboratory Program laboratories (either Enseco-Quanterra, Core Laboratories, or TMA-Eberline).

Both laboratory and field QA/QC samples were collected and analyzed to evaluate the validity of the analytical data. Section 6.2 presents a summary of the laboratory QA/QC procedures for each phase of the confirmatory sampling. The laboratory QA/QC procedures varied between the various analytical laboratories and included the use of method blanks, matrix spikes, matrix spike duplicates, duplicate control samples, single control samples, spiked blanks, spiked blank duplicate, laboratory control samples (LCS), laboratory control sample duplicates, replicates, calibration blanks, and LCS recovery samples. The results of the QA/QC procedures also are provided in Section 6.2. Field QA/QC samples are discussed with the results of each phase of the confirmatory sampling.

Verification and validation of the analytical data were performed in accordance with the SNL/NM procedure "Verification and Validation of Chemical and Radiochemical Data" (TOP 94-03) (SNL/NM 1994c). The results are listed in Section 6.2. Original laboratory reports are available for review at the Environmental Operations Records Center in Building 6584.

3.2.10.1 Confirmatory Sampling at Sewer-Line Trench

In 1993, the TA-II OU personnel collected soil samples from several sewer-line trenches at TA-II. The trenches were excavated so that the SNL/NM Facilities Engineering could connect the TA-II sewer lines to the City of Albuquerque sewer system (SNL/NM 1994b). One of the trenches, Trench 7, was located near the northeast corner of ER Site 45 along the sewer line from TA-II Building 913 (Figure 3-3). On November 8, 1993, three soil samples (ER92002060, ER92002061, ER92002062) were collected from Trench 7 as part of the characterization for ER Site 48 (SNL/NM 1994d). The shallowest sample was collected at a depth of 0.5 ft bgl, which is about 6.3 ft above the TA-II sewer line. The second sample was collected immediately above the sewer line at a depth of 6.8 ft bgl. The third soil sample was collected immediately beneath the sewer line at 7.5 ft bgl. No discolored soil was visible in the trench. The three soil samples were analyzed by off-site laboratories for VOCs, SVOCs, HE compounds, RCRA metals, and radionuclides. No VOCs or SVOCs were reported in excess of the respective detection limits of 0.5 and 330 µg/kg (ppb). No detections above the quantification limit of 1 mg/kg (ppm) were reported for the nine EPA Method 8330 HE compounds (octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine [HMX], hexahydro-1,3,5-trinitro-1,3,5-trazine [RDX], 1,3,5-trinitrobenzene, 1,3-dinitrobenzene, nitrobenzene, 2,4,6-trinitrotoluene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, and tetryl). Even though none of the HE compounds are COCs for ER Site 45, they are listed here for completeness sake. Additional details from the TA-II OU are presented in the ER Site 48 NFA proposal.

All reported detections of RCRA metals and radionuclides in the sewer-line soil samples are listed in Tables 3-4 and 3-5, respectively. Seven of the eight RCRA metals were detected, with the remaining metal (selenium) having a "J" value (Table 3-4). Gamma-emitting radionuclides were analyzed by gamma spectroscopy. Three gamma emitters were detected (Table 3-5). Radium-226 was reported at a maximum activity of 0.85 ± 0.17 picocuries per gram (pCi/g). The maximum activities of thorium-232 and thorium-234 were 1.3 ± 0.30 pCi/g and 1.2 ± 0.68 pCi/g, respectively. Tritium was detected in one of the three soil samples at 400 ± 190 pCi/L. With a soil moisture content of 7.2 percent by weight, the equivalent tritium activity

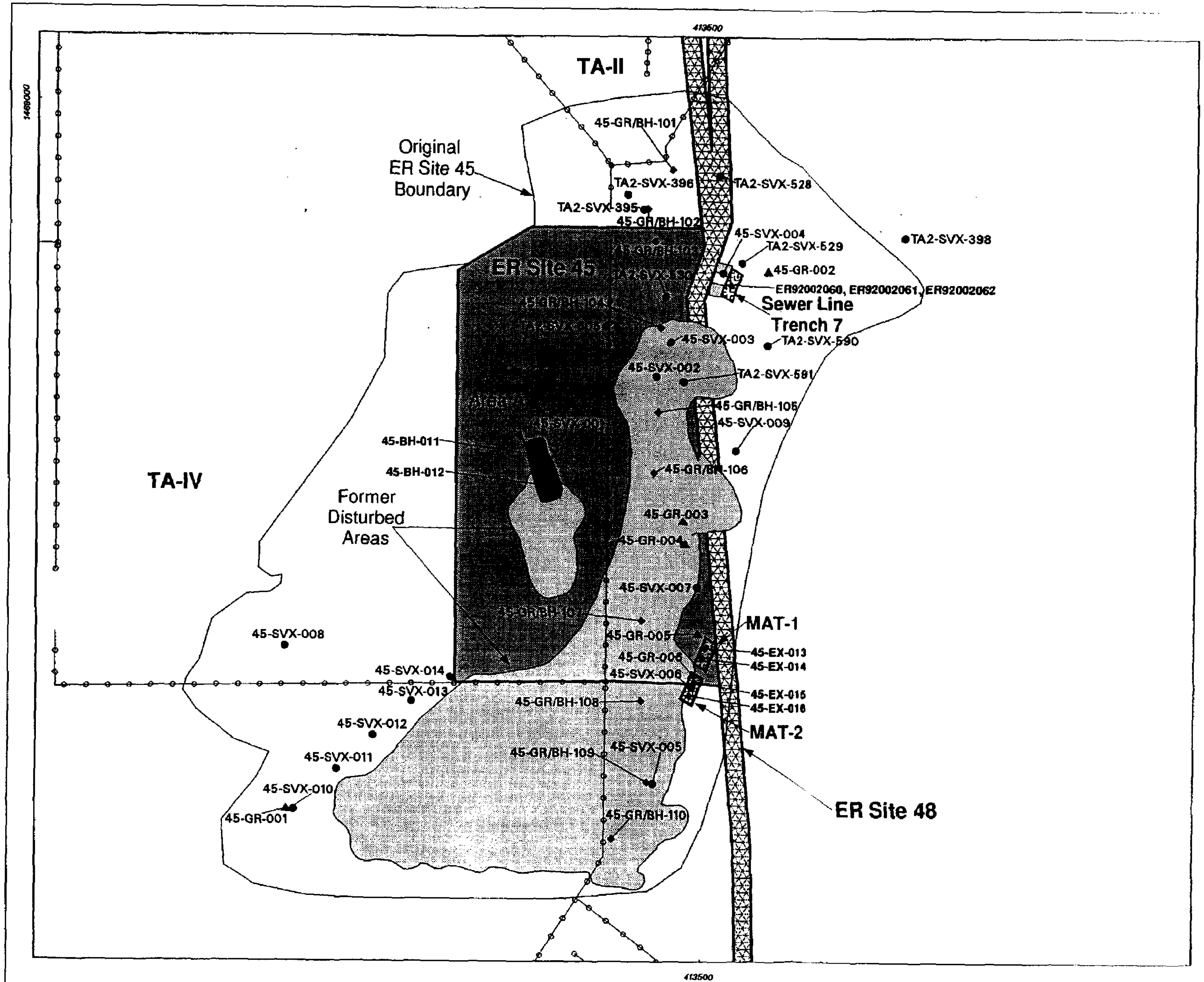


Figure 3-3
All Sampling Locations at ER Site 45

	1:720	MAPID=970629b
Unclassified	DRAFT	SNL GIS ORG. 6682
dahelfr	dh970629b.aml	07/22/97

Table 3-4
Confirmatory-Sampling Results for RCRA Metals in Soil Samples Collected from Sewer-Line Trench 7 at ER Site 45

				Concentration in Soil, mg/kg (ppm)							
Sample Number	ER Sample ID	Sample Date	Sample Depth (ft, BGL)	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
TA2-TR7-0.5	ER92002060-2	11/8/93	0.5	2.9	119	0.56	7	6.7	0.19	<1	<1
TA2-TR7-6.8	ER92002061-2	11/8/93	6.8	1.4	43.1	<0.5	7.1	8	<0.1	<1	2
TA2-TR7-7.5	ER92002062-2	11/8/93	7.5	1.5	52.4	<0.5	12.8	12.8	0.8	0.21 J	8.7
			Maximum concentration	2.9	119	0.56	12.8	12.8	0.8	0.21 J	8.7
			Detection Limit	0.5	1	0.5	1	0.5	0.1	1	1
			SNL/NM North Super Group background	4.4	200	<1	NC	11.2	<0.1	<1	<1
			Tijeras Arroyo background	5.9	298	3.0	NC	23.1	NC	NC	NC

Analytical Laboratory: Enseco-Quanterra.
Analytical Methods: RCRA metals by EPA Method 6010, except lead by EPA Method 7421 and mercury by EPA Method 7471.
Alternate sample numbers: SNL0033880 (ER92002060-2), SNL0033889 (ER92002061-2), SNL0033898 (ER92002062-2).
J - value is at or below the detection limit
NC - Not calculated because of insufficient detections for statistical analysis.
Sampling technique: grab from backhoe bucket

Table 3-5
Confirmatory-Sampling Results for All Reported Radionuclides in Soil Samples Collected from Sewer-Line Trench 7 at ER Site 45

					Activity in soil			
Sample Number	ER Sample ID	Sample Date	Soil Moisture (% weight)	Sample Depth (ft, BGL)	Tritium (pCi/L)	Radium-226 (pCi/g)	Thorium-232 (pCi/g)	Thorium-234 (pCi/g)
TA2-TR7-0.5	ER92002060-3	11/8/93	NA	0.5	NA	0.70 ± 0.16	1.3 ± 0.30	1.2 ± 0.68
TA2-TR7-6.8	ER92002061-3	11/8/93	NA	6.8	NA	0.85 ± 0.17	1.3 ± 0.29	<0.31
TA2-TR7-7.5	ER92002062-3	11/8/93	NA	7.5	NA	0.82 ± 0.20	1.2 ± 0.34	0.88 ± 0.46
TA2-TR7-0.5	ER92002060-4	11/8/93	4.1	0.5	<250	NA	NA	NA
TA2-TR7-6.8	ER92002061-4	11/8/93	3.9	6.8	<250	NA	NA	NA
TA2-TR7-7.5	ER92002062-4	11/8/93	7.2	7.5	400 ± 190	NA	NA	NA
				Maximum activity	400	0.85	1.3	1.2
				Minimum detectable activity	250	0.18	0.29	0.31

Analytical Laboratory: TMA-Eberline.
Analytical Methods: *Tritium* by EPA Method 600-906.0; other radionuclides by gamma spectroscopy.
Sampling technique: grab from backhoe bucket
NA - Not analyzed.

in soil is 0.029 pCi/g. The significance of the metal concentrations and radionuclide activities in soil is discussed in the risk-assessment discussion in Section 6.1.

3.2.10.1.1 *Quality Assurance/Quality Control Results*

The field QA/QC sample for Trench 7 consisted of a soil trip blank; the lack of detectable VOCs indicated that no sampling or handling problems affected the sampling results.

The laboratory QA/QC samples are listed in Section 6.2. All reported data were within QA/QC control limits.

3.2.10.2 *Confirmatory Sampling at the Liquid-Discharge Area*

This phase of confirmatory sampling was conducted to evaluate the suspected discharge location of the "brownish" water. The liquid-discharge area is defined by the aerial photography as the 'former disturbed area' east of the TA-IV fence along the arroyo rim (Figure 3-3).

On October 18, 1995, ten locations (45-GR/BH-101 through 45-GR/BH-110) were sampled with a hand auger for VOCs and RCRA metals. The soil samples were not analyzed for SVOCs because no SVOCs had been detected in the Petrex™ soil-vapor-samples or in soil samples from the sewer-line trench. The samples were categorized as surface (0 to 0.5 ft bgl) and subsurface (1 to 1.5 ft bgl) soil. Thirty-two fractions (Table 3-6) were analyzed for RCRA metals by the on-site ERCL. Six RCRA metals (arsenic, barium, lead, chromium, selenium, and silver) were reported for the soil samples. All four arsenic concentrations (44 to 88 mg/kg [ppm]) were "J" values. The maximum barium concentration was 240 mg/kg (ppm). The maximum chromium and lead concentrations were 94 and 100 mg/kg (ppm), respectively. The two selenium values of 49 and 51 mg/kg (ppm) were "J" values. The maximum silver concentration was 9.1 mg/kg (ppm). The significance of the metal concentrations is discussed in the Risk Assessment Analysis (Section 6.1). Eleven of the thirty-two soil samples were analyzed for VOCs by the on-site ERCL laboratory. No VOCs exceeded the various detection limits, which ranged from 1 to 5 µg/kg (ppb). Two "J" values were reported. Sample 45-BH-108-1-S-02 was reported with a value of 1.7 "J" µg/kg (ppb) for trichloroethene. Sample 45-BH-109-1-S-02 was reported with 6.6 "J" µg/kg (ppb) for acetone.

Soil samples from four of the locations (GR/BH-104, GR/BH-105, GR/BH-109, and GR/BH-110) were analyzed by Core Laboratories. The samples were analyzed for VOCs and RCRA metals. Two samples (45-BH-104-1-S-04 and 45-BH-109-1-S-04) were analyzed for VOCs; no VOCs were detected above the various detection limits, which ranged from 1 to 100 µg/kg (ppb). All four samples (45-BH-104-1-S-03, 45-GR-105-0-SS-02, 45-BH-109-1-S-03, and 45-GR-110-0-SS-02) were analyzed for RCRA metals. Five RCRA metals (arsenic, barium, chromium, lead, and mercury) were detected in the soil samples (Table 3-7). The maximum arsenic concentration was 11 mg/kg (ppm). The maximum concentrations for barium and chromium were 219 and 12 mg/kg (ppm), respectively. The concentrations for lead ranged from 9 to 740 mg/kg (ppm). Mercury was detected in two of the four samples at 0.70 and 2.19 mg/kg (ppm). The significance of the metal concentrations is discussed in the Risk Assessment Analysis (Section 6.1).

Table 3-6
Confirmatory-Sampling Results for RCRA Metals in Soil Samples Collected at the Liquid-Discharge Area at ER Site 45

Sample Number	Sample Date	Sample Depth (ft, BGL)	*Concentration in Soil, mg/kg (ppm)* Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
45-GR-101-0-SS-01	10/18/95	0.5	<26	150	<2.1	<5.0	4.1 J	<0.20	<50	2.9 J
45-BH-101-1-S-01	10/18/95	1	<26	150	<2.1	<5.0	<3.4	<0.20	<50	<1.7
45-BH-101-1-S-02	10/18/95	1	<26	150	<2.1	<5.0	<3.4	<0.20	<50	<1.7
45-GR-102-0-SS-01	10/18/95	0.5	<26	180	<2.1	<5.0	5.3 J	<0.20	<50	2.2 J
45-BH-102-1-S-01	10/18/95	1	<26	130	<2.1	<5.0	<3.4	<0.20	<50	7.6
45-BH-102-1-S-02	10/18/95	1	<26	130	<2.1	<5.0	<3.4	<0.20	<50	2.4 J
45-GR-103-0-SS-01	10/18/95	0.5	<26	180	<2.1	<5.0	<3.4	<0.20	<50	<1.7
45-BH-103-1-S-01	10/18/95	1	<26	130	<2.1	<5.0	<3.4	<0.20	<50	<1.7
45-BH-103-1-S-02	10/18/95	1	<26	130	<2.1	<5.0	<3.4	<0.20	<50	1.7 J
45-GR-104-0-SS-01	10/18/95	0.5	<26	170	<2.1	<5.0	6.1	<0.20	<50	3.9 J
45-BH-104-1-S-01	10/18/95	1	<26	140	<2.1	<5.0	6.1	<0.20	<50	<1.7
45-BH-104-1-S-02	10/18/95	1	<26	160	<2.1	6.2 J	<3.4	<0.20	<50	2.1 J
45-GR-105-0-SS-01	10/18/95	0.5	<26	150	<2.1	9 J	23	<0.20	<50	1.9 J
45-BH-105-1-S-01	10/18/95	1	<26	160	<2.1	6.8 J	<3.4	<0.20	<50	2.3 J
45-BH-105-1-S-02	10/18/95	1	<26	160	<2.1	12 J	22	<0.20	<50	1.9 J
45-GR-106-0-SS-01	10/18/95	0.5	<26	170	<2.1	<26	11 J	<0.20	<50	<1.7
45-BH-106-1-S-01	10/18/95	1	47 J	220	<2.1	79	13	<0.20	<50	3.2 J
45-BH-106-1-SD-01	10/18/95	1	44 J	190	<2.1	86	25	<0.20	<50	1.9 J
45-BH-106-1-S-02	10/18/95	1	54 J	200	<2.1	71	19	<0.20	<50	1.8 J
45-BH-106-1-SD-02	10/18/95	1	88 J	190	<2.1	94	35	<0.20	<50	9.1
45-GR-107-0-SS-01	10/18/95	0.5	<26	150	<2.1	<5.0	6.5 J	<0.20	<50	<1.7
45-BH-107-1-S-01	10/18/95	1	<26	170	<2.1	19	88	<0.20	<50	2.0 J
45-BH-107-1-S-02	10/18/95	1	<26	160	<2.1	15 J	100	<0.20	<50	5.8 J
45-GR-108-0-SS-01	10/18/95	0.5	<26	240	<2.1	<5.0	4.4 J	<0.20	<50	2.0 J
45-BH-108-1-S-01	10/18/95	1	<26	160	<2.1	12 J	47	<0.20	<50	<1.7
45-BH-108-1-S-02	10/18/95	1	<26	160	<2.1	15 J	66	<0.20	<50	2.3 J
45-GR-109-0-SS-01	10/18/95	0.5	<26	220	<2.1	5.9 J	12 J	<0.20	<50	<1.7
45-BH-109-1-S-01	10/18/95	1	<26	150	<2.1	6.3 J	23	<0.20	49 J	2.7 J
45-BH-109-1-S-02	10/18/95	1	<26	160	<2.1	6.4	22	<0.20	51 J	7.8
45-GR-110-0-SS-01	10/18/95	0.5	<26	230	<2.1	<5.0	<3.4	<0.20	<50	<1.7
45-BH-110-1-S-01	10/18/95	1	<26	160	<2.1	<5.0	5.9 J	<0.20	<50	2.2 J
45-BH-110-1-S-02	10/18/95	1	<26	160	<2.1	<5.0	<3.4	<0.20	<50	6.5
		Maximum concentration	88 J	240	<2.1	94	100	<0.20	51 J	9.1
		Detection Limit	26	10	2.1	5.0	3.4	0.20	50	1.7
		Practical Quantitation Limits	98	38	8.0	19	13	0.80	191	6.4
		SNL/NM North Super Group background	4.4	200	<1	NC	11.2	<0.1	<1	<1
		Tijeras Arroyo background	5.9	298	3.0	NC	23.1	NC	NC	NC

Analytical Laboratory: ERCL
Analytical Method: RCRA metals by EPA Method 6010.
NC - Not calculated because of insufficient detections for statistical analysis.
Sampling technique: hand auger
SD - Soil duplicate.

Table 3-7
Off-Site Laboratory Confirmatory-Sampling Results for RCRA Metals in Soil Samples Collected at the Liquid-Discharge Area at ER Site 45.

Sample Number	Sample Date	Sample Depth (ft, BGL)	Concentration in Soil, mg/kg (ppm)							
			Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
45-BH-104-1-S-03	10/18/95	1	6	116	<0.5	8	9	2.19	<10	<1
45-GR-105-0-SS-02	10/18/95	0.5	9	111	<0.5	10	28	0.70	<10	<1
45-BH-109-1-S-03	10/18/95	1	9	130	<0.5	12	740	<0.02	<10	<1
45-GR-110-0-SS-02	10/18/95	0.5	11	219	<0.5	9	8	<0.02	<10	<1
		Maximum concentration	11	219	<0.5	12	740	2.19	<10	<1
		Detection Limit	5	1	0.5	1	5	0.02	10	1
		SNL/NM North Super Group background	4.4	200	<1	NC	11.2	<0.1	<1	<1
		Tijeras Arroyo background	5.9	298	3.0	NC	23.1	NC	NC	NC

Analytical Laboratory: Core Laboratories
Analytical Method: RCRA metals by EPA Method 6010
Alternate sample numbers: 45-BH-104-1-S-03 (024877-03), 45-GR-105-0-SS-02 (024875-02), 45-BH-109-1-S-03 (024878-03), 45-GR-110-0-SS-02 (024876-02).
NC - Not calculated because of insufficient detections for statistical analysis.
Sampling technique: hand auger

Two soil samples (45-BH-104-1-S-05 and 45-BH-109-1-S-05) were analyzed for gamma-emitting radionuclides by the Radiation Protection Sample Diagnostics laboratory. No anomalous gamma-emitting radionuclides were identified in the samples relative to background activity levels for SNL/NM soil (IT Corporation 1996), as modified during verbal discussions with representatives of NMED.

3.2.10.2.1 Quality Assurance / Quality Control Results

The field QA/QC samples consisted of four duplicates and two rinsates. The samples were analyzed by the ERCL. Neither Sample 45-BH-106-1-S-01 nor its duplicate BH-106-1-SD-02 contained detectable concentrations of VOCs above the detection limits, which ranged from 1 to 5 µg/kg (ppb). Likewise, neither Sample 45-BH-106-1-S-02 nor its duplicate 45-BH-106-1-SD-02 contained detectable concentrations of VOCs. Two duplicates were analyzed for RCRA metals (Table 3-6). The metal results were similar for BH-106-1-S-01 versus BH-106-1-SD-01 and for BH-106-1-S-02 versus BH-106-1-SD-02. The similarity of the results for the VOCs and metals indicates that the field QA/QC procedures were adequate.

Two aqueous equipment-wash (rinsate) blanks were prepared following completion of soil sampling and final equipment decontamination. Rinsate sample 45-RINSATE1-01 did not contain RCRA metals above the detection limit of 0.01 and 0.50 mg/L (ppm). Rinsate sample 45-RINSATE1-02 did not contain VOCs above the detection limit of 1 to 5 µg/kg (ppb). These rinsate analyses indicated that the soil-sampling decontamination procedures were adequate. The laboratory QA/QC samples are listed in Section 6.2. All reported data were within QA/QC control limits.

3.2.10.3 Confirmatory Sampling at Area A and Magnetic-Anomaly Excavations

This phase of confirmatory sampling occurred on October 23, 1995, and involved the collection of soil samples at Area A and the magnetic-anomaly trenches.

3.2.10.3.1 Confirmatory Sampling at Area A

Two boreholes (45-BH-011 and 45-BH-012) were sampled with a GeoProbe™ to investigate the Area A rectangular pit that was evident in a 1959 aerial photograph. This area is now overlain by an asphalt parking lot. The two boreholes are shown on Figure 3-3. Borehole 45-BH-011 was sampled to a depth of 16 ft bgl with soil samples being collected at depths of 1, 4, 9, and 14 ft bgl. Soil samples at Borehole 45-BH-012 were collected at depths of 3 and 6 ft bgl. Borehole 45-BH-012 met refusal at 6 ft bgl and the GeoProbe™ was moved laterally approximately 2 ft. Additional sampling was not attempted after refusal was again met at 6 ft bgl. The soil samples were analyzed for VOCs and RCRA metals. The soil samples were not analyzed for SVOCs because no SVOCs had been detected in the Petrex™ soil-vapor-samples or in soil samples from the sewer-line trench.

The soil samples were field screened with a ThermoAnalytical Model 580 Photoionization Detector (PID), which was calibrated with 100 mg/kg (ppm) isobutylene. No VOCs or SVOCs were detected in the soil samples.

Nine soil samples from the two boreholes were analyzed by the ERCL for RCRA metals (Table 3-8). Barium was reported at a maximum concentration of 310 mg/kg (ppm). Three other metals were reported with "J" values. The maximum chromium concentration was 7.3 "J" mg/kg (ppm). The maximum lead and silver concentrations were 5.2 "J" and 2.3 "J" mg/kg (ppm), respectively.

Six soil samples (45-BH-011-1-S-02, 45-BH-011-9-S-02, 45-BH-011-14-S-02, 45-BH-012-1-S-02, 45-BH-012-4-S-02, and 45-BH-012-4-SD-02) were analyzed by the ERCL for VOCs using EPA Method 8240/8260. None of the samples contained detectable concentrations of VOCs with detection limits that ranged from 1 to 5 µg/kg (ppb).

Two soil samples (45-BH-011-1-S-04 and 45-BH-011-1-S-03) also were sent to Core Laboratories for VOC and RCRA metals analyses. Sample 45-BH-011-1-S-04 did not contain detectable VOCs above the detection limits, which ranged from 1 to 100 µg/kg (ppb). Sample 45-BH-011-1-S-03 contained detectable concentrations for four of the eight RCRA metals (Table 3-9). Arsenic was detected at 10 mg/kg (ppm). Barium and chromium were detected at 176 and 12 mg/kg (ppm), respectively. Lead was detected at 6 mg/kg (ppm). The significance of the metal concentrations is discussed in the Risk Assessment Analysis (Section 6.1).

One soil sample (45-BH-011-1-S-05) was analyzed for gamma-emitting radionuclides by the Radiation Protection Sample Diagnostics laboratory. No anomalous gamma-emitting radionuclides were identified in the sample relative to background activity levels for SNL/NM soil (IT Corporation 1996), as modified during verbal discussions with representatives of NMED.

3.2.10.3.2 Confirmatory Sampling at and Magnetic-Anomaly Excavations

The locations of two "drum-size" magnetic anomalies and one smaller anomaly were excavated. The trenches were dug with a backhoe, with each trench centered on the strongest signal from the Schonstedt magnetic locator. Trenching began at three separate locations; however, the second and third locations were enlarged into a single trench, which is shown on Figure 3-3 as MAT-2. The resulting two trenches, MAT-1 and MAT-2, were dug to depths of 4 and 6 ft bgl, respectively. The dimensions of both MAT-1 and MAT-2 were approximately 7-ft wide by 17-ft long. The depth of the trenches was based upon the response from the metal detector; digging continued until all metal was removed from each excavation. As shown in Table 3-10, the debris encountered in the trenches was limited to a depth of 3 ft bgl and included metal scrap and concrete rubble. Even though a steel drum ring was found in MAT-2, no drums or other containers were present in either of the two trenches.

During the excavation operation, the soil and debris were scanned for organic compounds and radiation. Organics were evaluated with a ThermoAnalytical Model 580 PID, which was calibrated with 100 mg/kg (ppm) isobutylene. No VOCs or SVOCs were detected. The radiation survey was conducted with an Eberline ESP-2 portable scaler with an Eberline SPA-8 sodium-iodide detector. No radioactive anomalies (defined as more than 30 percent above natural background) were detected. After soil samples were collected, the trenches were subsequently backfilled with the soil and debris.

Table 3-8
Confirmatory-Sampling Results for RCRA Metals for Soil Samples Collected from Area A at ER Site 45

Sample Number	Sample Date	Sample Depth (ft, BGL)	Concentration in Soil, mg/kg (ppm)							
			Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
45-BH-011-01-S-01	10/23/95	1	<26	220	<2.1	5.2 J	4.6 J	<0.20	<50	<1.7
45-BH-011-04-S-01	10/23/95	4	<26	100	<2.1	<5.0	<3.4	<0.20	<50	2.3 J
45-BH-011-09-S-01	10/23/95	9	<26	140	<2.1	<5.0	<3.4	<0.20	<50	<1.7
45-BH-011-09-S-02	10/23/95	9	<26	130	<2.1	6.8	5.2 J	<0.20	<50	2.1 J
45-BH-011-14-S-01	10/23/95	14	<26	310	<2.1	7.3 J	<3.4	<0.20	<50	<1.7
45-BH-011-14-S-02	10/23/95	14	<26	310	<2.1	<5.0	<3.4	<0.20	<50	<1.7
45-BH-012-01-S-01	10/23/95	1	<26	220	<2.1	<5.0	<3.4	<0.20	<50	<1.7
45-BH-012-04-S-01	10/23/95	4	<26	88	<2.1	<5.0	<3.4	<0.20	<50	<1.7
45-BH-012-04-S-02	10/23/95	4	<26	180	<2.1	<5.0	<3.4	<0.20	<50	2.1 J
		Maximum concentration	<26	310	<2.1	7.3 J	5.2 J	<0.20	<50	2.3 J
		Detection Limit	26	10	2.1	5.0	3.4	0.20	50	1.7
		Practical Quantitation Limit	98	38	8.0	19	13	0.80	191	6.4
		SNL/NM North Super Group background	4.4	200	<1	NC	11.2	<0.1	<1	<1
		Tijeras Arroyo background	5.9	298	3.0	NC	23.1	NC	NC	NC

Analytical Laboratory: ERCL
Analytical Method: RCRA metals by EPA Method 6010.
NC - Not calculated because of insufficient detections for statistical analysis.
Sampling technique: GeoProbe™

Table 3-9
Off-Site Laboratory Confirmatory-Sampling Results for RCRA Metals in Soil Samples Collected from Area A at ER Site 45

Sample Number	Sample Date	Sample Depth (ft, BGL)	Concentration in Soil, mg/kg (ppm)							
			Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
45-BH-011-1-S-03	10/23/95	1	10	176	<0.5	12	6	<0.02	<10	<1
		Maximum concentration	10	176	<0.5	12	6	<0.02	<10	<1
		Detection Limit	5	1	0.5	1	5	0.02	10	1
		SNL/NM North Super Group background	4.4	200	<1	NC	11.2	<0.1	<1	<1
		Tijeras Arroyo background	5.9	298	3.0	NC	23.1	NC	NC	NC

Analytical Laboratory: Core Laboratories
Analytical Method: RCRA metals by EPA Method 6010 except mercury by EPA Method 7471.
Alternate sample number: 45-BH-011-1-S-03 (024879-01).
NC - Not calculated because of insufficient detections for statistical analysis.
Sampling technique: GeoProbe™

Table 3-10
Dimensions, Contents, and Soil Samples for Magnetic-Anomaly Trenches

	Excavation Size (ft)	Excavation Depth (ft bgl)	Debris	Soil Sample Locations	Sample Depth (ft bgl)
MAT-1	7 by 17	4	• 9-ft long, steel rebar • 6-ft long, metal sheet • concrete blocks with metal reinforcement • various metal wires • red-clay pipe	45-EX-013-3 45-EX-014-3	3 3
MAT-2	7 by 17	6	• 6-ft long, 2-ft diameter culvert pipe with 4 bolts through bottom • culvert pipe filled with concrete • concrete rubble • metal grating • sheet metal • steel ring for 55-gal drum • metal scrap	45-EX-015-3 45-EX-016-3	3 3

bgl - Below ground level.
ft - feet.

Twelve soil-sample fractions were collected from four locations (45-EX-013-3, 45-EX-014-3, 45-EX-015-3, and 45-EX-016-3). Each soil sample was collected below the debris layer at a depth of 3 ft bgl using the backhoe bucket. The samples were analyzed for VOCs and RCRA metals.

Four soil fractions (45-EX-013-03-S-01, 45-EX-013-03-SD-01, 45-EX-014-03-S-01, and 45-EX-016-03-S-01) were analyzed for RCRA metals by the on-site ERCL using EPA Method 6010 (Table 3-11). Four RCRA metals (barium, lead, chromium, and silver) were reported for the soil samples. The maximum barium and lead concentrations were 200 and 32 mg/kg (ppm), respectively. The two reported chromium concentrations (5.1 and 5.4 mg/kg [ppm]) were both "J" values. The three reported silver concentrations also were "J" values and ranged from 1.8 to 2.5 mg/kg (ppm). The significance of the metal concentrations is discussed in the Risk Assessment Analysis (Section 6.1).

Five soil fractions (45-EX-013-03-S-02, 45-EX-013-SD-02, 45-EX-014-3-S-01, 45-EX-015-3-S-01, and 45-EX-016-3-S-02) were analyzed for VOCs by the on-site ERCL. None of the samples contained VOCs above the method detection limits that range from 1 to 5 µg/kg (ppb).

Two soil-sample fractions (45-EX-014-3-S-04 and 45-EX-014-3-S-03) also were sent to Core Laboratories in Denver. Sample 45-EX-014-3-S-04 did not contain detectable VOCs above the EPA Method 8240 detection limits, which ranged from 1 to 100 µg/kg (ppb). Sample 45-EX-014-3-S-03 contained detectable concentrations for four of the eight RCRA metals (Table 3-12). Arsenic was detected at 9 mg/kg (ppm). Barium and chromium were detected at

Table 3-11
Confirmatory-Sampling Results for RCRA Metals in Soil Samples Collected from Magnetic-Anomaly Trenches at ER Site 45

				Concentration in Soil, mg/kg (ppm)							
Sample Number	Location	Sample Date	Sample Depth (ft, BGL)	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
45-EX-013-03-S-01	MAT-1	10/23/95	3	<26	160	<2.1	5.4 J	9.4 J	<0.20	<50	<1.7
45-EX-013-03-SD-01	MAT-1	10/23/95	3	<26	150	<2.1	5.1 J	12 J	<0.20	<50	2.5 J
45-EX-014-03-S-01	MAT-1	10/23/95	3	<26	200	<2.1	<5.0	32	<0.20	<50	1.8 J
45-EX-016-03-S-01	MAT-2	10/23/95	3	<26	110	<2.1	<5.0	<3.4	<0.20	<50	1.9 J
			Maximum concentration	<26	200	<2.1	5.4 J	32	<0.20	<50	2.5 J
			Detection Limit	26	10	2.1	5.0	3.4	0.20	50	1.7
			Practical Quantitation Limit	98	38	8.0	19	13	0.80	191	6.4
			SNL/NM North Super Group background	4.4	200	<1	NC	11.2	<0.1	<1	<1
			Tijeras Arroyo background	5.9	298	3.0	NC	23.1	NC	NC	NC

Analytical Laboratory: ERCL
Analytical Method: RCRA metals by EPA Method 6010.
NC - Not calculated because of insufficient detections for statistical analysis.
Sampling technique: grab from backhoe bucket

Table 3-12
Confirmatory-Sampling Results for RCRA Metals in Soil Sample Collected from Magnetic-Anomaly Trench-1 (MAT-1) at ER Site 45

Sample Number	Location	Sample Date	Sample Depth (ft, BGL)	Concentration in Soil, mg/kg (ppm)							
				Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
45-EX-014-3-S-03	MAT-1	10/23/95	3	9	143	<0.5	9	59	<0.02	<10	<1
			Maximum concentration	9	143	<0.5	9	59	<0.02	<10	<1
			Detection Limit	5	1	0.5	1	5	0.02	10	1
			SNL/NM North Super Group background	4.4	200	<1	NC	11.2	<0.1	<1	<1
			Tijeras Arroyo background	5.9	298	3.0	NC	23.1	NC	NC	NC

Analytical Laboratory: Core Laboratories
Analytical Method: RCRA metals by EPA Method 6010 except mercury by EPA Method 7471.
Alternate sample number: 45-EX-014-1-S-03 (024881-01).
NC - Not calculated because of insufficient detections for statistical analysis.
Sampling technique: GeoProbe™

143 and 9 mg/kg (ppm), respectively. Lead was detected at 59 mg/kg (ppm). The significance of the metal concentrations is discussed in the Risk Assessment Analysis (Section 6.1).

Soil-sample fraction (45-EX-014-3-S-05) was analyzed for gamma-emitting radionuclides by the Radiation Protection Sample Diagnostics laboratory for gamma spectroscopy. No anomalous gamma-emitting radionuclides were identified in the sample relative to background activity levels for SNL/NM soil (IT Corporation 1996), as modified during verbal discussions with representatives of NMED.

3.2.10.3.3 *Quality Assurance / Quality Control Results*

The field QA/QC samples for the confirmatory sampling at Area A and the magnetic-anomaly trenches consisted of duplicate and rinsate samples. Three duplicate samples (45-EX-013-3-SD-01, 45-BH-012-4-SD-02, and 45-EX-013-3-SD-02) were analyzed by the ERCL. The RCRA metal concentrations for sample 45-EX-013-3-S-01 and its duplicate 45-EX-013-3-SD-01 were similar (Table 3-11). Neither sample 45-BH-012-4-S-02 nor its duplicate 45-BH-012-4-SD-02 contained detectable concentrations of VOCs for the detection limits, which ranged from 1 to 5 µg/kg (ppb). Neither sample 45-EX-013-3-S-02 nor its duplicate 45-EX-013-3-SD-02 contained detectable concentrations of VOCs for the detection limits, which ranged from 1 to 5 µg/kg (ppb).

Two aqueous equipment-wash (rinsate) blanks were prepared following completion of soil sampling and final equipment decontamination. Rinsate sample 45-RINSATE2-01 did not contain RCRA metals above the detection limits of 0.01 and 0.50 mg/L (ppm). Rinsate sample 45-RINSATE2-02 did not contain VOCs above the detection limits of 1 to 5 µg/kg (ppb). These rinsate analyses indicated that the soil-sampling decontamination procedures were adequate.

The laboratory QA/QC samples are listed in Section 6.2. All reported data were within QA/QC control limits.

3.2.11 Summary of Site-Specific Background Sampling

Site-specific (Tijeras Arroyo) background sampling was conducted in 1994 (SNL/NM 1996). Twenty-four soil samples were collected along the northern rim of Tijeras Arroyo between Pennsylvania Avenue and the Eubank Extension (Powerline Road). The samples were collected to a maximum depth of 3 ft bgl. The calculated background values for these soil samples are discussed in the Risk Assessment Report in Section 6.1. Site-specific background values were calculated for four of the RCRA metals: arsenic, barium, cadmium, and lead. A background value was not calculated for chromium because chromium-VI was not a COC for ER Site 45. Background values were not calculated for mercury, selenium, and silver because too few detectable concentrations were reported for statistical analysis.

3.3 Gaps in Information

The SNL/NM ER Project has rectified the information gaps in the CEARP and RCRA Facility Assessment by the completion of the items in Section 3.2.1.

3.4 Risk Evaluation

3.4.1 Human Health Risk Assessment

ER Site 45 has been recommended for industrial land use. A complete discussion of the risk assessment process, results, and uncertainties is provided in Section 6.1. Due to the presence of several metals at concentrations greater than background levels, it was necessary to perform a human health risk assessment analysis for the site. Besides metals, any VOCs or SVOCs detected above their reporting limits and any radionuclides either detected above background levels and/or the minimum detectable activity are included in this assessment. The risk assessment process provides a quantitative evaluation of the potential adverse human health effects caused by constituents in the site's soil. The Risk Assessment Report calculated the Hazard Index and excess cancer risk for both and industrial and residential land-use settings. The excess cancer risk for nonradiological and radiological COCs is not additive (EPA 1989).

In summary, the Hazard Index calculated for ER Site 45 nonradiological COCs is 0.3 for an industrial land-use setting, which is less that the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk. The incremental Hazard Index is 0.32. The excess cancer risk from ER Site 45 nonradiological COCs is 6×10^{-5} for an industrial land-use setting, which is within the acceptable risk range of 10^{-4} to 10^{-6} (EPA 1989). The incremental excess cancer risk for ER Site 45 is 5.7×10^{-5}. The incremental total effective dose equivalent for radionuclides for an industrial land-use setting is 2×10^{-5} millirem per year, which is well below the standard dose limit of 15 millirem per year (40CFR196 1994). The incremental excess cancer risk for radionuclides is 8×10^{-10} for an industrial land-use scenario, which is much less than risk values calculated due to naturally occurring radiation and from intakes considered background concentration values.

3.4.2 Ecological Risk Assessment

A complete discussion of the ecological risk for ER Site 45 is provided in Section 6.1.

None of the VOCs or radiologicals posed an ecological risk. Seven of the eight RCRA metals may potentially present ecological risks to one or more of the three indicator species. These seven metals are: arsenic, barium, chromium, lead, mercury, selenium, and silver. However, the conservative use of a single maximum concentration for each metal maybe unrealistic when the maximum concentrations are compared to the total data set of 54 metal analyses.

For example, the lead and mercury values were not confirmed by independent analytical laboratories. The maximum lead concentration of 740 mg/kg (ppm) reported by ERCL for sample fraction 45-BH-109-1-S-03 was not confirmed by the two soil-sample fractions which were analyzed by Core Laboratories; sample fractions 45-BH-109-1-S-01 and 45-BH-109-1-S-02 were both reported as nondetects (<0.20 mg/kg [ppm]). Mercury posed a similar problem. The maximum mercury concentration of 2.19 mg/kg (ppm) reported by Core Laboratories for sample fraction 45-BH-104-1-S-03 was not confirmed by the two soil-sample fractions which were analyzed by ERCL; sample fractions 45-BH-104-1-S-01 and 45-BH-104-1-S-02 were both reported as nondetects (<0.20 mg/kg [ppm]).

The use of barium at 310 mg/kg (ppm) maybe unrealistic. The maximum barium concentration of 310 mg/kg (ppm) is close to the Tijeras Arroyo site-specific background value of 298 mg/kg (ppm) and the North Super Group background of 200 mg/kg (ppm).

It is worth noting that the selenium values are suspect. The reporting of three 'J' values for selenium was not confirmed by any detections in the other fifty-one samples.

The reported concentrations for arsenic, chromium, and silver at borehole BH-106 suggest that resampling for subsequent analyses with lower detection limits maybe worthwhile.

4.0 RATIONALE FOR NFA DECISION

Based on field investigation data and the human-health risk assessment analysis, an NFA is being recommended for ER Site 45 for the following reasons:

- Field surveys indicated that no radioactive or UXO/HE material was present.
- The soil at ER Site 45 has been sampled for all relevant COCs.
- No nonradiological or radiological COCs were present in soil at levels considered hazardous to human health for an industrial land-use scenario.

Based on the evidence provided above, ER Site 45 is proposed for NFA according to Criterion 5 of the ER Document of Understanding (NMED 1996).

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6.0 ANNEX

6.1 Risk Assessment Report

6.2 Summary of QA/QC Procedures and Results for Soil Samples Collected at ER Site 45

Section 6.1
Risk Assessment Report

ER SITE 45: RISK ASSESSMENT ANALYSIS

I. Site Description and History

Sandia National Laboratories/New Mexico (SNL/NM) Environmental Restoration (ER) Site 45, the Liquid Discharge site, covers 0.8 acre near the northeast corner of Technical Area (TA) IV and the southern apex of TA-II. ER Site 45 is situated along the northern rim of Tijeras Arroyo on fenced, industrial land controlled by the U.S. Department of Energy (DOE). The topography is nearly flat and well above the 100-year floodplain. The active channel for Tijeras Arroyo is located approximately 1,600 feet southeast of ER Site 45. No perennial surface water bodies are present near ER Site 45. The depth to groundwater is approximately 300 feet.

Environmental concern about ER Site 45 is based upon a single discharge of "brownish" water from an unidentified tank truck in 1985. No hazardous chemicals or materials are known to have been disposed of at ER Site 45. No stained soil has been observed at ER Site 45. The SNL/NM ER Project has assumed that the potential constituents of concern (COC) in soil consist of organic compounds and Resource Conservation and Recovery Act (RCRA) metals.

Two biological surveys have been conducted at ER Site 45; the vicinity of ER Site 45 has been significantly disturbed by construction activities; no undisturbed natural habitat remains. Vegetation is limited to scattered ruderal plants. Sufficient food, water, and cover are not available to support wildlife. No federally-listed endangered or threatened species (plants or animals) or state-listed endangered wildlife species (Group 1 or Group 2) are present. No natural water bodies or wetlands are present, and all surface-water flows are intermittent, occurring during periods of precipitation.

A digitally enhanced aerial photography report has been completed for ER Site 45. The aerial photography interpretation revealed that the site previously contained soil piles and excavations from cut-and-fill operations. No water or other liquids were evident in the aerial photography.

Numerous field surveys have been conducted at ER Site 45. The site has been visually surveyed for unexploded ordnance and high explosives (HE) material; none was found. A surface gamma radiation survey also has been conducted; no radioactive anomalies (defined as more than 30 percent above natural background) were detected. A 100-percent coverage, pedestrian survey was conducted by an archaeologist in 1994; no cultural resources were evident in the vicinity of the site. Soil vapor at ER Site 45 has been sampled; no organic contaminants were detected. A geophysical (magnetic) survey has been conducted across the unpaved ground surface of ER Site 45. Three subsurface anomalies were identified. The anomalies were subsequently excavated; the metallic debris consisted of scrap metal, wires, and culvert pipes.

Confirmatory soil sampling has been conducted at three types of locations at ER Site 45: a sewer-line trench, the liquid-discharge area, and subsurface magnetic-anomalies. Analytical results from the confirmatory sampling were used in the following risk evaluation.

II. Human Health Risk Assessment Analysis

Risk assessment of this site includes a number of steps, which culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents located at the site. The steps to be discussed in this section include:

Step 1.	Site data are described that provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site.
Step 2.	Potential pathways by which a representative population might be exposed to the COCs are identified.
Step 3.	The potential intake of these COCs by the representative population is calculated using a tiered approach. The tiered approach includes screening steps, followed by potential intake calculations and a discussion or evaluation of the uncertainty in those calculations. Potential intake calculations are also applied to background screening data.
Step 4.	Data are described on the potential toxicity and cancer effects from exposure to the COCs and associated background constituents and subsequent intake.
Step 5.	Potential toxicity effects (specified as a Hazard Index) and cancer risks are calculated for nonradiological COCs and background. For radiological COCs, the incremental total effective dose equivalent (TEDE) and incremental estimated cancer risk are calculated by subtracting applicable background concentrations directly from maximum on-site contaminant values. This background subtraction only occurs when a radiological COC occurs as contamination and exists as a natural background radionuclide.
Step 6.	These values are compared with guidelines established by the U.S. Environmental Protection Agency (EPA) and the DOE to determine whether further evaluation, and potential site clean-up, is required. Nonradiological COC risk values are also compared to background risk so that an incremental risk may be calculated.
Step 7.	Uncertainties in the previous steps are discussed.

II.1 Step 1. Site Data

Site history and characterization activities are used to identify potential COCs. The identification of COCs and the sampling to determine the concentration levels of those COCs across the site are described in the ER Site 45 No Further Action (NFA) Proposal. In order to provide conservatism in this risk assessment, the calculation uses only the maximum concentration value of each COC determined for the entire site. Maximum concentrations reported from the subsurface and surface samples were combined into a single table to provide conservative risk calculations. Site-specific background data and the minimum sitewide upper tolerance limit (UTL) or 95th percentile, as appropriate, were selected to provide the background screen in Table 1, and the minimum value between the site-specific and sitewide background concentration was used to calculate risk attributable to background in Table 6. Chemicals that are essential nutrients, such as iron, magnesium, calcium, potassium, and sodium, were not included in this risk assessment (EPA 1989a). Both radioactive and nonradioactive COCs are evaluated. The nonradioactive COCs evaluated are both metals and organics.

Table 1
Nonradioactive COCs at ER Site 45 and Comparison to the Background Screening Values

COC name	Maximum concentration (mg/kg)	Tijeras Arroyo 95th % or UTL Level (mg/kg)	Is maximum COC concentration less than or equal to the applicable Tijeras Arroyo background screening value?	SNL/NM 95th % or UTL Level (mg/kg)	Is maximum COC concentration less than or equal to the applicable SNL/NM background screening value?
Arsenic	88 J	5.9	No	4.4	No
Barium	310	298	No	200	No
Cadmium	1.05**	3.0	Yes	<1	NA
Chromium, total*	94	NC	NA	NC	NA
Lead	740	23.1	No	11.2	No
Mercury	2.19	NC	NA	<0.1^	No
Selenium	51 J	NC	NA	<1^	No
Silver	9.1	NC	NA	<1^	No

*total chromium assumed to be chromium VI (most conservative).
** concentrations are assumed to be one-half of the detection limit.
NC - not calculated.
NA - not applicable.
J - estimated concentration.
^ uncertainty due to detection limits.

II.2 Step 2. Pathway Identification

ER Site 45 has been designated with a future industrial land-use scenario (DOE and USAF 1995) (see Appendix 1 for default exposure pathways and parameters). Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure for nonradiological COCs is considered to be soil ingestion. For radiological COCs, the primary pathway for human exposure is inhalation for the industrial land-use scenario and plant ingestion for the residential land-use scenario. The inhalation pathway for chemicals is included because of the potential to inhale dust and volatiles. The soil ingestion pathway is also included for radionuclides. No water pathways to the groundwater are considered because the depth to groundwater at Site 45 is approximately 300 feet. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered to not be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the industrial land-use scenario. However, plant uptake is considered for the residential land-use scenario.

PATHWAY IDENTIFICATION

Chemical Constituents	Radionuclide Constituents
Soil ingestion	Soil ingestion
Inhalation (dust and volatiles)	Inhalation (dust and volatiles)
Plant uptake (residential only)	Plant uptake (residential only)

II.3 Steps 3-5. Calculation of Hazard Indices and Cancer Risks

Steps 3 through 5 are discussed in this section. These steps include the discussion of the tiered approach in eliminating potential COCs from further consideration in the risk assessment process and the calculation of intakes from all identified exposure pathways, the discussion of the toxicity information, and the calculation of the hazard indices and cancer risks.

The risks from the COCs at ER Site 45 were evaluated using a tiered approach. First, the maximum concentrations of nonradiological COCs were compared to Tijeras Arroyo-specific background screening levels using 95th UTLs or percentile values (SNL/NM 1996). Maximum COC concentrations reported from the subsurface and surface samples were combined into a single table to provide conservative risk calculations. If a maximum concentration of a particular COC exceeded the Tijeras Arroyo-specific background screening level or if it was a radiological COC, then the COC was compared to the SNL/NM background screening level for the SNL/NM North Super Group (IT Corporation 1996), as modified during verbal discussion with representatives of New Mexico Environment Department (NMED). The SNL/NM UTL chosen for comparison was the minimum value when comparing surface and subsurface UTL values. This procedure was implemented to ensure use of the most conservative value during the comparison process and due to uncertainties associated with some sample depths. If a SNL/NM-specific screening level was not available for a constituent, then a background value was obtained, when possible, from the U.S. Geological Survey (USGS) National Uranium Resource Evaluation program (USGS 1994).

If any nonradiological COCs were above both the Tijeras Arroyo and SNL/NM background screening levels or, as applicable, the USGS background value, all nonradiological COCs were considered in further risk assessment analyses.

For radiological COCs that exceeded 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 orders. Radioactive COCs that did not have a background value and were detected above the analytical minimum detectable activity were carried through the risk assessment at their maximum levels. This step is performed (rather than carry the below-background radioactive COCs through the risk assessment and then perform a background risk assessment to determine incremental TEDE and estimated cancer risk) to prevent the "masking" of radiological contamination that may occur if on-site background radiological COCs exist in concentrations sufficiently below the assigned background level. When this "masking" occurs, the final incremental TEDE and estimated cancer risk are reduced and, therefore, provide a nonconservative estimate of the potential impact on an on-site receptor. This approach is also consistent with the regulatory approach (40 CFR Part 196 1994), which sets a TEDE limit to the on-site receptor in excess of background. The resultant radioactive COCs remaining after this step are referred to as background-adjusted radioactive COCs.

Second, the remaining maximum concentration for each nonradiological COC was compared with action levels calculated using methods and equations promulgated in the proposed RCRA Subpart S (40 CFR Part 264 1990) and Risk Assessment Guidance for Superfund (RAGS) (EPA 1989a) 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 the samples were all taken from the surface to 19 feet below the surface, this assumption is considered conservative. If there are ten or fewer COCs and each has a maximum concentration less than one-tenth of the action level, then the site would be judged to pose no significant health hazard to humans. If there are more than ten COCs, the Subpart S screening procedure was skipped.

Third, hazard indices and risk due to carcinogenic effects were calculated using reasonable maximum exposure (RME) methods and equations promulgated in RAGS (EPA 1989a). The combined effects of all nonradiological COCs in the soils were calculated. The combined effects of the COCs at their respective UTL or 95th-percentile background concentration in the soils were also calculated. The most conservative background concentration between the Tijeras Arroyo-specific and SNL/NM concentration (minimum value of the 95th UTL or percentile concentration value, as applicable) was used in the risk calculation. For toxic compounds, calculating combined effects was accomplished by summing the individual hazard quotients for each compound into a total Hazard Index. This Hazard Index is compared to the recommended guideline of 1. For potentially carcinogenic compounds, the individual risks were summed. The total risk was compared to the recommended acceptable risk range of 10^{-4} to 10^{-6}. For the radioactive COCs, the incremental TEDE was calculated and the corresponding incremental cancer risk estimated using DOE's RESRAD computer code.

II.3.1 Comparison to Background and Action Levels

Nonradioactive ER Site 45 COCs are listed in Table 1; radioactive COCs are listed in Table 2. Both tables show the associated 95th-percentile or UTL background levels (SNL/NM 1996; IT Corporation 1996).

Table 2
Radioactive COCs at ER Site 45 and Comparison to the Background Screening Values

COC name	Maximum concentration (pCi/g)	SNL/NM 95th % or UTL Level (pCi/g)	Is maximum COC concentration less than or equal to the applicable SNL/NM background screening value?
H-3	0.03	NC	No

NC - not calculated.

A background level for tritium is not applicable because this radionuclide does not occur naturally or, when due to fallout, at levels detectable by common laboratory analytical instrumentation. The Tijeras Arroyo background levels have not yet been approved by the EPA or the NMED but are the result of statistical analyses of samples collected from background areas within the Tijeras Arroyo. These background concentrations have been recalculated from those used in the June 1995 NFA proposals. The values shown in Table 1 supersede the background values described in an interim background study report (IT Corporation 1994). The recalculated Tijeras Arroyo values were prepared using a more rigorous statistical approach according to EPA guidance (EPA 1989b, 1992a, 1992b). The Tijeras Arroyo background locations were not differentiated on the basis of depth because of the homogeneous nature of the soil and the limited sampling depth of 0 to 36 inches.

As part of the IT Corporation (1996) SNL/NM study, background concentrations were calculated for both the surface (0- to 6-inch depth) and subsurface (>6-inch depth) soils of the North Super Group, which is defined as soils present in TA-I, TA-II, TA-IV, the northern rim of the Tijeras Arroyo, and the northeastern portion of Kirtland Air Force Base (KAFB). The SNL/NM UTL chosen for comparison was the minimum value when comparing surface and subsurface UTL values, as modified during verbal discussion with representatives of the NMED. The SNL/NM background levels have not yet been approved by the EPA or the NMED but are the result of a comprehensive study of joint SNL/NM and U.S. Air Force data for KAFB (IT Corporation 1996).

Several compounds have maximum measured values greater than background screening levels. Therefore, all nonradiological COCs were retained for further analysis with the exception of lead. The maximum concentration value for lead at Site 45 is 740 milligrams per kilogram (mg/kg). The EPA intentionally does not provide any toxicological data on lead, and therefore, no risk parameter values can be calculated. However, EPA guidance for the screening value for lead for an industrial land-use scenario is 2,000 mg/kg (EPA 1996a). The maximum concentration value for lead at this site is less than this screening value, and therefore, lead is eliminated from further consideration in this risk assessment. Because organic compounds do not have calculated background values, this screening step was skipped, and all organics are carried into the risk assessment analyses.

Because several nonradiological COCs had concentrations greater than their respective Tijeras Arroyo-specific or SNL/NM background 95th percentile or UTL, the site fails the background screening criteria, and all nonradiological COCs proceed to the proposed Subpart S action level screening procedure. Because the ER Site 45 sample set had more than ten COCs that continued past the first screening level (including organics that do not have background screening values), the proposed Subpart S screening process was skipped. All remaining nonradiological COCs must have a Hazard Index value and cancer risk value calculated.

Radioactive contamination does not have predetermined action levels analogous to proposed Subpart S, and therefore, this step in the screening process is not performed for radionuclides.

II.3.2 Identification of Toxicological Parameters

Tables 3 and 4 show the COCs that have been retained in the risk assessment and the values for the toxicological information available for those COCs. Dose conversion factors (DCF) used in determining the incremental TEDE values for the individual pathways were the default values provided in the RESRAD computer code as developed for the following:

Table 3
Nonradioactive Toxicological Parameter Values for ER Site 45 COCs

COC name	RfD_o (mg/kg/d)	RfD_{inh} (mg/kg/d)	Confidence	SF_o (kg-d/mg)	SF_{inh} (kg-d/mg)	Cancer Class ^
Arsenic	0.0003	--	M	1.5	15.1	A
Barium	0.07	0.000143	M	--	--	D
Cadmium	0.0005	0.0000571	H	--	6.3	B1
Chromium, total*	0.005	--	L	--	42	D
Mercury	0.0003	0.0000857	M	--	--	D
Selenium	0.005	--	H	--	--	D
Silver	0.005	--	L	--	--	D
Acetone	0.1	--	L	--	--	D
Trichloroethene	0.006	--	--	0.011	0.006	B2

RfD_o - oral chronic reference dose in mg/kg-day.
RfD_{inh} - inhalation chronic reference dose in mg/kg-day.
Confidence - L = low, M = medium, H = high.
SF_o - oral slope factor in $(mg/kg\text{-}day)^{-1}$.
SF_{inh} - inhalation slope factor in $(mg/kg\text{-}day)^{-1}$.
^ EPA weight-of-evidence classification system for carcinogenicity:

A - human carcinogen.
B1 - probable human carcinogen. Limited human data are available.
B2 - probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
C - possible human carcinogen.
D - not classifiable as to human carcinogenicity.

-- information not available.
* total chromium is assumed to be chromium VI (most conservative).

Table 4
Radiological Toxicological Parameter Values for ER Site 45 COCs

COC name	SF_o (1/pCi)	SF_{inh} (1/pCi)	SF_{ev} (g/pCi-yr)	Cancer Class^
H-3	7.2E-14	9.6E-14	0	A

SF_o - oral (ingestion) slope factor (risk/pCi).
SF_{inh} - inhalation slope factor (risk/pCi).
SF_{ev}- external volume exposure slope factor (risk/yr per pCi/g).
^ EPA weight-of-evidence classification system for carcinogenicity:

A - human carcinogen.
B1 - probable human carcinogen. Limited human data are available.
B2 - probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
C - possible human carcinogen.
D - not classifiable as to human carcinogenicity.
E - evidence of noncarcinogenicity for humans.

- For ingestion and inhalation, DCFs are taken from Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion* (EPA 1988a).
- The 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).
- The 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* (Health Physics 28:193-205) (Kocher 1983), and ANL/EAIS-8, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil* (Yu et al. 1993a).

II.3.3 Exposure Assessment and Risk Characterization

Section II.3.3.1 describes the exposure assessment for this risk assessment. Section II.3.3.2 provides the risk characterization, including the Hazard Index value and the excess cancer risk, for both the potential nonradiological COCs and associated background for industrial and residential land uses.

The incremental TEDE and incremental estimated cancer risk are provided for the background-adjusted radiological COCs for industrial and residential land uses.

II.3.3.1 Exposure Assessment

Appendix 1 shows the equations and parameter values used in the calculation of intake values and the subsequent Hazard Index and excess cancer risk values for the individual exposure pathways. The appendix shows the parameters for both industrial and residential land-use scenarios. The equations are based upon RAGS (EPA 1989a). The parameters are based on information from RAGS (EPA 1989a), as well as other EPA guidance documents, and reflect the RME approach advocated by RAGS (EPA 1989a). For radionuclides, the coded equations provided in the RESRAD computer code were used to estimate the excess dose and cancer risk for the individual exposure pathways. Further discussion of this process is provided in Manual for Implementing Residual Radioactive Material Standards Using RESRAD, Version 5.0 (Yu et al. 1993b).

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

II.3.3.2 Risk Characterization

Table 5 shows that for the ER Site 45 nonradioactive COCs, the Hazard Index value is 0.3, and the excess cancer risk is 6 x 10^{-5} for the designated industrial land-use scenario. The numbers presented included exposure from soil ingestion and dust and volatile inhalation for the nonradioactive COCs. Table 6 shows that assuming the maximum background concentrations of the ER Site 45 associated nonradiological background constituents, the Hazard Index is 0.01, and the excess cancer risk is 3 x 10^{-6} for the designated industrial land-use scenario.

For the radioactive COCs, the TEDE for industrial land use is 2 x 10^{-5} millirem per year (mrem/yr). In accordance with proposed EPA guidance, the guideline being utilized is an excess TEDE of 15 mrem/yr (40 CFR Part 196 1994) for the probable land-use scenario (industrial in this case); the calculated dose value for ER Site 45 for the industrial land use is well below this guideline. The estimated excess cancer risk from radioactive COCs for industrial land-use is 8 x 10^{-10}.

For the residential land-use scenario, the Hazard Index value increases to 28, and the excess cancer risk is 1 x 10^{-3}. The numbers presented included exposure from soil ingestion, dust and volatile inhalation, and plant uptake. Although the EPA (1991) generally recommends that inhalation not be included in a residential land-use scenario, this pathway is included because of the potential for soil in Albuquerque, New Mexico, to be eroded and, subsequently, for dust to be present even in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Appendix 1). Table 6 also shows that for the ER Site 45 associated nonradiological background constituents, the Hazard Index is 0.3, and the excess cancer risk is 5 x 10^{-5}.

For the radioactive COCs, the TEDE for residential land-use is 2 x 10^{-4} mrem/yr. In accordance with proposed EPA guidance, the guideline being utilized is an excess TEDE of 75 mrem/yr (40 CFR Part 196 1994) for a complete loss of institutional controls (the residential land-use scenario in this case); the calculated dose values for ER Site 45 for the residential land-use scenario is well below this guideline. It should also be noted that, consistent with the proposed guidance (40 CFR Part 196 1994), ER Site 45 should be eligible for unrestricted radiological release, because the residential scenario resulted in an incremental TEDE to the on-site receptor of less than 15 mrem/yr. The estimated excess cancer risk from radioactive COCs for the residential land-use scenario is 6 x 10^{-9}. The excess cancer risk from the nonradioactive COCs and the radioactive COCs is not additive, as noted in RAGS (EPA 1989a).

II.4 Step 6. Comparison of Risk Values to Numerical Guidelines.

The risk assessment analyses considered the evaluation of the potential for adverse health effects for both an industrial land-use scenario, which is the designated land-use scenario for this site, and a residential land-use scenario.

Table 5
Nonradioactive Risk Assessment Values for ER Site 45 COCs

COC Name	Maximum concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	88 J	0.29	6E-5	5.03	1E-3
Barium	310	0.00	--	0.05	--
Cadmium	1.05**	0.00	4E-10	0.86	6E-10
Chromium, total*	94	0.02	3E-7	0.07	4E-7
Mercury	2.19	0.01	--	3.77	--
Selenium	51 J	0.01	--	17.94	--
Silver	9.1	0.00	--	0.38	--
Acetone	0.0066 J	0.00	--	0.00	--
Trichloroethene	0.0017 J	0.00	4E-10	0.00	5E-9
TOTAL		**0.3**	**6E-5**	**28**	**1E-3**

-- information not available.
* total chromium assumed to be chromium VI (most conservative).
J - estimated concentration.
** concentrations are assumed to be one-half of the detection limit.

Table 6
Nonradioactive Risk Assessment Values for ER Site 45 Background Constituents

Constituent Name	Background concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	4.4	0.01	3E-6	0.25	5E-5
Barium	200	0.00	--	0.03	--
Cadmium	<1	--	--	--	--
Chromium, total*	NC	--	--	--	--
Mercury	<0.1	--	--	--	--
Selenium	<1	--	--	--	--
Silver	<1	--	--	--	--
TOTAL		**0.01**	**3E-6**	**0.3**	**5E-5**

-- information not available.
J - estimated value.
* total chromium assumed to be chromium VI (consistent with Table 5).
NC - not calculated due to absence in SNL/NM background reports (IT Corporation 1996; SNL/NM 1996).

For the industrial land-use scenario, the Hazard Index calculated is 0.3; this is much less than the numerical guideline of 1 suggested in RAGS (EPA 1989a). The excess cancer risk is estimated at 6×10^{-5}. In RAGS, the EPA suggests that a range of values (10^{-6} to 10^{-4}) be used as the numerical guideline; the value calculated for this site is in the middle of the suggested acceptable risk range. This risk assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the industrial and residential land-use scenarios. For the industrial land-use scenario, the Hazard Index is 0.01. The excess cancer risk is estimated at 3×10^{-6}. Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk. These numbers are not rounded before the difference is determined and, therefore, may appear to be inconsistent with numbers presented in tables and within the text. The incremental Hazard Index is 0.32, and the incremental cancer risk is 5.7×10^{-5} for the industrial land-use scenario. These incremental risk calculations indicate insignificant risk to human health from the COCs considering an industrial land-use scenario.

For the radioactive components of the industrial land-use scenario, the calculated incremental TEDE is 2×10^{-5} mrem/yr, which is significantly less than the numerical guideline of 15 mrem/yr suggested in the draft EPA guidance. The excess cancer risk estimate is 8×10^{-10}.

For the residential land-use scenario, the calculated Hazard Index is 28, which is greater than the numerical guidance. The excess cancer risk is estimated at 1×10^{-3}; this value is also above the suggested acceptable risk range. The Hazard Index for associated background for the residential land-use scenario is 0.3. The excess cancer risk is estimated at 5×10^{-5}. For the residential land-use scenario, the incremental Hazard Index is 27.82, and the incremental cancer risk is 9.5×10^{-4}. These incremental risk calculations indicate significant contribution to human health risk from the COCs considering a residential land-use scenario.

The incremental TEDE from the radioactive components is 2×10^{-4} mrem/yr, which is significantly less than the numerical guideline of 75 mrem/yr suggested in the draft EPA guidance. The associated cancer risk is 6×10^{-9}.

II.5 Step 7 Uncertainty Discussion

The data used to characterize ER Site 45, the Liquid Discharge site, was based upon 100 soil samples. This number of samples was deemed adequate to fully characterize the site. The soil samples were collected at a sewer-line trench, the liquid-discharge area, and subsurface magnetic anomalies. The field quality assurance (QA)/quality control (QC) samples consisted of five duplicates, one soil-trip blank, and four rinsates. Seventy-five percent were analyzed on site, and twenty-five percent of the samples were analyzed by off-site Contract Laboratory Program (CLP) laboratories.

The COCs for ER Site 45 are organic compounds and RCRA metals. As a conservative measure, the soil and QA/QC samples have been analyzed for volatile organic compounds (VOC) by EPA Method 8240, semivolatile organic compounds by EPA Method 8270, RCRA metals by EPA Methods 6010/7421/7471, HE compounds by EXP-USATHAMA/HPLC, tritium by EPA Method 600-906.0, and radioisotopes by gamma spectroscopy.

The soil and QA/QC samples were sent to three off-site CLP laboratories: Enseco-Quanterra, Core Laboratories, and TMA-Eberline. Soil samples were also analyzed on site at the Environmental Restoration Chemistry Laboratory and the Radiation Protection Sample Diagnostics Laboratory. These analytical data were determined to be adequate for risk assessment purposes based upon laboratory and field QA/QC checks.

The conclusion from the risk assessment analysis is that the potential effects caused by potential nonradiological COCs on human health are within the acceptable range compared to established numerical guidelines for the industrial land-use scenario. Calculated incremental risk between potential nonradiological COCs and associated background indicate an acceptable contribution of risk from nonradiological COCs when considering the industrial land-use scenario.

For the radiological COCs, the conclusion from the risk assessment is that the potential effect on human health for the industrial land-use scenario is well within the proposed guideline (40 CFR Part 196 1994) and is a small fraction of the estimated 290 mrem/yr received due to natural background (NCRP 1987).

The potential effects on human health for the nonradiological COCs are greater when considering the residential land-use scenario. Incremental risk between potential nonradiological COCs and associated background also indicate an increased contribution of risk from the nonradiological COCs. The increased effects on human health are primarily the result of including the plant uptake exposure pathway. Nonradiological constituents that posed little to no risk considering an industrial land-use scenario (some of which are below background screening levels) contribute a significant portion of the risk associated with the residential land-use scenario. These constituents bioaccumulate in plants. Because ER Site 45 is an industrial site, the likelihood of significant plant uptake in this area is highly unlikely, as is the likelihood that this site will be residential in the near future (DOE and USAF 1995). The uncertainty in this conclusion is considered to be small.

For the radiological COCs the conclusion from the risk assessment is that the potential effect on human health for the residential land-use scenario is well within proposed guidelines (40 CFR Part 196 1994) and is a small fraction of the estimated 290 mrem/yr received due to natural background (NCRP 1987).

Because of the location, history of the site, and the future land-use (DOE and USAF 1995), there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in making the risk assessment analysis. Because the COCs are found in surface and near-surface soils (less than 20 feet below ground) 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, which means that the parameter values used in the calculations were conservative and that the calculated intakes are likely overestimates. Maximum measured values of the concentrations of the COCs and minimum value of the 95th UTL or percentile concentration value, as applicable, of background concentrations associated with the COCs were used to provide conservative results.

Table 3 shows the uncertainties (confidence) in the nonradiological toxicological parameter values. There is a mixture of estimated values and values from the Health Effects Assessment Summary Tables (HEAST) (EPA 1996b) and Integrated Risk Information System (IRIS) (EPA 1988b, 1994, 1997a) databases. Where values are not provided, information is not available from HEAST, IRIS, or EPA regions. Because of the conservative nature of the RME approach, the uncertainties in the toxicological values are not expected to be of high enough concern to change the conclusion from the risk assessment analysis.

The risk assessment values are within the acceptable range for the industrial land-use scenario compared to the established numerical guidelines. Though the residential land-use Hazard Index and cancer risk are above the numerical guidelines, it has been determined that future land use at this locality will not be residential (DOE and USAF 1996). The radiological incremental TEDE is a very small fraction of estimated background TEDE for both the industrial and residential land-use scenarios, and both are well within proposed guidelines (40 CFR Part 196 1994). The overall uncertainty in all of the steps in the risk assessment process is considered not significant with respect to the conclusion reached.

II.6 Summary

ER Site 45, the Liquid Discharge site, had relatively minor soil contamination consisting of some inorganic and organic nonradioactive compounds and radionuclides. Because of the location of the site on KAFB, the designated industrial land-use scenario, and the nature of the contamination, the potential exposure pathways identified for this site included soil ingestion and dust and volatile inhalation for chemical constituents and soil ingestion, dust and volatile inhalation, and direct gamma exposure for radionuclides. Plant uptake was included as an exposure pathway for the residential land-use scenario.

Using conservative assumptions and employing an RME approach to the risk assessment, the calculations show that for the industrial land-use scenario the Hazard Index (0.3) is significantly less than the accepted numerical guidance from the EPA. The estimated cancer risk (6×10^{-5}) is in the middle of the suggested acceptable risk range. The incremental Hazard Index is 0.32, and the incremental cancer risk is 5.7×10^{-5} for the industrial land-use scenario. Incremental risk calculations indicate acceptable risk to human health from the COCs considering an industrial land-use scenario.

The incremental TEDE and corresponding estimated cancer risk from the radioactive components are much less than EPA guidance values; the estimated incremental TEDE is 2×10^{-5} rem/yr for the industrial land-use scenario. This value is much less than the numerical guidance of 15 mrem/yr in draft EPA guidance. The corresponding estimated cancer risk value is 8×10^{-10} for the industrial land-use scenario.

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

III. Ecological Risk Assessment

III.1 Introduction

This section addresses the ecological risks associated with exposure to constituents of potential ecological concern (COPEC) in soils from SNL/NM ER Site 45. The ecological risk assessment process performed for this site is a screening-level assessment that follows the methodology presented in IT Corporation (1997) and SNL/NM (1997). The methodology was based upon screening level guidance presented by the EPA (EPA 1992c, 1996c, 1997b) and by Wentsel et al. (1996) and is consistent with a phased approach. This assessment utilizes conservatism in the estimation of ecological risks; however, ecological relevance and professional judgment are also incorporated as recommended by the EPA (1996c) and Wentsel et al. (1996) to ensure that the predicted exposures of selected ecological receptors reasonably reflect those expected to occur at the site.

III.2 Site Description and Ecological Pathways

ER Site 45 is located near the south corner of TA-II, where fill material has been pushed over the northern embankment of the Tijeras Arroyo, covering the original soil and vegetation. The open channel from this site descends this slope and has deposited sediments at its base. Complete ecological pathways may exist at this site through the exposure of plants and wildlife to COPECs in surface and subsurface soil. Previous survey results (IT Corporation 1995) show the vegetation in this area is dominated by ruderals on the slope and at the base, including four-wing saltbush (*Atriplex canescens*), snakeweed (*Gutierrezia sarothrae*), and Russian thistle (*Salsola kali*). The top of the slope is nearly barren due to disturbance. No sensitive species were observed at this site, and none are expected to occur due to the degree of habitat modification.

III.3 Constituents of Potential Ecological Concern

The COPECs at this site include RCRA metals and VOCs. Radiologicals are not COPECs for ER Site 45; however they are used in this ecological risk assessment as a conservative measure. Following the screening process used for the selection of potential COCs for the human health risk assessment, the inorganic COCs were screened against background UTLs. Seven inorganic analytes were identified as COPECs at Site 45: arsenic, barium, chromium, lead, mercury, selenium, and silver. The VOCs of potential ecological concern were acetone and trichloroethene. Chemicals that are essential nutrients, such as iron, magnesium, calcium, potassium, and sodium, were not included in this risk assessment per EPA guidance (EPA 1989). Residual tritium was detected in soil; the maximum concentration for tritium is 0.03 picocuries per gram (pCi/g).

III.4 Receptors and Exposure Modeling

A nonspecific perennial plant was used as the receptor to represent plant species at the site. Two wildlife receptors (deer mouse and burrowing owl) were used to represent wildlife use of the site. Exposure modeling for the wildlife receptors was limited to the food ingestion pathway. 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 as an omnivore (50 percent of its diet is plants and 50 percent is soil invertebrates), and the burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet is deer mice). Both were modeled with soil ingestion comprising 2 percent of the total dietary intake. Table 7 presents the species-specific factors used in modeling exposures in the wildlife receptors. Although home range is also included in this table, exposures for this screening-level assessment were modeled using an area use factor of 1, implying that all food items and soil ingested are from the site being investigated.

Table 7
Exposure Factors for Ecological Receptors at Environmental Restoration Site 45, Sandia National Laboratories, New Mexico

Receptor species	Class/Order	Trophic level	Body weight (kg)[a]	Food intake rate (kg/d)[b]	Dietary Composition[c]	Home range (acres)
Deer Mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Omnivore	0.0239[d]	0.00372	Plants: 50% Invertebrates: 50% (+ Soil at 2% of intake)	0.27[e]
Burrowing owl (*Speotyto cunicularia*)	Aves/ Strigiformes	Carnivore	0.155[f]	0.0173	Rodents: 100% (+ Soil at 2% of intake)	34.6[g]

[a]Body weights are in kilograms wet weight.
[b]Food intake rates are estimated from the allometric equations presented in Nagy (1987). Units are kilograms dry weight per day.
[c]Dietary compositions are generalized for modeling purposes. Default soil intake value of 2 percent of food intake.
[d]From Silva and Downing (1995).
[e]From EPA (1993), based on the average home range measured in semi-arid shrubland in Idaho.
[f]From Dunning (1993).
[g]From Haug et al. (1993).

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

Table 8 presents the transfer factors used in modeling the concentrations of nonradioactive COPECs through the food chain. Table 9 presents the maximum concentrations of nonradioactive COPECs in soil, the derived concentrations in the various food-chain elements, and the modeled dietary exposures for each of wildlife receptor species.

Table 8
Transfer Factors Used in Exposure Models for Constituents of Potential Ecological Concern at Environmental Restoration Site 45, Sandia National Laboratories, New Mexico

Constituent of Potential Ecological Concern	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor
Arsenic	4.00×10^{-2} [a]	1.00×10^{0} [b]	2.00×10^{-3} [a]
Barium	1.50×10^{-1} [a]	1.00×10^{0} [b]	2.00×10^{-4} [c]
Chromium (Total)	4.00×10^{-2} [c]	1.30×10^{-1} [e]	3.00×10^{-2} [c]
Lead	9.00×10^{-2} [c]	4.00×10^{-2} [d]	8.00×10^{-4} [c]
Mercury	1.00×10^{0} [c]	1.00×10^{0} [b]	2.50×10^{-1} [a]
Selenium	5.00×10^{-1} [c]	1.00×10^{0} [b]	1.00×10^{-1} [c]
Silver	1.00×10^{0} [c]	2.50×10^{-1} [d]	5.00×10^{-3} [c]
Acetone	5.33×10^{1} [f]	1.28×10^{1} [g]	1.04×10^{-8} [f]
Trichloroethene	1.05×10^{0} [f]	1.80×10^{1} [g]	1.16×10^{-5} [f]

[a]From Baes et al. (1984).
[b]Default value.
[c]From NCRP (1989).
[d]From Stafford et al. (1991).
[e]From Ma (1982).
[f]From equations developed in Travis and Arms (1988).
[g]From equations developed in Connell and Markwell (1990).

With regard to the radionuclides, the ecological receptors are exposed to radiation internally from tritium only. Internal dose rates to the deer mouse and burrowing owl were approximated using dose rate models from the *Hanford Site Risk Assessment Methodology* (DOE 1995). Radionuclide-dependent data for the dose rate calculations were referenced from Baker and Soldat (1992). The internal dose rate model assumes that absorbed energy data for the radionuclides (Baker and Soldat 1992) are a function of the effective body radius of the receptor. Any radionuclide present in the body of the receptor concentrates at the center of the organism and contribute to a whole-body dose. The internal dose rate model assumes that the deer mouse ingests tritium from soil and plants and that the burrowing owl ingests tritium from soil and its diet of deer mice. A detailed description of the method to estimate radiation dose to these receptors is presented in DOE (1995) and IT Corporation (1997).

III.4 Toxicity Benchmarks

Benchmark toxicity values for the plant and wildlife receptors are presented in Table 10. For plants, the benchmark soil concentrations are based on the lowest-observed-adverse-effect level (LOAEL). LOAELs were not available in the literature for many of the organics. For wildlife, the toxicity benchmarks are based on the no-observed-adverse-effect level (NOAEL) for chronic oral exposure in a taxonomically similar test species. Insufficient toxicity information was found to estimate the NOAELs for silver and VOCs for birds. The benchmark used for

Table 9
Media Concentrations (mg/kg)[a] for Constituents of Potential Ecological Concern at Environmental Restoration Site 45, Sandia National Laboratories, New Mexico

Constituent of Potential Ecological Concern	Soil (maximum)	Plant Foliage[b]	Soil Invertebrate[b]	Deer Mouse Tissues[c]
Arsenic	8.80×10^{1}	3.52×10^{0}	8.80×10^{1}	2.97×10^{-1}
Barium	2.40×10^{2}	3.60×10^{1}	2.40×10^{2}	8.93×10^{-2}
Chromium (Total)	9.40×10^{1}	3.76×10^{0}	1.22×10^{1}	9.25×10^{-1}
Lead	7.40×10^{2}	6.66×10^{1}	2.96×10^{1}	1.57×10^{-1}
Mercury	2.19×10^{0}	2.19×10^{0}	2.19×10^{0}	1.75×10^{0}
Selenium	5.10×10^{1}	2.55×10^{1}	5.10×10^{1}	1.23×10^{1}
Silver	9.10×10^{0}	9.10×10^{0}	2.28×10^{0}	9.17×10^{-2}
Acetone	6.60×10^{-3}	3.52×10^{-1}	8.44×10^{-2}	7.09×10^{-9}
Trichloroethene	1.70×10^{-3}	1.79×10^{-3}	3.05×10^{-2}	5.87×10^{-7}

[a]Milligrams per kilogram. All are based on dry weight of the media.
[b]Product of the soil concentration and the corresponding transfer factor.
[c]Product of the average concentration in food times the food-to-muscle transfer factor times the wet weight-dry weight conversion factor of 3.125 (from EPA 1993).

exposure of terrestrial receptors to radiation was 0.1 rad/day. This value has been recommended by the International Atomic Energy Agency (1992) for the protection of terrestrial populations. Because plants and insects are less sensitive to radiation than vertebrates (Whicker and Schultz 1982), the dose of 0.1 rad/day should also offer sufficient protection to other components within the terrestrial habitat of Site 45.

III.5 Risk Characterization

The maximum soil concentrations or one-half the detection limits for the explosives and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. The results of these comparisons are presented in Table 11. Hazard quotients (HQ) are used to quantify the comparison with the benchmarks for plant and wildlife exposure. Maximum soil concentrations for all inorganic COPECs except barium exceeded their respective plant benchmark concentrations. Cadmium is within the background range. No organic COPECs for which toxicity data could be found exceeded their respective plant benchmark concentrations. For the deer mouse, HQs exceeded unity for arsenic (HQ = 55.5), barium (HQ = 2.11), mercury (HQ = 5.55) and selenium (HQ = 15.6). For the burrowing owl, only the HQs for mercury (HQ = 31.2) and selenium (HQ = 3.37) exceeded unity. Tables 12 and 13 present the results of the internal dose rate models applied to tritium ingestion for each receptor. The total radiation dose rate to the mouse was predicted to be 4.59×10^{-10} rad/day.

Table 10
Toxicity Benchmarks for Ecological Receptors at Environmental Restoration Site 45, Sandia National Laboratories, New Mexico

		Mammalian NOAELs			Avian NOAELs		
Constituent of Potential Ecological Concern	Plant Benchmark[a]	Mammalian Test Species[b]	Test Species NOAEL[c]	Deer Mouse NOAEL[d]	Avian Test Species[e]	Test Species NOAEL[e]	Burrowing Owl NOAEL[f]
Arsenic	10	Lab mouse	0.126	0.133	Mallard	5.14	5.14
Barium	500	Lab rat[g]	5.1	9.98	Chicks	20.8	20.8
Chromium (Total)	1	Lab rat	2737	5354	Black Duck	1.0	1.0
Lead	50	Lab rat	8	15.7	American kestrel	3.85	3.85
Mercury	0.3	Lab rat	0.032	0.0626	Mallard	0.0064	0.0064
Selenium	1	Lab rat	0.2	0.391	Screech owl	0.44	0.44
Silver	2	Lab rat[i]	17.8[h]	34.8	---[i]	---	---
Acetone	---	Lab rat	10	19.6	---	---	---
Trichloroethene	---	Lab mouse	0.7	0.741	---	---	---

[a]From Will and Suter (1995).
[b]From Sample et al. (1996), except where noted. Body weights (in kilograms) for no-observed-adverse-effect level (NOAEL) conversion are: lab mouse, 0.030; lab rat, 0.350 (except where noted); and mink, 1.0.
[c]From Sample et al. (1996), except where noted.
[d]Based on NOAEL conversion methodology presented in Sample et al. (1996), using a deer mouse body weight of 0.239 kilograms and a mammalian scaling factor of 0.25.
[e]From Sample et al. (1996).
[f]Based on 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.
[g]Body weight of 0.435 kg was used for NOAEL conversion (Sample et al. 1996).
[h]From EPA (1997a).
[i]--- designates insufficient toxicity data.

Table 11
Comparisons to Toxicity Benchmarks for Ecological Receptors at Environmental Restoration Site 45, Sandia National Laboratories, New Mexico

Constituent of Potential Ecological Concern	Plant Hazard Quotient[a]	Deer Mouse Hazard Quotient	Burrowing Owl Hazard Quotient
Arsenic	**8.80×10^{0}**	**5.55×10^{1}**	4.46×10^{-2}
Barium	4.80×10^{-1}	**2.11×10^{0}**	2.62×10^{-2}
Chromium (Total)	**9.40×10^{1}**	2.87×10^{-4}	3.13×10^{-1}
Lead	**1.48×10^{1}**	6.26×10^{-1}	4.33×10^{-1}
Mercury	**7.30×10^{0}**	**5.55×10^{0}**	**3.12×10^{1}**
Selenium	**5.10×10^{1}**	**1.56×10^{1}**	**3.37×10^{0}**
Silver	**4.55×10^{0}**	2.62×10^{-2}	---[b]
Acetone	---	1.74×10^{-3}	---
Trichloroethene	---	3.40×10^{-3}	---

[a]Bold text indicates hazard quotient exceeds unity.

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

Table 12
Internal and External Dose Rates for Mice Exposed to Radionuclides at Environmental Restoration Site 45, Sandia National Laboratories, New Mexico

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/d)	External Dose (rad/d)	Total Dose (rad/d)
Tritium	0.03	4.59×10^{-10}	NA	4.59×10^{-10}

NA = Not Applicable. Tritium does not contribute to the external dose rate.

Table 13
Internal and External Dose Rates for Owl Exposed to Radionuclides at Environmental Restoration Site 45, Sandia National Laboratories, New Mexico

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/d)	External Dose (rad/d)	Total Dose (rad/d)
Tritium	0.03	4.64×10^{-10}	NA	4.64×10^{-10}

NA = Not Applicable. Tritium does not contribute to the external dose rate.

The total dose rate to the burrowing owl was predicted to be 4.64 x 10^{-10} rad/day. The internal dose rate, in this assessment, was the only contributor to the total dose rate. The dose rates for the deer mouse and the burrowing owl are considerably less than the benchmark of 0.1 rad/day.

III.6 Uncertainties

Many uncertainties are associated with the characterization of ecological risks at ER Site 45. These uncertainties result in the use of assumptions in estimating risk that may lead to an overestimation or underestimation of the true risk presented at a site. For this screening-level risk assessment, assumptions are made that are more likely to overestimate risk rather than to underestimate it. These conservative assumptions are used to be more protective of the ecological resources potentially affected by the site. Conservatisms incorporated into this risk assessment include the use of the maximum measured soil concentration or maximum detection limit to evaluate risk, the use of earthworm-based transfer factors or a default factor of 1.0 for modeling COPECs into soil invertebrates in the absence of insect data, and the use of 1.0 as the use factor for wildlife receptors regardless of seasonal use or home range size. Uncertainties associated with the estimation of risk to ecological receptors following exposure to tritium are primarily related to those inherent in the dose rate models and related exposure parameters. The internal models are based upon the assumption that ingested radionuclides are present at the center of a spherical-shaped receptor, forming a point source of radiation. The receptor is assumed to be exposed uniformly from this source of radiation at the center and receives a total-body dose.

III.7 Summary

Potential ecological risks were indicated for all three ecological receptors at ER Site 45; however, the use of the maximum measured soil concentration or detection limit to evaluate risk provided a conservative exposure scenario for the risk assessment and may not reflect actual site conditions.

Maximum soil concentrations for all inorganic COPECs except barium exceeded their respective plant benchmark concentrations. It is very likely that the risk results for the remaining metals are driven by conservatisms in data analysis. The maximum value (88 J mg/kg) of arsenic was found in only 1 out of 24 samples analyzed by the on-site laboratory. Nineteen of these samples were nondetects (<26 mg/kg). Seven samples analyzed by the off-site laboratory ranged from 2.9 to 11 mg/kg, with an average of 8.1 mg/kg. Therefore, a realistic maximum would be about 11 mg/kg for arsenic. The only HQ related to the maximum arsenic concentration that exceeded unity would be for the mouse (HQ=3) considering the incremental risk above background. By using the average of the data set for barium, total chromium, lead, mercury, and silver, the HQs for these metal would be less than 1. HQs for selenium are high due to a J value (51 mg/kg and the ND was 50 mg/kg) of the on-site laboratory. The result of the off-site laboratory for selenium were nondetects (<10 mg/kg).

No organic COPECs (acetone and trichloroethene) for which toxicity data could be found exceeded their respective plant benchmark concentrations. Based on these results, acetone and trichloroethene can be justified for elimination as COPECs at ER Site 45.

No ecological risks were predicted from exposure to tritium at the site.

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APPENDIX 1.

Sandia National Laboratories Environmental Restoration Program

EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

BACKGROUND

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

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

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

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

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

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

Based on the location of the SNL ER sites 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 ER sites, there does not presently occur any consumption of fish, shell fish, fruits, vegetables, meat, eggs, or dairy products that originate on-site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

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

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

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

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

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

EQUATIONS AND DEFAULT PARAMETER VALUES FOR IDENTIFIED EXPOSURE ROUTES

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land use scenarios. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for Superfund (RAGS): Volume 1 (EPA 1989a and 1991). These general equations also apply to

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

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

Generic Equation for Calculation of Risk Parameter Values

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

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

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

where

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

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

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

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

<u>Summary</u>

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

Table 2. Default Parameter Values for Various Land Use Scenarios

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

*** The exposure frequencies for the land use scenarios are often integrated into the overall contact rate for specific exposure pathways. When not included, the exposure frequency for the industrial land use scenario is 8 h/d for 250 d/y; for the recreational land use, a value of 2 hr/wk for 52 wk/y is used (EPA 1989b); for a residential land use, all contact rates are given per day for 350 d/y.

[a] RAGS, Vol 1, Part B (EPA 1991).

[b] Exposure Factors Handbook (EPA 1989b)

[c] EPA Region VI guidance.

[d] For radionuclides, RESRAD (ANL 1993) is used for human health risk calculations; default parameters are consistent with RESRAD guidance.

[e] Dermal Exposure Assessment (EPA 1992).

References

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DOE, 1996 Environmental Assessment of the Environmental Restoration Project at Sandia National Laboratories/New Mexico, US. Dept. of Energy, Kirtland Area Office.

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

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

EPA, 1992, Dermal Exposure Assessment: Principles and Applications, EPA/600/8-91/011B, Office of Research and Development, Washington, D.C.

Section 6.2
Summary of QA/QC Procedures and Results for Soil Samples Collected at ER Site 45

Summary of QA/QC Procedures and Results for ER Site 45

Sample Number (with alternate ER Sample ID, where applicable)	Location, Sampling Date, and AR/COC	Analytical Laboratory	Analytes and Methods	QA/QC Procedures and Results
ER92002060-1 (SNL0033879) ER92002060-2 (SNL0033886, SNL0033887, SNL0033880) ER92002061-1 (SNL0033888) ER92002061-2 (SNL0033895, SNL0033896, SNL0033889) ER92002062-1 (SNL0033897) ER92002062-2 (SNL0033904, SNL0033905, SNL0033898) Trip Blank: ER92002048-1 (SNL0033878)	Sewer-line Trench 11/8/93: [AR/COC 508012]	Enseco	• VOCs by EPA Method 8240. • SVOCs by EPA Method 8270. • *HE Compounds* by EXP-USATHAMA/HPLC. • RCRA metals by EPA Method 6010 except lead by EPA Method 7421, and mercury by EPA Method 7471.	• Enseco-Quanterra utilized Method Blank, SCS, and DCS (MS/MSD) samples; • RPD, accuracy average, and percent recovery were within QA/QC limits. • SNL/NM SMO compiled DV1 and DV2 checklists; no significant QA/QC problems were noted. • The soil-trip blank showed nondetects for VOCs.
ER92002060-3 (TA2-TR7-0.5) ER92002060-4 (TA2-TR7-0.5) ER92002061-3 (TA2-TR7-6.8) ER92002061-4 (TA2-TR7-6.8) ER92002062-3 (TA2-TR7-7.5) ER92002062-4 (TA2-TR7-7.5)	Sewer-line Trench 11/8/93: [AR/COC 508013]	TMA Eberline	• The radioisotopes of actinium, americium, cerium, cobalt, cesium, chromium, iron, potassium, ruthenium, zirconium, radium, bismuth, lead, radon, thorium, thallium and uranium by gamma spectroscopy. Tritium by EPA Method 600-906.0.	• TMA Eberline utilized Reagent Blank and LCS samples; • Percent recovery was within QA/QC limits. • SNL/NM SMO compiled DV1 and DV2 checklists; no significant QA/QC problems were noted.
ER92002062-5 (TA2-TR7-7.5)	Sewer-line Trench 11/8/93: [AR/COC 508013]	Radiation Protection Sample Diagnostics - SNL/NM Department 7714	• The radioisotopes of actinium, americium, bismuth, cerium, cesium, chromium, cobalt, iron, lead, potassium, radium, radon, thallium, thorium, ruthenium, uranium, and zirconium by gamma spectroscopy.	• Radiation Protection Sample Diagnostics utilized Blank, Duplicate, and LCS samples; • Percent recovery was within QA/QC limits. • The sample results were consistent with the surface radiation survey that detected background levels of radionuclides. • The sample results were consistent with TMA Eberline reporting of background levels of radionuclides.

Refer to notes at end of table.

Summary of QA/QC Procedures and Results for ER Site 45 (Continued)

Sample Number (with alternate ER Sample ID, where applicable)	Location and Sampling Date	Analytical Laboratory	Analytes and Methods	QA/QC Procedure and Results
45-GR-001-0-S-1 45-GR-001-1-S-3 45-GR-001-1-S-5 45-GR-002-0-S-1 45-GR-002-1-S-3 45-GR-002-1-S-5 45-GR-003-0-S-1 45-GR-003-1-S-5 45-GR-003-1-S-3 45-GR-004-0-S-1 45-GR-004-1-S-3 45-GR-004-1-S-5 45-GR-005-0-S-1 45-GR-005-1-S-3 45-GR-005-1-S-5 45-GR-006-0-S-1 45-GR-006-1-S-3 45-GR-006-1-S-5	Scoping-sampling area 6/19/95: [AR/COC 509094] 6/21/95: AR/COC 509097	ERCL	• VOCs by EPA Method 8240. • RCRA metals by EPA Method 6010.	• ERCL utilized Method Blank, Replicate, and Calibration Samples; • RPD and Percent recovery were within QA/QC limits. • Field QA/QC samples were not collected as part of this Scoping-Sampling phase.
45-GR-001-0-S-1 45-GR-001-1-S-4 45-GR-002-0-S-2 45-GR-002-1-S-4 45-GR-003-0-S-2 45-GR-003-1-S-4 45-GR-004-0-S-2 45-GR-004-1-S-4 45-GR-005-0-S-2 45-GR-005-1-S-4 45-GR-006-0-S-2 45-GR-006-1-S-4	Scoping-sampling area 6/19/95: AR/COC 509092	Radiation Protection Sample Diagnostics SNL/NM Department 7714	• The radioisotopes of actinium, americium, bismuth, cerium, cesium, chromium, cobalt, iron, lead, potassium, radium, radon, thallium, thorium, ruthenium, uranium, and zirconium by gamma spectroscopy.	• Radiation Protection Sample Diagnostics utilized Blank, Duplicate, and LCS samples; • Percent recovery was within QA/QC limits.
45-BH-104-1-S-03 (024877-03) 45-BH-104-1-S-04 (024877-04) 45-GR-105-0-SS-02 (024875-02) 45-BH-109-1-S-03 (024878-03) 45-BH-109-1-S-04 (024878-04) 45-GR-110-0-SS-02(024876-02)	*Liquid-discharge Area* 10/18/95: [AR/COC 02862]	*Core Labs*	• VOCs by EPA Method 8240. • RCRA metals by EPA Method 6010 except mercury by EPA Method 7471.	• Core Labs utilized Method Blank, LCS/LCD and SB/SBD samples; • RPD and Percent recovery were within QA/QC limits. • SNL/NM SMO compiled DV1 checklist; no significant QA/QC problems were noted.

Refer to notes at end of table.

Summary of QA/QC Procedures and Results for ER Site 45 (Continued)

Sample Number (with alternate ER Sample ID, where applicable)	Location and Sampling Date	Analytical Laboratory	Analytes and Methods	QA/QC Procedure and Results
45-GR-101-0-SS-01 45-BH-101-1-S-01 45-BH-101-1-S-02 45-GR-102-0-SS-01 45-BH-102-1-S-01 45-BH-102-1-S-02 45-GR-103-0-SS-01 45-BH-103-1-S-01 45-BH-103-1-S-02 45-GR-104-0-SS-01 45-BH-104-1-S-01 45-BH-104-1-S-02 45-GR-105-0-SS-01 45-BH-105-1-S-01 45-BH-105-1-S-02 45-GR-106-0-SS-01 45-BH-106-1-S-01 45-BH-106-1-S-02 45-GR-107-0-SS-01 45-BH-107-1-S-01 45-BH-107-1-S-02 45-GR-108-0-SS-01 45-BH-108-1-S-01 45-BH-108-1-S-02 45-GR-109-0-SS-01 45-BH-109-1-S-01 45-BH-109-1-S-02 45-GR-110-0-SS-01 45-BH-110-1-S-01 45-BH-110-1-S-02 <u>Duplicates:</u> 45-BH-106-1-SD-01 45-BH-106-1-SD-02 <u>Rinsates:</u> 45-RINSATE1-01 45-RINSATE1-02	Liquid-discharge Area 10/18/95 [AR/COC 508984]	ERCL	• RCRA metals by EPA Methods 6010/7421/7471. • VOCs by EPA Methods 8240/8260.	• ERCL utilized Method Blank, Replicate, and Calibration Samples; • RPD and Percent recovery were within QA/QC limits. • The two aqueous equipment-wash (rinsate) blanks were prepared following completion of soil sampling and final equipment decontamination. Rinsate sample 45-RINSATE1-01 did not contain RCRA metals. Rinsate sample 45-RINSATE-1-02 did not contain VOCs. These rinsate analyses indicated that the soil-sampling decontamination procedures were adequate.

Refer to notes at end of table.

Summary of QA/QC Procedures and Results for ER Site 45 (Continued)

Sample Number (with alternate ER Sample ID, where applicable)	Location and Sampling Date	Analytical Laboratory	Analytes and Methods	QA/QC Procedure and Results
45-BH-104-1-S-05 (024877-05) 45-BH-109-1-S-05 (024878-05)	Liquid-discharge Area 10/18/95: [AR/COC 04444]	Radiation Protection Sample Diagnostics - SNL/NM Department 7714	• The radioisotopes of actinium, americium, bismuth, cerium, cesium, chromium, cobalt, iron, lead, potassium, radium, radon, thallium, thorium, ruthenium, uranium, and zirconium by Gamma Spectroscopy.	• Radiation Protection Sample Diagnostics utilized Blank, Duplicate, and LCS samples; • LCS recovery was within QA/QC limits.
<u>Area A:</u> 45-BH-011-1-S-01 45-BH-011-1-S-02 45-BH-011-4-S-01 45-BH-011-9-S-01 45-BH-011-9-S-02 45-BH-011-14-S-01 45-BH-011-14-S-02 45-BH-012-1-S-01 45-BH-012-1-S-02 45-BH-012-4-S-01 45-BH-012-4-S-02 <u>Soil from magnetic-anomaly trenches:</u> 45-EX-013-3-S-01 45-EX-013-3-S-02 45-EX-014-3-S-01 45-EX-014-3-S-02 45-EX-015-3-S-01 45-EX-016-3-S-01 45-EX-016-3-S-02 <u>Area A Duplicate:</u> 45-BH-012-4-SD02 <u>Trench duplicates:</u> 45-EX-013-3-SD01 45-EX-013-3-SD02 <u>Rinsate:</u> 45-RINSATE2-01 45-RINSATE2-02	Area A and Magnetic Anomaly Trenches 10/23/95: [AR/COC 508985]	ERCL	• RCRA metals by EPA Methods 6010/7000/7421/7471 • VOCs by EPA Methods 8240/8260.	• ERCL utilized Replicate and Calibration Samples; • RPD and Percent recovery were within QA/QC limits. • The two aqueous equipment-wash (rinsate) blanks was prepared following completion of soil sampling and final equipment decontamination. Rinsate sample 45-RINSATE2-01 did not contain RCRA metals. Rinsate sample 45-RINSATE2-02 did not contain VOCs. These rinsate analyses indicated that the soil-sampling decontamination procedures were adequate.

Refer to notes at end of table.

Summary of QA/QC Procedures and Results for ER Site 45 (Concluded)

Sample Number (with alternate ER Sample ID, where applicable)	Location and Sampling Date	Analytical Laboratory	Analytes and Methods	QA/QC Procedure and Results
<u>Soil from Area A boreholes:</u> 45-BH-011-1-S-03 (024879-01) 45-BH-011-1-S-04 (024879-02) <u>Soil from magnetic anomaly trenches:</u> 45-EX-014-3-S-03 (024881-01) 45-EX-014-3-S-04 (024881-02)	Area A and Magnetic Anomaly Trenches 10/23/95: [AR/COC 02863]	*Core Labs*	• VOCs by EPA Method 8240. • RCRA metals by EPA Method 6010 except mercury by EPA Method 7471.	• Core Labs utilized Method Blank, LCS/LCSD and SB/SBD samples; • RPD and Percent recovery were within QA/QC limits. • SNL/NM SMO compiled DV1 and DV2 checklists; no significant QA/QC problems were noted.
<u>Soil from Area A boreholes:</u> 45-BH-011-1-S-05 (024879-03) <u>Soil from magnetic anomaly trench:</u> 45-EX-014-3-S-05 (024881-03)	Area A and Magnetic Anomaly Trenches 10/23/95: [AR/COC 02864]	Radiation Protection Sample Diagnostics - SNL/NM Department 7714	• The radioisotopes of actinium, americium, bismuth, cerium, cesium, chromium, cobalt, iron, lead, potassium, radium, radon, thallium, thorium, ruthenium, uranium, and zirconium by Gamma Spectroscopy.	• Radiation Protection Sample Diagnostics utilized Blank, Duplicate, and LCS samples; • LCS recovery was within QA/QC limits.

AR/COC - Analyses Request / Chain of Custody form
DCS - Duplicate Control Samples
DV - Data Verification/Validation
LCS - Laboratory Control Standard
LCSD - Laboratory Control Standard Duplicate
PID - Photoionization Detector
RPD - Relative Percent Difference
SB - Spiked Blank
SBD - Spiked Blank Duplicate
SCS - Single Control Samples

RSI

U.S. Department of Energy
Albuquerque Operations Office
Kirtland Area Office
P.O. Box 5400
Albuquerque, NM 87185-5400

SEP 15 [illegible]

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. James Bearzi, Chief
Hazardous and Radioactive Materials Bureau
New Mexico Environment Department
2044 Galisteo Street
P.O. Box 26110
Santa Fe, NM 87502-2100

Dear Mr. Bearzi:

Enclosed is one of two NMED copies of the Department of Energy and Sandia National Laboratories/New Mexico response to the NMED Request for Supplemental Information (RSI) for the sixth through the eleventh rounds of No Further Action (NFA) proposals.

If you have any questions, please contact John Gould at (505) 845-6089.

Sincerely,

Michael J. Zamorski
Area Manager

Enclosure

cc w/enclosure:
D. Bourne, AL, ERD
J. Parker, NMED-OB
R. Kennett, NMED-OB
D. Neleigh, EPA, Region 6 (2 copies via certified mail)
~~W. Moats,~~ NMED-HRMB (via Certified Mail)

cc w/o enclosure:
J. Cormier, KAO-AIP
W. Cox, SNL, MS 1089

Sandia National Laboratories
Albuquerque, New Mexico
September 1999

Environmental Restoration Project
Responses to NMED Request for Supplemental Information
No Further Action Proposals (9th Round)
Dated September 1997

INTRODUCTION

This document responds to comments received in a letter from the State of New Mexico Environment Department (NMED) to the U.S. Department of Energy (DOE) (Kieling, June 9, 1999) documenting the review of 13 No Further Action (NFA) Proposals submitted in September 1997.

The following five operable units (OU) and thirteen environmental restoration (ER) sites were included in the September 1997 NFA proposals:

- OU 1303
  - ER Sites 1 & 3, Radioactive Waste Landfill and Chemical Disposal Pits
  - ER Site 44, Uranium Calibration Pits and Decontamination Area
- OU 1309
  - ER Site 45, Liquid Discharge
- OU 1332
  - ER Site 19, TRUPAK Boneyard Storage Area
- OU 1333
  - ER Site 59, Pendulum Site
  - ER Site 63A, Balloon Test Area: Plutonium Dispersal Studies Project Site
  - ER Site 64, Gun Site
  - ER Site 63B, Balloon Test Area: Balloon/Helicopter Site

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Attachment

G, H, I, J, K

- OU 1334
  - ER Site 11, Radioactive Explosives Burial Mounds
  - ER Site 21, Metal Scrap
  - ER Site 57B, Workman Site: Target Area
  - ER Site 70, Explosives Test Pit
  - ER Site 88B, Firing Site: Instrumentation Poles

Of these thirteen sites, three were designated appropriate for NFA: ER Site 19 (OU 1332) and ER Sites 59 and 63B (in OU 1333). The remaining ten sites have supplemental information included within this response document.

This response document is organized on the first level by OU number and on the second level by ER site number. Each OU section restates the New Mexico Environment Department comments (in **bold** font) in the same order in which they were provided in the call for response to comments. Following each comment, the word "Response" introduces the reply (in normal font style) of the U.S. Department of Energy/Sandia National Laboratories/New Mexico. Responses to general technical comments begin on page 5 and responses to site-specific technical comments begin on page 7. Additional supporting information for the site-specific comments is included in the attachments that follow each OU section. Changes to previously submitted text or tables are provided with redline/strikeout indicators and are labeled "Revised." Changes to previously submitted figures are not provided with redline/strikeout indicators but are labeled "Revised." Newly submitted information (including text, tables, and figures) is labeled "Supplemental."

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RESPONSES TO COMMENTS
ON NO FURTHER ACTION PROPOSALS
SEPTEMBER 1997 (9TH ROUND)

GENERAL COMMENTS

1. **Drafts of maps, supporting documents, appendices, and data tables are unfinished products. For the purpose of a No Further Action (NFA) proposal, final versions of these and other types of information must be submitted.**

   Response: Final versions of maps, supporting documents, appendices, and data tables will be submitted in this response or subsequent to any additional work.

2. **Tables of laboratory data supplied with some NFA proposals are incomplete. As applicable, data tables should include sample identification numbers, analytical methods, method detection limits (MDL's) or minimum detectable activities (MDA's), analytical results, maximum contaminant limits, and approved background levels. Also, offsite laboratory results must be included and clearly identified.**

   Response: All tables will be completed as requested.

3. **It is helpful to include analytical results for field and equipment blanks, and duplicates in data tables. Quality assurance/quality control (QA/QC) data should not be mixed with environmental data in the same tables. If applicable, the QA/QC data tables should also include comparisons of offsite and onsite laboratory results (e.g., RPD's). The text should include a discussion of field and laboratory quality control results (the good points as well as the not-so-good points) and should indicate whether the sampling results are generally acceptable.**

   Response: For those NFAs for which additional information is requested, the data presentation will be examined and the information requested will be provided in the recommended format.

4. **Many data tables for volatile organic compounds (VOC's), semi-volatile organic compounds (SVOC's), high explosives (HE), and polychlorinated biphenyls (PCB's) list only the constituents that were detected, or list just whether any constituent of a group was detected. While summary tables like these are acceptable (and preferred for review purposes), they provide only part of the information needed to fully evaluate a NFA proposal. To complete the data package, additional tables must be submitted listing all of the various constituents that were analyzed for and their MDL's. Please note that "J-coded" data must be reported as detected constituents.**

General Comments

Response: The additional information will be provided for those specific NFAs for which such information has been requested as part of this Request for Supplemental Information. J-coded data will be reported as detects, as previously agreed to between U.S. Department of Energy, Sandia National Laboratories/New Mexico and the Hazardous and Radioactive Materials Bureau.

5. **For many data tables, sample locations and depths must be inferred from the sample identification numbers. Notes describing how such information is encoded into the sample identification numbers must be added to the tables or to the text.**

   Response: The data tables or text referring to the data tables will be revised so that map location, sample locations, and depth all correspond.

6. **To ensure that appropriate background levels are utilized, Area or Super Groups need to be specified for all NFA proposals.**

   Response: The area or supergroup for approved background values will be clearly identified. Correct values will be used.

Site-Specific Comments

OU 1309

ER Site 45, Liquid Discharge

ER Site 45 is not appropriate for NFA petition.

1. **Figure 3-2 —This figure is labeled "draft". See general comment 1.**

   Response: The Request for Supplemental Information for ER Site 45 requests additional sampling and excavation. It also requests laboratory method detection limits that are lower than background levels. A plan will be developed for the requested field work. Laboratories with method detection limits lower than background will be used to perform sample analysis. This plan will be presented to the Hazardous and Radioactive Materials Bureau contact before the field work is performed. A new NFA proposal will be submitted following the evaluation of the data resulting from the field work. Since this new field work will result in new data, tables, and figures, the Request for Supplemental Information comments regarding data, tables, and figures will be addressed when the new NFA proposal is submitted.

2. **The "Scoping Sampling" results for VOC's and radionuclides in soil must be summarized in tables. See general comments 2-4.**

   Response: See response to Specific Comment 1.

3. **Table 3-2 – the MDL's for As, Cd, Se, and Ag are too high to meet data quality objectives. See specific comment 15.**

   Response: See response to Specific Comment 1.

4. **Figure 3-3 —This figure is labeled "draft". See general comment 1.**

   Response: See response to Specific Comment 1.

5. **Table 3-4—Data in this table indicate that soils adjacent to Sewer Line Trench 7 are contaminated with Hg, Ag, and possibly tritium. Additionally, the samples collected at the maximum depth have the highest concentrations of contaminants. This part of ER Site 45 has not been adequately characterized; additional soil sampling to determine the nature and extent of contamination is required.**

   Response: See response to Specific Comment 1.

6. **Section 3.2.10.1—DOE/SNL must provide summary tables showing the results of VOC, SVOC, and HE analyses. See general comments 2-4.**

   Response: See response to Specific Comment 1.

Site-Specific Comments

7. **Table 3-6—Data in this table suggest that Ag is a widespread contaminant in the "Liquid Discharge" area. The extent of this contamination has not been adequately characterized. The MDL for Ag is also too high. See specific comment 15.**

   Response: See response to Specific Comment 1.

8. **Table 3-6—the MDL's for As, Se, and Ag are too high to meet data quality objectives. See specific comment 15.**

   Response: See response to Specific Comment 1.

9. **Section 3.2.10.2—DOE/SNL must provide summary tables showing the results of VOC and radionuclide analyses. See general comments 2-4.**

   Response: See response to Specific Comment 1.

10. **Section 3.2.10.3.1 —DOE/SNL must provide summary tables showing the results of VOC and radionuclide analyses. See general comments 2-4.**

    Response: See response to Specific Comment 1.

11. **Table 3-8—the MDL's for As, Se, and Ag are too high to meet data quality objectives. See specific comment 15.**

    Response: See response to Specific Comment 1.

12. **The pit at "Area A" should be excavated to determine whether waste has been disposed of at this location.**

    Response: See response to Specific Comment 1.

13. **Section 3.2.10.3.2 —DOE/SNL must provide summary tables showing the results of VOC and radionuclide analyses. See general comments 2-4.**

    Response: See response to Specific Comment 1.

14. **Table 3-11—the MDL's for As, Se, and Ag are too high to meet data quality objectives. See specific comment 15.**

    Response: See response to Specific Comment 1.

Site-Specific Comments

15. Additional analysis of As, Se, and Ag concentrations in soil must be done to adequately characterize the site. DOE/SNL must use laboratory methods that are capable of achieving MDL's that are lower than background levels for these constituents.

Response: See response to Specific Comment 1.

tran

National Nuclear Security Administration
Sandia Site Office
P.O. Box 5400
Albuquerque, New Mexico 87185-5400

NOV 1 2 2004

CC: Peter Davies
Paul Freshour
Eric Larsen
Stacey Griffith
C. Daniel
ESH Records

CERTIFIED MAIL--RETURN RECEIPT REQUESTED

Mr. James Bearzi, Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Road East, Building 1
Santa Fe, NM 87505

Dear Mr. Bearzi:

On behalf of the Department of Energy (DOE) and Sandia Corporation, DOE is submitting additional information to complete responses to the New Mexico Environment Department (NMED) for the Solid Waste Management Units (SWMUs) identified below:

OU 1303, SWMUs 1 and 3: This submittal documents the final backfilling of the Voluntary Corrective Measure excavation and provides a risk assessment. It is an addendum to the No Further Action (NFA) proposal of September 1997 and provides additional information in response to the three NMED Requests for Supplemental Information (RSIs) of January, June, and December 1999.

OU 1306, SWMU 78: This submittal completes the response to the NMED RSI of May 2000. It includes results of additional sampling, a geophysical survey, an NFA proposal, and a risk assessment.

OU 1306, SWMU 196: This submittal completes the response to the NMED RSI of May 2000. It includes the results of additional sampling, an NFA proposal, and a risk assessment.

OU 1309, SWMU 45: This submittal completes the response to the three NMED RSIs of January, June, and December 1999. It provides results of the additional requested fieldwork and evaluates newly identified information that was not available at the time of the initial response in September1999. It also includes a risk assessment.

OU 1309, SWMU 46: This submittal completes the response to the NMED Notice of Deficiency of October 1999 and provides the final results for the Voluntary Corrective Action (VCA) conducted at the site in 2003. In addition to the results of the VCA, it includes a risk assessment.

Review and analyses of all relevant data for these SWMUs indicate that *concentrations of constituents of concern* are lower than applicable risk assessment action levels. Based upon confirmatory sampling data, constituents of concern that

could have been released from each site to the environment pose an acceptable level of risk under current and projected land use. Therefore, a determination of Corrective Action Complete without controls is recommended for all these SWMUs.

If you have any questions regarding this submittal, please contact John Gould of my staff at (505) 845-6089.

Sincerely,

Patty Wagner
Manager

Enclosures

cc w/enclosures:
W. Moats, NMED (Via Certified Mail)
M. Gardipe, DOE/SC/ERD
C. Voorhees, NMED-OB, Santa Fe
D. Bierley, NMED-OB

cc w/o enclosures:
L. King, EPA Region 6 (Via Certified Mail)
F. Nimick, SNL, MS 1089
D. Stockham, SNL, MS 1087
B. Langkopf, SNL, MS 1087
C. Chocas, SNL, MS 1120
J. Copland, SNL, MS 1087
D. Miller, SNL, MS 1088
R. E. Fate, SNL, MS 1089
M. J. Davis, SNL, MS 1089
A. Blumberg, SNL, MS 0141

Sandia National Laboratories
Albuquerque, New Mexico
October 2004

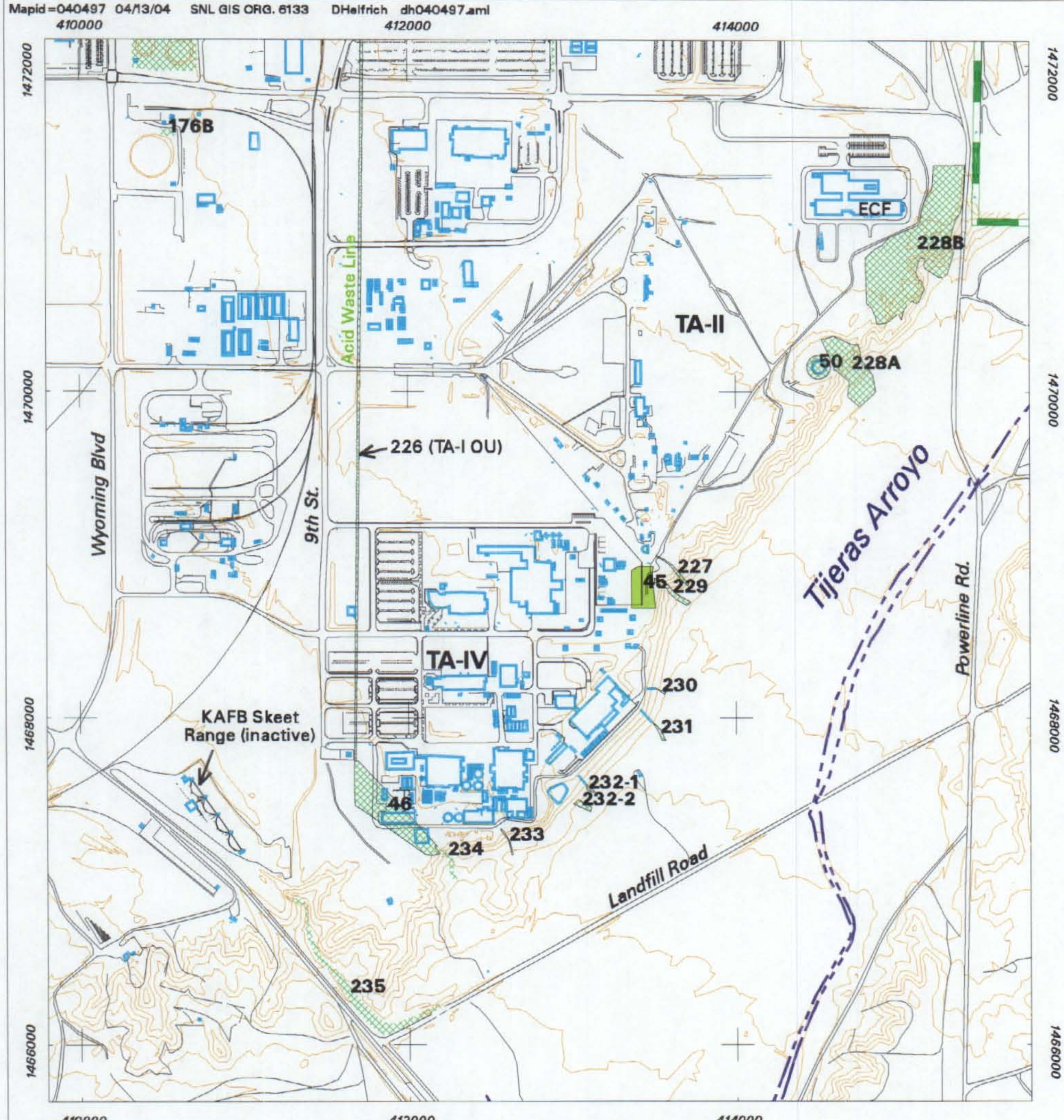
Environmental Restoration Project
Response to NMED Request for Supplemental Information
for Solid Waste Management Unit 45
No Further Action Proposal (9th Round)
Dated September 1997

INTRODUCTION

The U.S. Department of Energy (DOE) and Sandia National Laboratories/New Mexico (SNL/NM) are submitting this response to the Request for Supplemental Information (RSI) for Solid Waste Management Unit (SWMU) 45, the Liquid Discharge Site, which is managed by the Tijeras Arroyo Operable Unit. In September 1997, SNL/NM submitted a no further action (NFA) proposal (SNL/NM September 1997) to the New Mexico Environment Department (NMED). In June and December 1999, NMED issued a pair of identical RSIs requiring additional fieldwork. SNL/NM submitted an RSI Response in 1999 that briefly acknowledged the need for additional fieldwork at SWMU 45. This RSI response documents the results of the additional fieldwork and evaluates newly identified information that was not available at the time of the initial response.

SWMU 45, which covers 0.78 acres on the east side of Technical Area (TA)-IV (Figure 1), was listed as a SWMU based upon reports of a discharge of brownish water from an unmarked tank truck in 1985. At that time, the site was used for the temporary storage of construction-fill soil. No testing or waste disposal activities have occurred at the site. The constituents of concern (COCs) are volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and Resource Conservation and Recovery Act (RCRA) metals.

The September 1997 NFA proposal cited several previous investigations that have been conducted at SWMU 45. During these investigations, soil and soil-vapor samples were collected at the site, and no significant contamination was identified. However, the detection limits used in the analysis of the soil samples were too high for a definitive conclusion to be made. Radiological, unexploded ordnance (UXO)/high explosive (HE), and geophysical surveys have been conducted. No radiological or UXO/HE anomalies were identified. However, the geophysical survey identified a small amount of buried metal that is similar to the scrap metal found scattered across the site.



Legend

- Road
- 10 Foot Contour
- Tijeras Arroyo Channel
- KAFB Boundary
- Building / Structure
- SWMU 45
- Other SWMU

Figure 1
Tijeras Arroyo Operable Unit 1309
Solid Waste Management Unit 45

0 500 1000
Scale in Feet

0 120 240
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

840857.02100000 A6

A meeting between SNL/NM and NMED staff in November 2003 clarified several RSI issues, including NMED's fieldwork request (Copland November 2003a). The fieldwork, which was completed in early 2004, consisted of a Geoprobe™ investigation involving the collection of confirmatory soil samples at the Area A Pit. An off-site laboratory analyzed the soil samples and a risk assessment was prepared using the confirmatory analytical data. Documentation of the requested fieldwork and resultant risk assessment is included in this RSI response.

Two sources of information, not available for the NFA proposal, have been compiled and evaluated in this RSI response. First, interview notes were used to identify the water discharge location as the nearby SWMU 229 outfall ditch. Second, a recent review of historical aerial photographs has identified the likely purpose of the Area A Pit (trench). The trench may have been a "hull down defilade firing position" where an Army tank was parked for security purposes in the 1950s. A review of this new information is presented in Attachment A.

This RSI response restates each of the NMED comments (in bold font) in the same order in which the comments were provided. Following each comment, the word "Response" introduces the DOE/SNL/NM reply. Additional supporting information is included in the attachments.

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LIST OF ATTACHMENTS

Attachment	Title
A	SWMU 45 Review of Confidential Interviews and Historical Aerial Photographs
B	SWMU 45 Final Versions of Figures 3-2 and 3-3
C	Summary of Previously Submitted Off-Site Analytical Results for SWMU 45
D	Summary of Environmental Investigation Conducted for the RSI Response for SWMU 45
E	Risk Assessment Report for SWMU 45
F	Site Conceptual Model for SWMU 45

LIST OF ACRONYMS

COC	constituent of concern
COPEC	constituent of potential ecological concern
DOE	U.S. Department of Energy
ER	Environmental Restoration
ERCL	Environmental Restoration Chemistry Laboratory
HE	high explosive(s)
HI	hazard index
HQ	hazard quotient
kg	kilogram(s)
MDL	method detection limit
mg	milligram(s)
NFA	no further action
NMED	New Mexico Environment Department
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RPD	relative percent difference
RPSD	Radiation Protection Sample Diagnostics
RSI	Request for Supplemental Information
SNL/NM	Sandia National Laboratories/New Mexico
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
TA	Technical Area
UCL	upper confidence limit
UXO	unexploded ordnance
VOC	volatile organic compound

Response to Comments
Request for Supplemental Information
Comments by Permits Management Program,
Hazardous Waste Bureau, New Mexico Environment Department
for
U.S. Department of Energy and
Sandia National Laboratories/New Mexico
Proposal for No Further Action for Environmental Restoration (ER) Site 45
Liquid Discharge Site, Operable Unit 1309, September 1997 (9th Round)

GENERAL COMMENTS

1. **Drafts of maps, supporting documents, appendices, and data tables are unfinished products. For the purpose of a No Further Action (NFA) proposal, final versions of these and other types of information must be submitted.**

   Response: Final versions of maps, supporting documents, appendices, and data tables are included in this response.

2. **Tables of laboratory data supplied with some NFA proposals are incomplete. As applicable, data tables should include sample identification numbers, analytical methods, method detection limits (MDLs) or minimum detectable activities (MDAs), analytical results, maximum contaminant limits, and approved background levels. Also, offsite laboratory results must be included and clearly identified.**

   Response: Tables with the requested information are included in this response.

3. **It is helpful to include analytical results for field and equipment blanks, and duplicates in data tables. Quality assurance/quality control (QA/QC) data should not be mixed with environmental data in the same tables. If applicable, the QA/QC data tables should also include comparisons of offsite and onsite laboratory results (e.g., RPDs). The text should include a discussion of field and laboratory quality control results (the good points as well as the not-so-good points) and should indicate whether the sampling results are generally acceptable.**

   Response: The request for relative percent differences (RPDs) is not applicable because no on-site laboratory analyses are used in this response. The acceptability of laboratory results is discussed in the data validation reports.

4. **Many data tables for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), high explosives (HE), and polychlorinated biphenyls (PCBs) list only the constituents that were detected, or list just whether any constituent of a group was detected. While summary tables like these are acceptable (and preferred for review purposes), they provide only part of the information needed to fully evaluate a NFA proposal. To complete the data package, additional tables must be**

submitted listing all of the various constituents that were analyzed for and their MDLs. Please note that "J-coded" data must be reported as detected constituents.

Response: Additional data tables are included in this response, identifying all analyzed constituents and the method detection limits (MDLs) for each analyte. J-coded (J qualified) data also are included.

5. **For many data tables, sample locations and depths must be inferred from the sample identification numbers. Notes describing how such information is encoded into the sample identification numbers must be added to the tables or to the text.**

Response: The data tables and accompanying text present the requested information using the Round 12 format.

6. **To ensure that appropriate background levels are utilized, Area or Super Groups need to be specified for all NFA proposals.**

Response: Background values for the North Area Supergroup (Dinwiddie September 1997) are applicable to SWMU 45. These values are used in this RSI response and are reported in the Risk Assessment Report for SWMU 45 (Attachment E).

Specific Comments

SPECIFIC COMMENTS

OU 1309

ER Site 45, Liquid Discharge

ER Site 45 is not appropriate for NFA petition.

1. **Figure 3-2 —This figure is labeled "draft". See general comment 1.**

   Response: The final version of Figure 3-2 is presented in Attachment B.

2. **The "Scoping Sampling" results for VOCs and radionuclides in soil must be summarized in tables. See general comments 2-4.**

   Response: At the NMED's direction, the scoping-sampling results from the SWMU 45 NFA proposal (SNL/NM September 1997) are not summarized or otherwise resubmitted in this RSI response. A meeting held between SNL/NM and NMED staff on November 4, 2003, reached the consensus that the scoping-sampling results did not incorporate sufficient quality assurance (QA)/quality control (QC) measures (Copland November 2003b).

3. **Table 3-2 – the MDLs for As, Cd, Se, and Ag are too high to meet data quality objectives. See specific comment 15.**

   Response: Table 3-2 of the SNL/NM NFA proposal (SNL/NM September 1997) contained the scoping-sampling results, which, as noted in the response to Specific Comment 2, are not summarized or otherwise resubmitted in this RSI response. Because these data are no longer relied upon in the NFA proposal, the issue of MDLs for Table 3-2 (scoping-sampling results) is no longer a concern for NMED (Copland November 2003b).

4. **Figure 3-3 —This figure is labeled "draft". See general comment 1.**

   Response: The final version of Figure 3-3 is presented in Attachment B.

5. **Table 3-4—Data in this table indicate that soils adjacent to Sewer Line Trench 7 are contaminated with Hg, Ag, and possibly tritium. Additionally, the samples collected at the maximum depth have the highest concentrations of contaminants. This part of ER Site 45 has not been adequately characterized; additional soil sampling to determine the nature and extent of contamination is required.**

   Response: The location of Sewer Line Trench 7 was inaccurately reported in the SWMU 45 NFA proposal (SNL/NM September 1997). This trench is not located within SWMU 45. The location for Sewer Line Trench 7 is accurately depicted on Figure A-1 of Attachment A, which shows it to be located within SWMU 48, and was derived from the TA-II RCRA Facility Investigation Workplan (SNL/NM August 1994). SWMU 48 (the Building 904 Septic System) is managed by TA-II Operable Unit 1303. Analytical results for Sewer Line Trench 7 have been submitted to the NMED as part of the SWMU 48 RSI response (SNL/NM June 2004).

6. **Section 3.2.10.1—DOE/SNL must provide summary tables showing the results of VOC, SVOC, and HE analyses. See general comments 2-4.**

   Response: Section 3.2.10.1 of the SWMU 45 NFA proposal (SNL/NM September 1997) addressed Sewer Line Trench 7. As discussed in the response to Specific Comment 5, analytical results for the trench have been submitted to the NMED as part of the SWMU 48 (Building 904 Septic System) RSI response (SNL/NM June 2004).

7. **Table 3-6—Data in this table suggest that Ag is a widespread contaminant in the "Liquid Discharge" area. The extent of this contamination has not been adequately characterized. The MDL for Ag is also too high. See specific comment 15.**

   Response: The confirmatory sampling results in Table 3-6 of the SWMU 45 NFA proposal (SNL/NM September 1997) consist of the on-site Environmental Restoration Chemistry Laboratory (ERCL) analytical results for the Liquid Discharge area. The meeting held between SNL/NM and NMED staff on November 4, 2003, reached the consensus that the metal results do not conclusively demonstrate that silver contamination was present (Copland November 2003b). Confirmatory sampling results in Table 3-7 of the SWMU 45 NFA proposal (SNL/NM September 1997) show that silver was not detected in soil samples sent to the off-site laboratory. The Core Laboratories MDL for silver is 1 milligram (mg)/kilogram (kg). The North Area Supergroup background value for silver is less than or equal to 1 mg/kg (Dinwiddie September 1997); the exact background value is not quantified.

8. **Table 3-6—the MDLs for As, Se, and Ag are too high to meet data quality objectives. See specific comment 15.**

   Response: Table 3-6 of the SWMU 45 NFA proposal (SNL/NM September 1997) contains the on-site ERCL confirmatory sampling results for the Liquid Discharge area. A November 4, 2003, meeting held between SNL/NM and NMED staff reached the consensus that the on-site ERCL results did not incorporate sufficient QA/QC measures (Copland November 2003b). At the NMED's direction, the on-site ERCL results from the SWMU 45 NFA proposal (SNL/NM September 1997) are not summarized or otherwise resubmitted in this RSI response. Because these data are no longer relied upon in the NFA proposal, the issue of MDLs for Table 3-6 is no longer relevant.

9. **Section 3.2.10.2—DOE/SNL must provide summary tables showing the results of VOC and radionuclide analyses. See general comments 2-4.**

   Response: Section 3.2.10.2 of the SWMU 45 NFA proposal (SNL/NM September 1997) addresses the Liquid Discharge area. The requested summary tables for VOC and radionuclide analyses from the off-site analytical laboratories are presented in Tables C-1 and C-10 of Attachment C.

10. **Section 3.2.10.3.1 —DOE/SNL must provide summary tables showing the results of VOC and radionuclide analyses. See general comments 2-4.**

Response: Section 3.2.10.3.1 of the SWMU 45 NFA proposal (SNL/NM September 1997) addresses confirmatory sampling results for the Area A Pit. The requested summary tables for VOC and radionuclide analyses from the off-site analytical laboratories are presented in Tables C-1 and C-10 of Attachment C.

11. **Table 3-8—the MDLs for As, Se, and Ag are too high to meet data quality objectives. See specific comment 15.**

Response: Table 3-8 of the SWMU 45 NFA proposal (SNL/NM September 1997) addresses on-site ERCL confirmatory sampling results for the Area A Pit. At a meeting held on November 4, 2003, SNL/NM and NMED staff reached the consensus that the on-site ERCL results did not incorporate sufficient QA/QC measures (Copland November 2003b). At the NMED's direction, the on-site ERCL results from the SWMU 45 NFA proposal (SNL/NM September 1997) are not summarized or otherwise resubmitted in this RSI response. Because these data are no longer relied upon in the NFA proposal, the issue of MDLs for Table 3-8 is no longer relevant.

12. **The pit at "Area A" should be excavated to determine whether waste has been disposed of at this location.**

Response: The meeting held between SNL/NM and NMED staff on November 4, 2003, reached the consensus that a Geoprobe™ investigation would be sufficient to determine whether buried waste was present at the former Area A Pit (buried trench)(Copland November 2003b). The Geoprobe™ investigation was conducted in February 2004. A discussion of the field activities performed and a summary of the confirmatory sampling results are presented in Attachment D.

13. **Section 3.2.10.3.2 —DOE/SNL must provide summary tables showing the results of VOC and radionuclide analyses. See general comments 2-4.**

Response: Section 3.2.10.3.2 of the SWMU 45 NFA proposal (SNL/NM September 1997) addresses confirmatory sampling results for the Magnetic Anomaly Trenches. The requested summary tables for VOC and radionuclide analyses from the off-site analytical laboratories are presented in Tables C-1 and C-10 of Attachment C.

14. **Table 3-11—the MDLs for As, Se, and Ag are too high to meet data quality objectives. See specific comment 15.**

Response: Table 3-11 of the SWMU 45 NFA proposal (SNL/NM September 1997) addresses the on-site ERCL results for the Magnetic Anomaly Trenches. At a meeting held on November 4, 2003, SNL/NM and NMED staff reached the consensus that the on-site ERCL results did not incorporate sufficient QA/QC measures (Copland November 2003b). At the NMED's direction, the on-site ERCL results from the SWMU 45 NFA proposal (SNL/NM September 1997) are not summarized or otherwise resubmitted in this response. Because these data are no longer relied upon in the NFA proposal, the issue of MDLs for Table 3-11 is no longer relevant.

15. **Additional analysis of As, Se, and Ag concentrations in soil must be done to adequately characterize the site. DOE/SNL must use laboratory methods that are capable of achieving MDLs that are lower than background levels for these constituents.**

Response: In accordance with the NMED's request (Copland November 2003b), additional confirmatory sampling was conducted at the Area A Pit in February 2004. An off-site laboratory performed Target Analyte List metals analyses using detection limits that were lower than background concentrations. The confirmatory sampling results are presented in Attachment D.

Off-Site Confirmatory Sample Data

The off-site confirmatory sample data set for SWMU 45 is comprised of 21 samples. The sampling results were derived from three separate sampling events:

SWMU 45 Confirmatory Sampling

The SWMU 45 Confirmatory Sampling was conducted in October 1995. The sample results from this event were originally presented in Table 3-7 of the SWMU 45 NFA proposal (SNL/NM September 1997).

SWMU 229 Confirmatory Sampling

The SWMU 229 Confirmatory Sampling was conducted in September 1994 and March 2001. The NMED verbally endorsed the use of the sample results from these events for evaluating the water discharge at SWMU 45. As discussed in Attachment A, recent review of historical aerial photography and previously unavailable interview notes have identified that the water discharge location was at the nearby SWMU 229 outfall ditch (Copland November 2003c). Therefore, the westernmost SWMU 229 outfall ditch soil samples (denoted by * in Table 1) are used for characterizing the "brownish water discharge" that was the basis for identifying the area as SWMU 45. The lateral distribution of these samples was shown to the NMED in November 2003. The NMED verbally agreed that the distribution was representative of the entire cut and fill area including the suspected water discharge location (Copland November 2003a).

Specific Comments

SWMU 45 Geoprobe™ Characterization

As requested by the NMED in November 2003, a Geoprobe™ investigation was conducted in February 2004 to determine whether buried waste was present at the former Area A Pit (buried trench)(Copland November 2003b). The locations of the Area A Pit and the corresponding Geoprobe™ boreholes are shown in Figure D-1 of Attachment D.

The off-site confirmatory sample data set for SWMU 45 is presented in Table 1. In order to adequately characterize the site, these samples are grouped into one of three sub areas within SWMU 45:

- Liquid Discharge Area
- Area A Pit (buried trench)
- Magnetic Anomaly Trenches

Table 1
Confirmatory Soil Samples with Off-Site Analyses
Suitable for SWMU 45 Risk Assessment

Sample Number	Sub Area	Sample Date
229-01-A*	Liquid Discharge Area	09/29/94
229-01-B*		09/29/94
229-02-A*		09/29/94
229-02-B*		09/29/94
45-BH-104-1-S-03		10/18/95
45-GR-105-0-SS-02		10/18/95
45-BH-109-1-S-03		10/18/95
45-GR-110-0-SS-02		10/18/95
TJAOU-229-GR-05-14*		03/01/01
TJAOU-229-GR-05-19*		03/01/01
45-BH-011-1-S-03	Area A Pit (buried trench)	10/23/95
45-BH-013-2-3-SS		02/25/04
45-BH-013-8-SS		02/25/04
45-BH-013-8-DU		02/25/04
45-BH-013-8-10-SS		02/25/04
45-BH-013-8-10-DU		02/25/04
45-BH-014-1-SS		02/25/04
45-BH-014-1-2-SS		02/25/04
45-BH-014-8-SS		02/25/04
45-BH-014-8-10-SS		02/25/04
45-EX-014-3-S-03	Magnetic Anomaly Trenches	10/23/95

*Represents the westernmost SWMU 229 outfall ditch soil samples.
BH = Borehole.
DU = Duplicate sample.
EX = Excavation
GR = Grab sample.
S = Surface soil.
SS = Subsurface soil.
SWMU = Solid Waste Management Unit.
TJAOU = Tijeras Arroyo Operable Unit.

Specific Comments

Summary of Analytical Results for Risk Assessment

The three sampling events that provide the analytical data relevant to the SWMU 45 risk assessment are shown in Table 2.

Table 2
Soil Sampling Locations for SWMU 45 Risk Assessment

Sampling Event	Sample Locations	Sample Depth Range (ft bgs)
SWMU 45 Confirmatory Sampling	Area A Pit (buried trench):	
	45-BH-11	0.0-1.0
	Liquid Discharge Area:	
	45-GR-105	0.0-0.5
	45-GR-110	0.0-0.5
	45-BH-104	0.0-1.0
	45-BH-109	0.0-1.0
	Magnetic Anomaly Trenches:	
	45-EX-014	3.0
SWMU 229 Confirmatory Sampling	West End of Outfall Ditch:	
	229-01-A	0.0-0.5
	229-01-B	0.5-3.0
	229-02-A	0.0-0.5
	229-02-B	0.5-3.0
	Exploratory Excavation at Water Discharge Point:	
	TJAOU-229-GR-05	14.0-20.0
SWMU 45 Geoprobe™ Characterization	Area A Pit (buried trench):	
	45-BH-13	2.0-10.0
	45-BH-14	1.0-10.0

bgs = Below ground surface.
BH = Borehole.
EX = Excavation
ft = Foot (feet).
GR = Grab sample.
SWMU = Solid Waste Management Unit.
TJAOU = Tijeras Arroyo Operable Unit.

Summary of Analytes and Analytical Laboratories

Table 3 presents a summary of the analytical laboratories that performed the specific analyses for each sampling event.

The confirmatory analytical data were reviewed and verified/validated according to "Data Validation Procedure for Chemical and Radiochemical Data," SNL/NM ER Project Administrative Operating Procedure (AOP) 00-03 (SNL/NM December 1999). In addition, the Radiation Protection Sample Diagnostics (RPSD) Laboratory reviewed all gamma spectroscopy results according to "Laboratory Data Review Guidelines," Procedure No. RPSD-02-11, Issue No. 2 (SNL/NM July 1996). Data qualifiers from the verification/validation process are incorporated into the analytical tables that are presented in Attachments C and D. No significant QA/QC issues were identified.

Table 3
Analytes and Analytical Laboratories

Sampling Event	Sample Locations	Analytes	Laboratory
SWMU 45 Geoprobe™ Characterization	Area A Pit (buried trench): 45-BH-13 45-BH-14	VOCs, SVOCs, TAL Metals Gamma Spectroscopy	Severn Trent Laboratories
SWMU 45 Confirmatory Sampling	Area A Pit (buried trench): 45-BH-11	VOCs, RCRA Metals Gamma Spectroscopy	Core Laboratories RPSD Laboratory
	Liquid-Discharge Area: 45-GR-105 45-GR-110 45-BH-104 45-BH-109		
	Magnetic Anomaly Trenches: 45-EX-014		
SWMU 229 Confirmatory Sampling	West End of Outfall Ditch: 229-01-A 229-01-B 229-02-A 229-02-B	VOCs, SVOCs, RCRA Metals Gamma Spectroscopy	Environmental Control Technology RPSD Laboratory
	Exploratory Excavation at Water Discharge Point: TJAOU-229-GR-05	VOCs, SVOCs, RCRA Metals Gamma Spectroscopy	General Engineering Laboratories, Inc. RPSD Laboratory

BH = Borehole.
EX = Excavation
GR = Grab sample.
RCRA = Resource Conservation and Recovery Act.
RPSD = Radiation Protection Sample Diagnostics.
SVOC = Semivolatile organic compound.
SWMU = Solid Waste Management Unit.
TAL = Target Analyte List.
TJAOU = Tijeras Arroyo Operable Unit.
VOC = Volatile organic compound.

As shown in Table 4, a total of 54 analyses (soil samples plus duplicates) were used for the SWMU 45 risk assessment.

Highlights of the SWMU 45 analytical results for the three sampling events include:

- Six metals (antimony, arsenic, barium, cadmium, lead, and mercury) were detected at levels above background concentrations. A seventh metal (selenium) was not detected; however, in the Risk Assessment Report (Attachment E), it was reported as a concentration that is one-half the detection limit, which is above the background concentration for selenium.

Specific Comments

- No radionuclides were detected at levels above background activities but several minimum detectable activity values were above background levels.
- Low concentrations of five VOCs (acetone, bromoform, 2-butanone, dibromochloromethane, and methylene chloride) were detected.
- Low concentrations of ten SVOCs were detected.

Table 4
Number of Samples per Analyte for the Three Sampling Events
Applicable to the SWMU 45 Risk Assessment

Analyte	Environmental Samples	Duplicates	Total Soil Samples	Equipment Blanks	Trip Blanks
VOCs	10	2	12	2	2
SVOCs	10	2	12	2	--
Metals	15	1	16	2	--
Radionuclides	13	1	14	1	--
Total	48	6	54	7	2

SVOC = Semivolatile organic compound.
SWMU = Solid Waste Management Unit.
VOC = Volatile organic compound.
-- = Not analyzed.

Risk Summary

The analytical results of the soil sampling have identified only minor amounts of soil contamination remaining at SWMU 45. The maximum analyte values were used in the risk assessment. The Risk Assessment Report and the Site Conceptual Model for SWMU 45 are presented in Attachments E and F, respectively.

The risk assessment performed for this site initially used maximum COC concentrations to evaluate the potential for adverse health effects under industrial and residential land-use scenarios. For the industrial land-use scenario, the total and incremental human health hazard index (HI) and estimated excess cancer risk are below NMED guidelines.

Although both the HI and estimated excess cancer risk are above the NMED guidelines for the residential land-use scenario, maximum concentrations were used in the risk calculation. Because the site has been adequately characterized, average concentrations are more representative of actual site conditions. Using the 95% upper confidence limit (UCL) of the mean concentrations for the main contributors to excess cancer risk and hazards (Appendix 2 of Attachment E) reduces the total HI and estimated excess cancer risk values to 0.56 and 1.59E-5, respectively. The incremental HI and incremental excess cancer risk are reduced to 0.17 and 4.57E-6, respectively. Thus, by using realistic concentrations in the risk calculations that more accurately depict actual site conditions, both the total and incremental HI and the incremental excess cancer risk values are below NMED guidelines.

Specific Comments

The human health industrial and residential land-use scenario incremental dose calculations for radiological COCs are significantly below the U.S. Environmental Protection Agency numerical guidelines.

Ecological risks associated with SWMU 45 were estimated through a screening assessment that incorporates site-specific information when available. Initial calculations of hazard quotients (HQs) indicated a potential risk for 12 inorganic and 8 organic constituents of potential ecological concern (COPECs). However, based upon the analysis of uncertainties associated with these HQs, the actual potential for risk to ecological receptors from these COPECs is expected to be low. The overestimation of risk is primarily due to the use of maximum detected values as the exposure point concentrations for these HQs. Predicted risks from exposures based upon the 95% UCLs are less than 5 and/or can be attributed to conservative toxicity benchmarks or conservative assumptions of bioavailability. Based upon this final analysis, ecological risks associated with SWMU 45 are expected to be low.

In conclusion, human health and ecological risks are within the acceptable range according to NMED guidance.

Specific Comments

References

Copland, J.R. (Sandia National Laboratories/New Mexico), November 2003a. Logbook entry: "Follow up to RSI for SWMU 45 Meeting," Logbook ER-093, Operable Unit 1309, Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico. November 6, 2003, pp. 13 and 14.

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Copland, J.R. (Sandia National Laboratories/New Mexico), November 2003c. Memorandum to S.S. Collins, "Evaluation of future fieldwork at SWMU 45 with regards to a recent review of confidential interviews and historical aerial photographs," Tijeras Arroyo Operable Unit 1309, Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico. November 11, 2003.

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

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

Attachment A

ATTACHMENT A
SWMU 45
Review of Confidential Interviews and Historical Aerial Photographs

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LIST OF FIGURES

LIST OF TABLES

SOLID WASTE MANAGEMENT UNIT 45
REVIEW OF CONFIDENTIAL INTERVIEWS AND HISTORICAL AERIAL PHOTOGRAPHS

Introduction

Sandia National Laboratories/New Mexico (SNL/NM) performed a review of confidential interviews and historical aerial photographs for Solid Waste Management Unit (SWMU) 45 (the Liquid Discharge Site), which is near the northeastern corner of Technical Area (TA)-IV.

In the mid-1990s, portions of the confidential interviews associated with the identification of SWMU 45 apparently had been filed improperly at the Environmental Safety and Health and Security Records Center and unfortunately were not available when the SWMU 45 proposal for no further action (NFA) (SNL/NM September 1997) was submitted to the New Mexico Environment Department (NMED). The portions of the interviews related to SWMU 45 were discovered in the fall of 2003. By integrating the new interview information with historical aerial photographs and findings from the Environmental Restoration (ER) SWMUs 227/229 Notice of Deficiency (NOD) response (SNL/NM July 2003), the previously undisclosed water discharge location can now be identified and reported for the first time.

The following information from the SWMU 45 NFA proposal (SNL/NM September 1997) provides some background information. Please note that prior to 1999, SWMU 45 was referred to as Site 45.

> "A single discharge of water led to the identification of Site 45 in the Comprehensive Environmental Assessment and Response Program (CEARP) (DOE 1987). In February of 1985, a SNL/NM employee observed that a tank truck was discharging about 500 to 1,000 gallons of brownish water onto the ground surface east of TA-IV (confidential interview, 1993). The employee asked the truck driver what he was doing; he replied "discharging water". The tank truck did not have SNL/NM or military markings. The location of the discharge appeared wet during February 12 - 15, 1985. However, no documents record that the tank truck was at the site on more than one occasion. No more water-disposal details are available in the CEARP or any other documents. The precise location of the water discharge is not known; however, the location is within the 'liquid-discharge area' as defined in Section 3.2.10.2."

Review of Confidential Interviews

Two interviewees, herein identified as SNL/NM Employees #1 and #2, provide useful information for SWMU 45 (DOE 1987, Gaither February 1993). One interview includes the original handwritten February 1985 note that documented a discussion with SNL/NM Employee #1, which apparently led to the CEARP listing. In 1995, a brief phone call between an ER staff member and SNL/NM Employee #1 revealed that the water "was dumped in a ditch." SNL/NM Employee #1 also suggested that SNL/NM Employee #2 be contacted for further information regarding the incident. A subsequent field visit to SWMU 45 by the ER staff member and SNL/NM Employee #2 revealed that "the dumping had occurred just east of south corner of TA-II." The ER staff member wrote in their notebook "Probably should consider the site as being a 50 [foot] radius with a center on the manhole." A field sketch on the interview notes clearly identifies the manhole that is located outside the eastern fence of TA-IV and south of the southern TA-II apex. This area was extensively studied in 2002 and 2003 by the Tijeras Arroyo Operable Unit in preparing the NOD response for SWMUs 227/229 (SNL/NM July 2003).

By correlating the comments from SNL/NM Employees #1 and #2 with the ER staff member's field sketch, a strong inference can be made that the "brownish water discharge" occurred at a ditch located within 50 feet of the manhole. The only ditch located within a 50-foot radius of the manhole is the ER SWMU 229 outfall ditch (Figure A-1).

In the early 1990s, the original site boundary for SWMU 45 contained cut and fill areas, the SWMU 229 outfall ditch, and parts of SWMU 48 (Figure A-2). However, subsequent changes to the boundary have eliminated the overlap of the three sites. If the discharge location for the brownish water had been known, the overlap of SWMUs 45 and 229 would not have been eliminated. Another reason that the SWMU 45 boundary was changed to the current shape shown in Figure A-2 was to accommodate Facilities Engineering's request to construct TA-IV satellite dishes at the southwest corner of the site where no environmental problems had been identified.

Review of Historical Aerial Photographs

Most of the historical aerial photographs for SWMU 45 are presented in a report produced by Ebert & Associates, Inc. (November 1994). The report contains photographic enlargements and corresponding photointerpretive overlays. The enlargements are of excellent quality with a nominal scale of 1 inch equal to 200 feet. Photographs were available for 1951, 1959, 1964 through 1966, 1968, 1972 through 1980, and 1982 through 1993 (Table A-1).

Table A-1
Dates of Aerial Photographs for SWMU 45
(Ebert & Associates, Inc. November 1994)

November 11, 1951	April 14, 1980
November 6, 1959	March 7, 1982
April 10, 1964	March 9, 1983
April 15, 1965	January 27, 1984
March 30, 1966	March 18, 1985
March 28, 1968	April 21, 1986
November 10, 1972	March 4, 1987
March 25, 1973	March 8, 1988
January 24, 1974	April 12, 1989
April 15, 1975	March 22, 1990
February 26, 1976	March 9, 1991
January 1, 1977	March 25, 1992
March 16, 1978	March 8, 1993
March 14, 1979	

SWMU = Solid Waste Management Unit.

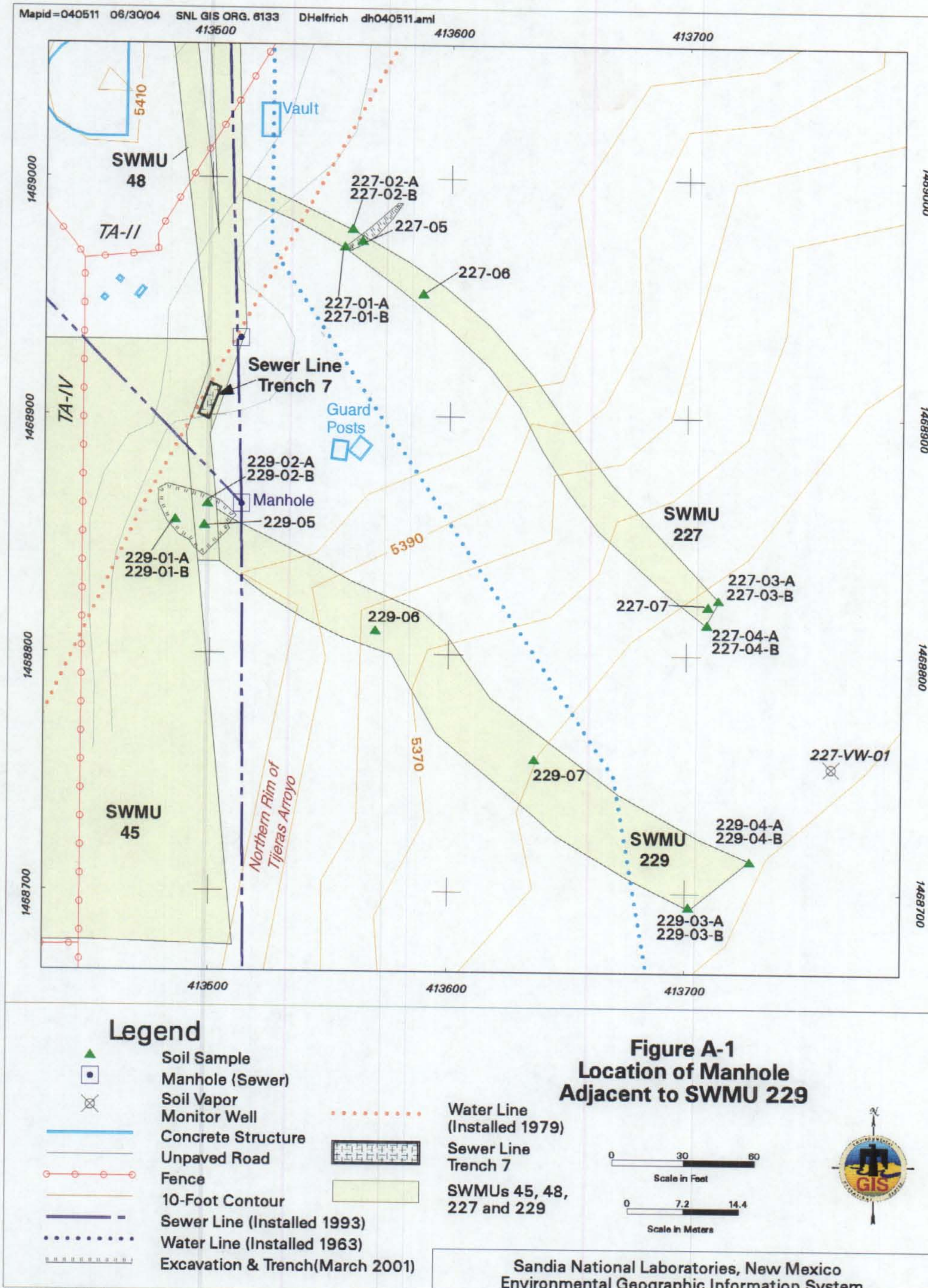
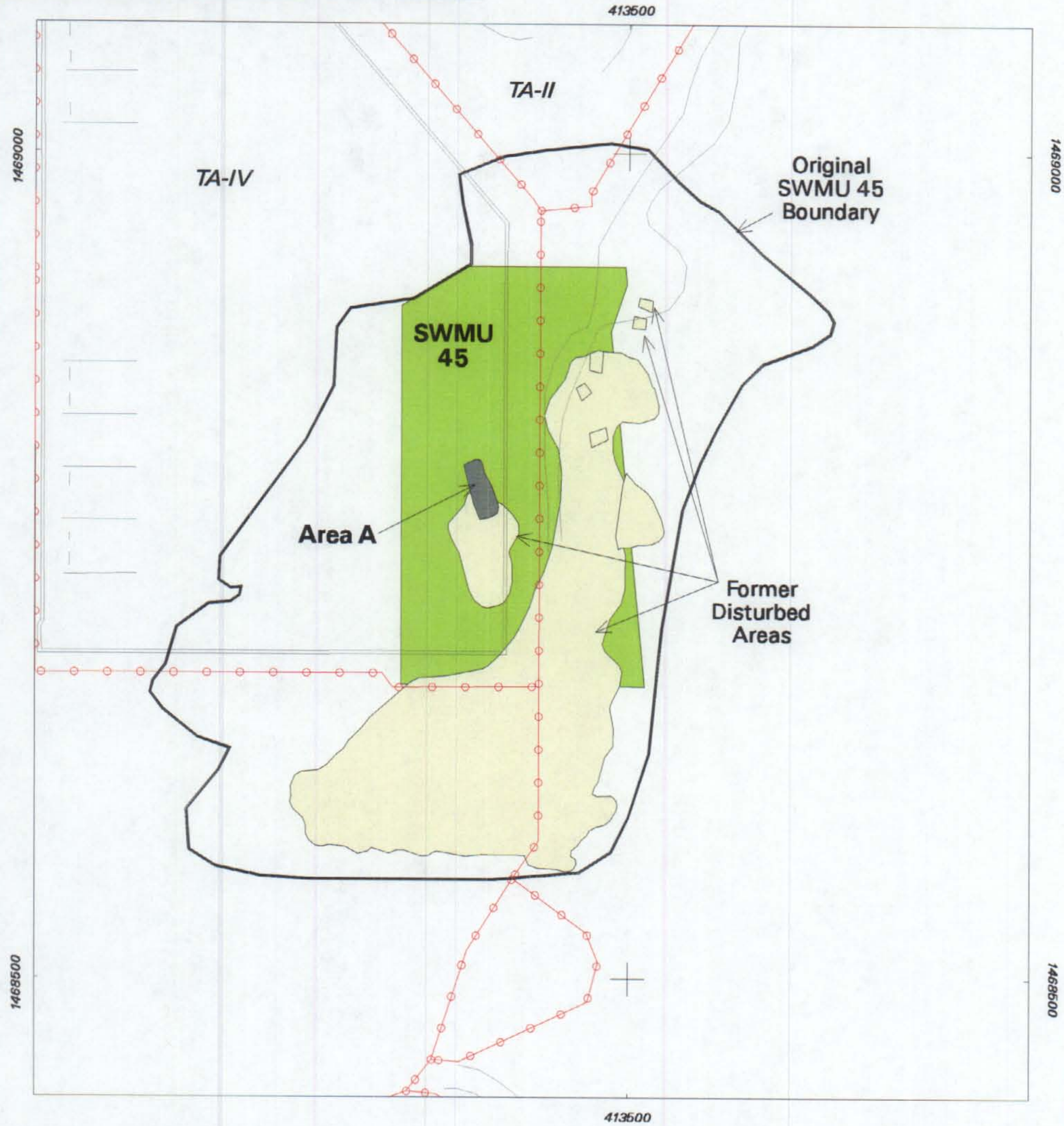


Figure A-1
Location of Manhole Adjacent to SWMU 229

840857.02100000A12

Mapid=040512 04/19/04 SNL EGIS ORG. 6133 DHelfrich dh040512.aml



Legend

Road

Fence

Original SWMU Boundary

SWMU 45

Former Disturbed Areas (Ebert & Associates, 1994)

Area A (Ebert & Associates, 1994)

Figure A-2
Current and Original Boundaries for SWMU 45

0 50 100
Scale In Feet

0 12 24
Scale In Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

840857.02100000A13

The photographs show that construction activities occurred at the site from prior to 1959 through 1990. Ebert & Associates, Inc. (November 1994) categorized the construction activities according to anomaly type (Table A-2). These types are used to annotate the photointerpretive overlays (Figures A-3, A-4, and A-5). Ebert & Associates, Inc. (November 1994) did not identify in any of the photographs (especially the March 18, 1985, photograph) any features such as soil staining or pools of liquids indicative of the "brownish water discharge" that occurred at SWMU 45 in February 1985.

Table A-2
Anomaly Types Used on Photointerpretation Overlays for SWMU 45
(Ebert & Associates, Inc. November 1994)

Anomaly Type	Description
1	Light-colored piles
2	Dark-colored piles
3	Piles interspersed with vegetation
4	Isolated piles
5	Trench
6	Large blocky debris
7	Equipment/debris
8	Cleared/depressed surfaces
9	Small debris
10	Cleared/disturbed surfaces

SWMU = Solid Waste Management Unit.

Findings concerning the historical aerial photographs are discussed as follows.

Cut and Fill Soil Piles

- Cut and fill soil piles are not present in 1951.
- Soil piles are present in 1959 (Figure A-3). Dozens of dump-truck loads of soil cover approximately 0.7 acres. Concrete rubble may be present.
- Cut and fill area is still active in 1964.
- No change occurs in 1965.
- Area remains active in 1966 and 1968.
- No activity occurs in 1972, 1973, 1974, 1975, 1976, 1977, or 1978.
- Kirtland Air Force Base (KAFB) water line is installed across site in 1979.
- Area is graded flat in 1980.

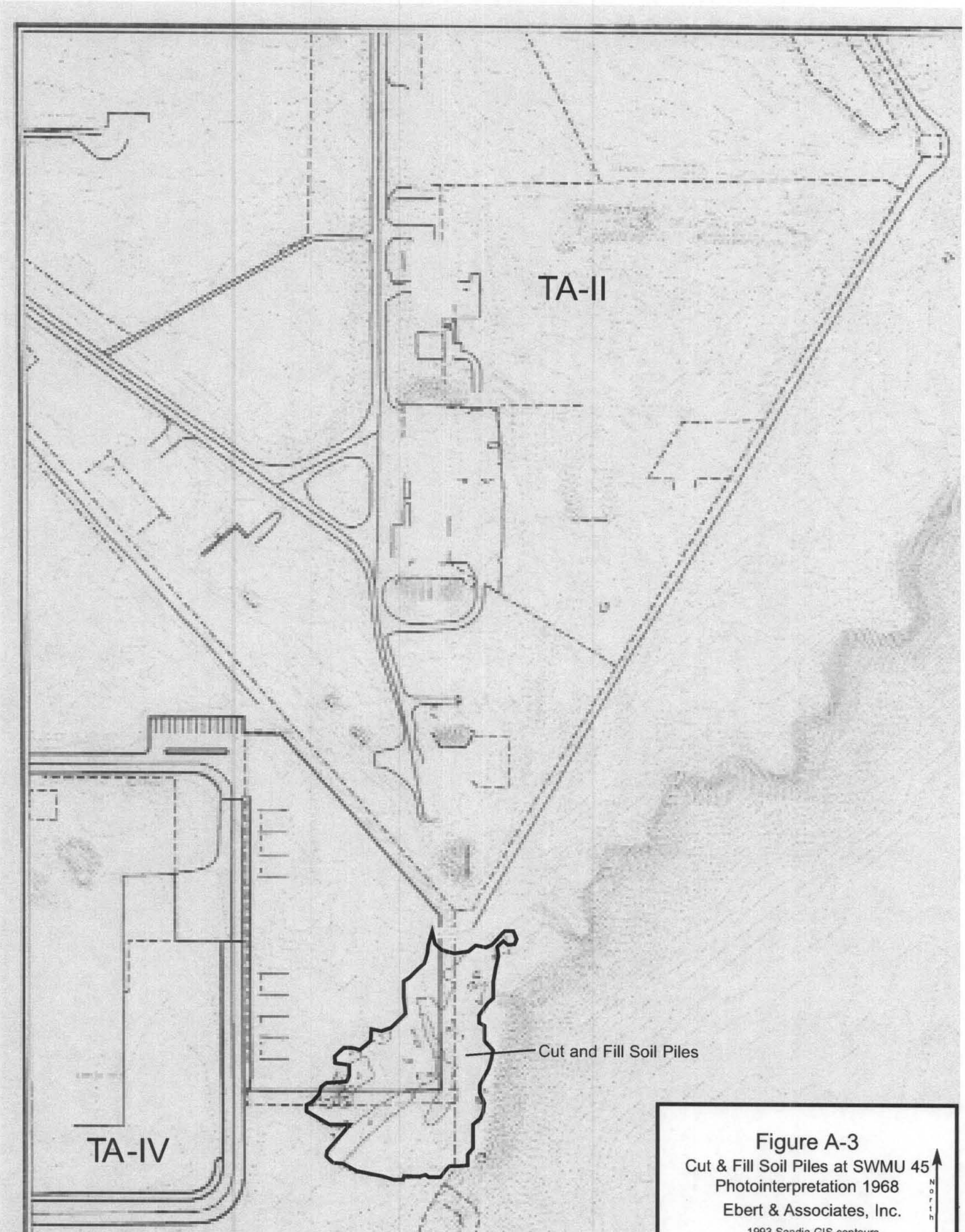


Figure A-3
Cut & Fill Soil Piles at SWMU 45
Photointerpretation 1968
Ebert & Associates, Inc.
1993 Sandia GIS contours
contour interval = 2 feet
Nominal Scale: 1" = 200'

840857.02100000A2

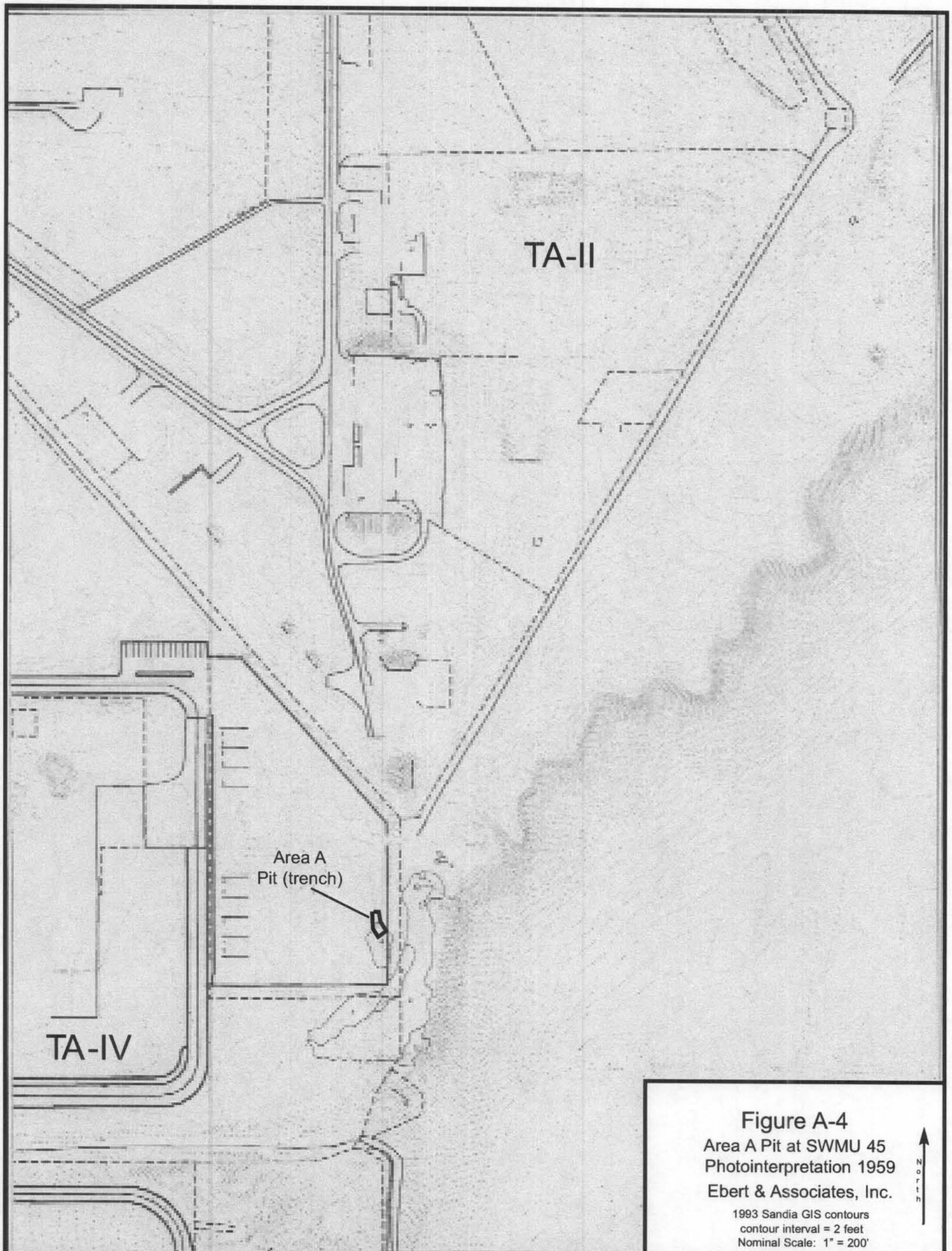
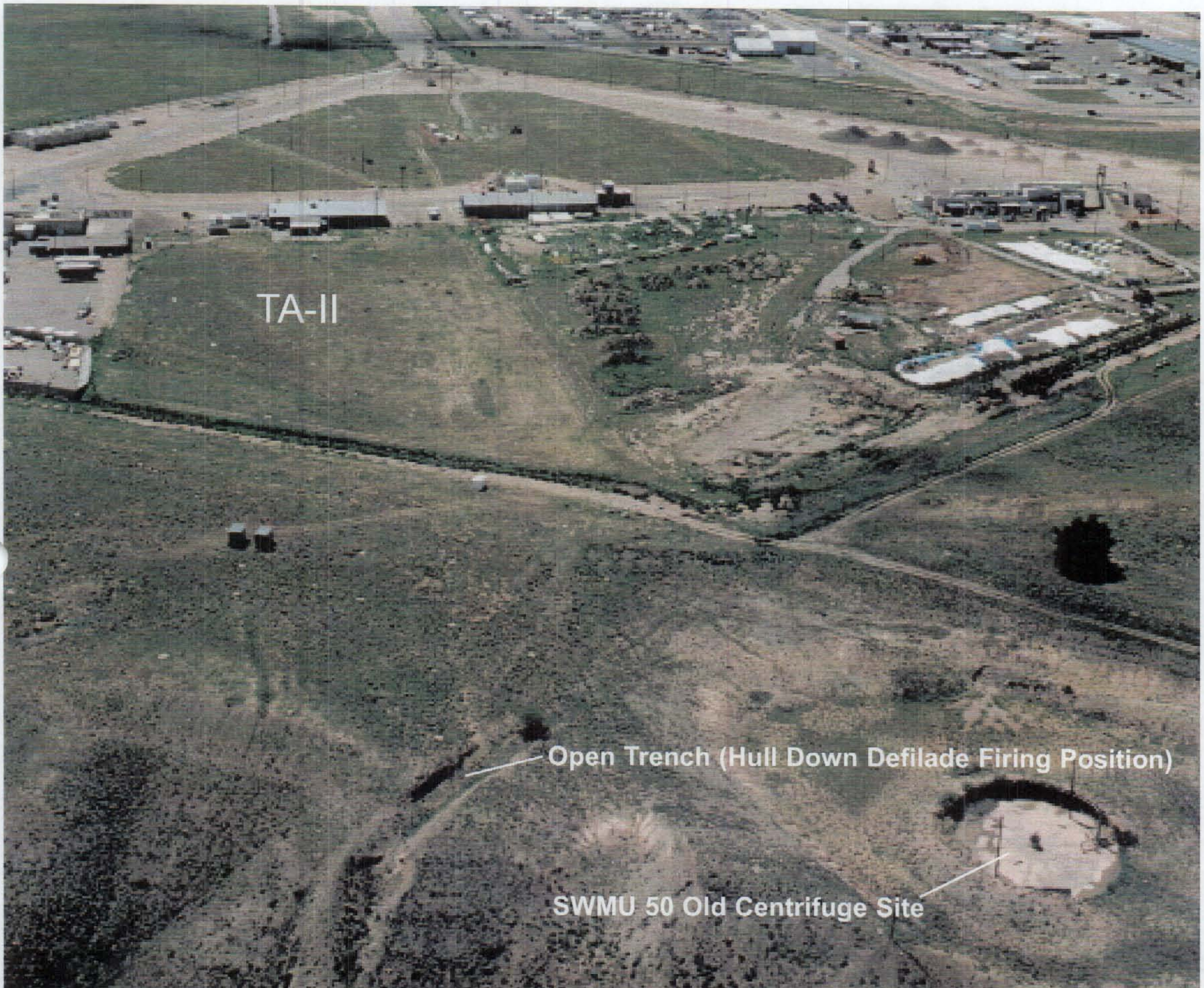


Figure A-4
Area A Pit at SWMU 45
Photointerpretation 1959
Ebert & Associates, Inc.
1993 Sandia GIS contours
contour interval = 2 feet
Nominal Scale: 1" = 200'

840857.02100000A3



840857.02100000 A4

Figure A-5
Low Altitude Oblique Photograph Showing Location of Open Trench East of TA-II used as a Hull Down Defilade Firing Position.

- No activity occurs in 1982, 1983, or 1984.
- East-west fence is installed in 1985 approximately 300 feet south of the southern TA-II apex.
- No activity occurs in 1986, 1987, or 1988.
- TA-IV Building 965 is built in 1989.
- Asphalt parking lot is constructed in 1990. North-south fence is installed on east side of TA-IV.
- Transport containers are present along the eastern TA-IV fence in 1991, 1992, and 1993.

Trench (Known as the 'Area A Pit' in the SWMU 45 NFA Proposal)

- The trench is first evident in 1959 (Figure A-4). Ebert & Associates, Inc. (November 1994) determined the trench was approximately 15 feet wide and 35 feet long. The depth was not estimated. In 2003, a former Ebert & Associates, Inc. employee subsequently analyzed several aerial photograph stereo pairs and estimated that the trench was approximately 5 feet deep (Copland November 2003).
- The trench is not evident in 1964. The trench had apparently been filled in and covered with cut and fill soil piles.
- The immediate vicinity of the trench was not disturbed by installation of a KAFB water line in 1979.
- The SWMU 45 area was graded flat in 1980.
- TA-IV Building 965 was built in 1989.
- An asphalt parking area was constructed and the north-south fence was installed on the east side of TA-IV in 1990.
- Transport containers were staged along the eastern TA-IV fence in 1991, 1992, and 1993.

In the 1959 photograph, a trench of similar dimensions is evident about 300 feet southeast of the eastern apex of TA-II. A 1996 low altitude oblique photograph illustrates the location of this trench (Figure A-5). A review of various aerial photographs contained in the report by Ebert & Associates, Inc. (November 1994) indicated that a total of four trenches existed around the perimeter of TA-II: one at the southern apex (i.e., the Area A Pit), two at the eastern apex, and one at the northern apex. The trenches are believed to have been used for security purposes as "hull down defilade firing positions" for Army tanks with unobstructed views of TA-II and the surrounding area (Copland October 2003).

Magnetic Anomaly Trenches

- The Magnetic Anomaly Trenches are first evident in 1964 (Figure A-6).
- The trenches are less visible in 1965 and 1966.
- The trenches are not evident (probably due to erosion and/or vegetation) in 1968 and later. No roads were located near the trenches.
- Area is graded flat prior to 1980.
- No changes occur through 1993.

The "magnetic" signature for the trench locations was first noted during a magnetometer survey conducted in 1995 (Lamb Associates Inc. July 1995). The Magnetic Anomaly Trenches were excavated in October 1995. A small amount of scrap metal was removed and disposed of off site (SNL/NM September 1997).

Conclusions

Figures A-7 and A-8 show that construction activity significantly changed the SWMU 45 area between 1959 and 1995 (SNL/NM July 2003). The three sub areas are discussed as follows.

Liquid Discharge Area

When the SWMU 45 NFA proposal (SNL/NM September 1997) was submitted to the NMED, the location of the brownish water discharge was not known; it was assumed to have been somewhere within the approximate 1.4-acre area previously disturbed by construction activity. Aerial photographs show that the SWMU 229 outfall ditch was the only ditch accessible to a water truck in the vicinity of the manhole, indicating that the discharge probably occurred there. The ditch was approximately 3 feet deep during the 1980s. In 2001, the SWMU 229 outfall ditch was excavated to 9 feet below ground surface (bgs) and sampled to a depth of 19 feet bgs.

Area A Pit (Trench)

The trench was excavated in the 1950s, probably for security purposes (Army tank-firing position). No waste or debris are evident in the 1959 photograph. The trench was probably backfilled with borrow soil in the 1960s. The trench location is depicted on a 1999 aerial photograph (Figure A-9). A pair of transport containers presently covers the southern end of the trench.

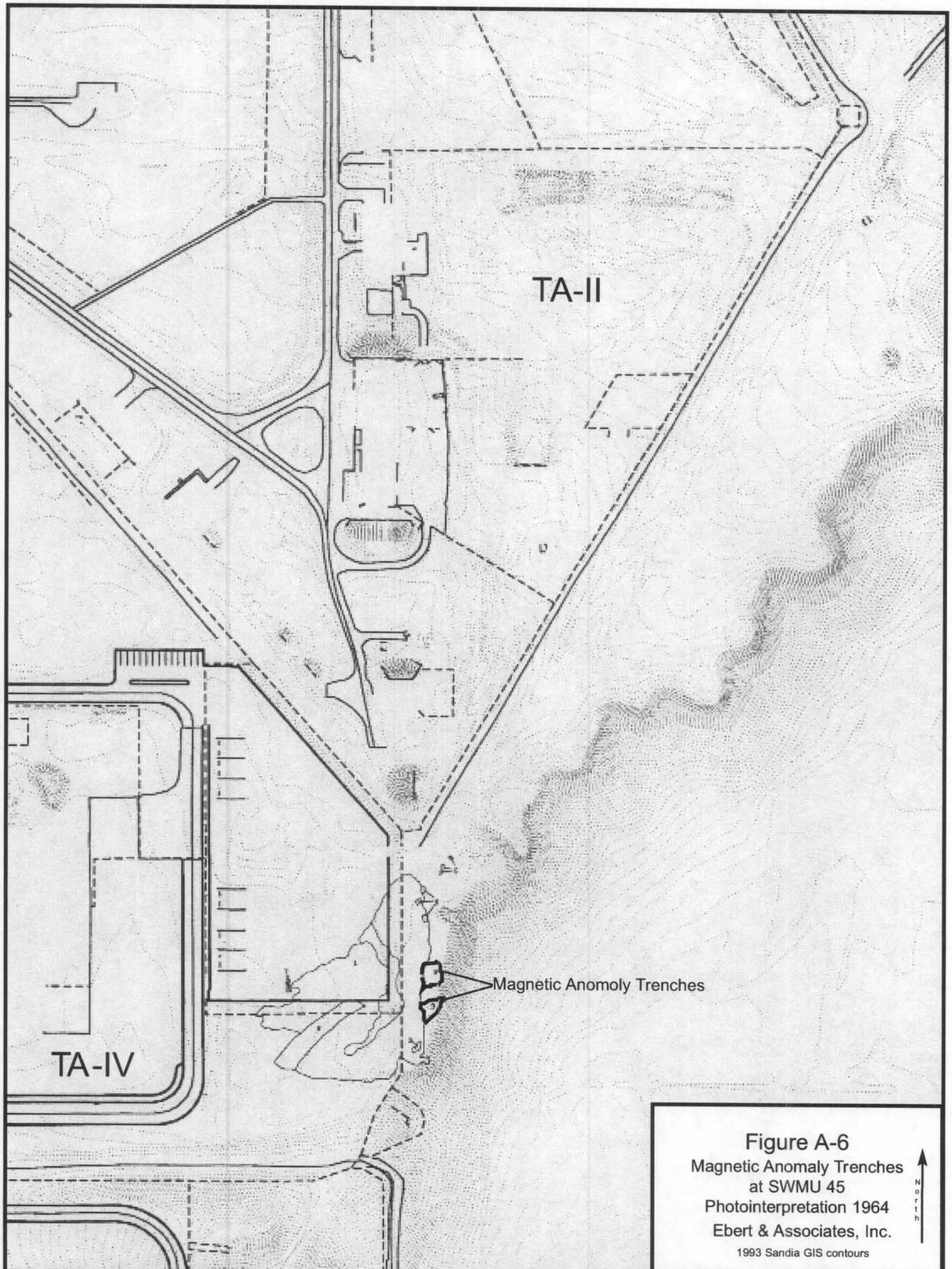


Figure A-6
Magnetic Anomaly Trenches
at SWMU 45
Photointerpretation 1964
Ebert & Associates, Inc.

840857.02100000A5

Mapid = 030002.apr 10/03/02 SNL EGIS ORG. 6135 MDBARTH

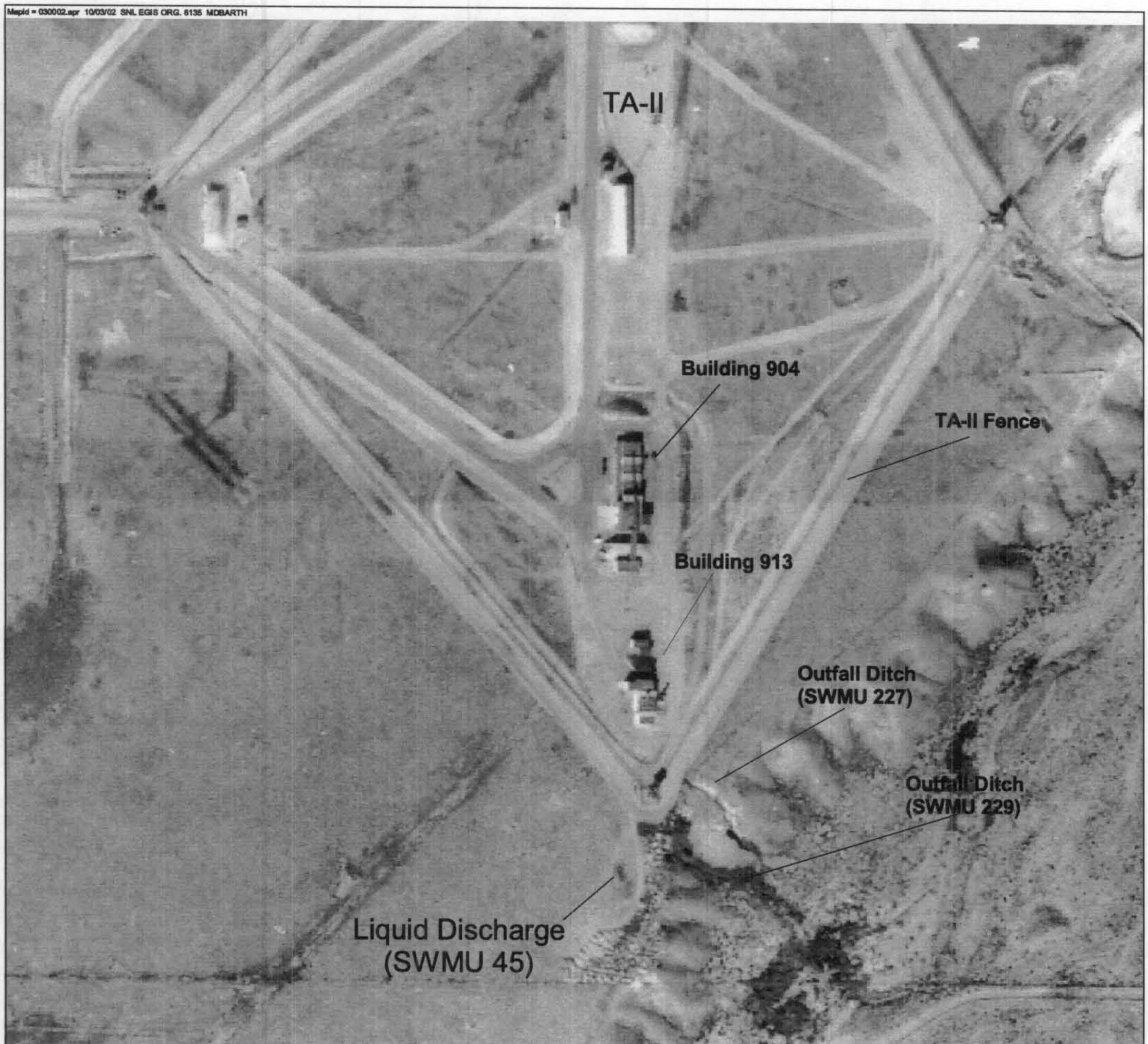


Photo Date: 11-6-59 Project: GS-VZR Frame: 2-33

Figure A-7
Aerial Photograph showing
TA-II and SWMUs 45, 227, & 229
November, 1959

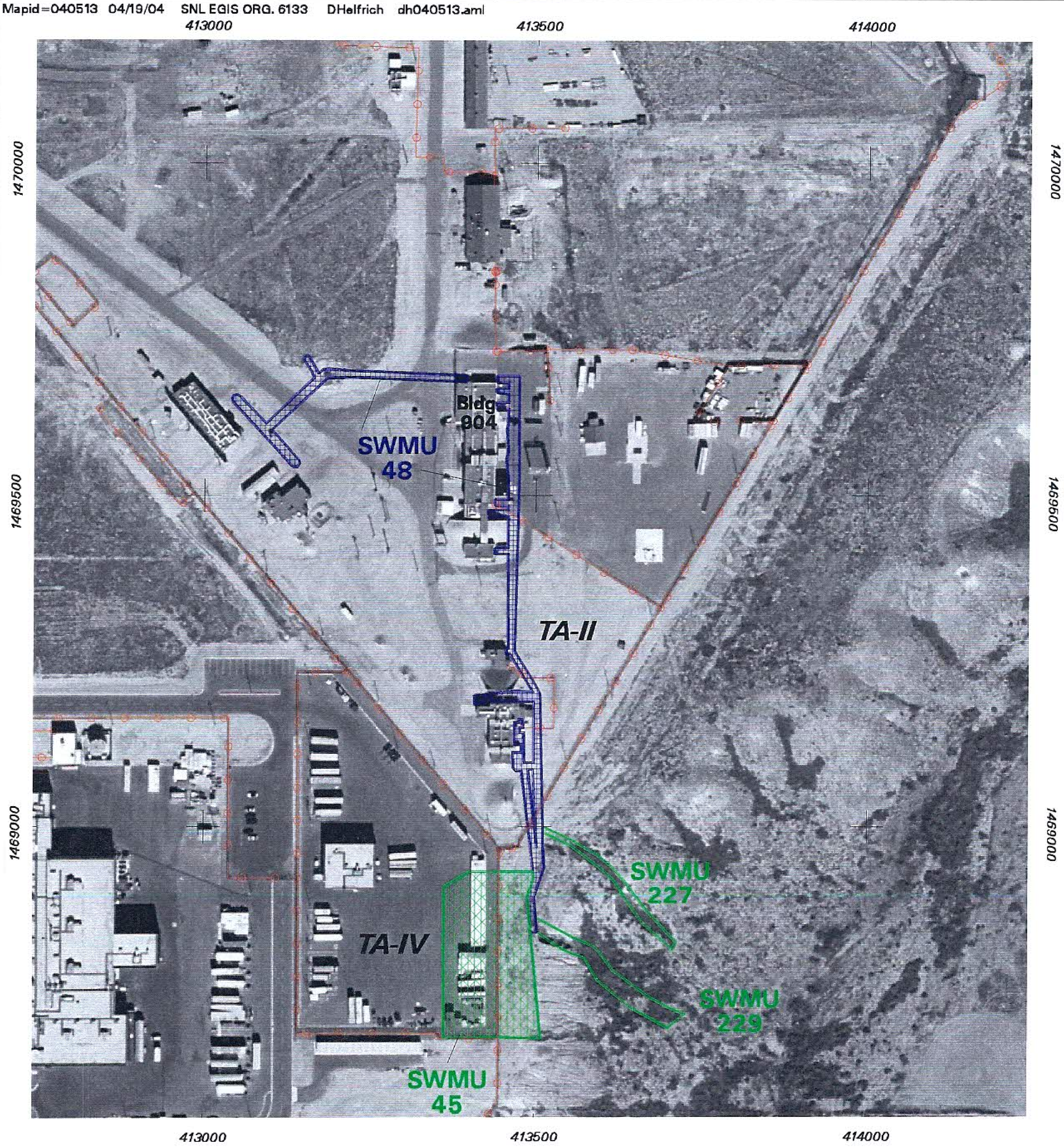
0 125 250

Approximate Scale in Feet

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

840857.02100000A16

Mapid=040513 04/19/04 SNL EGIS ORG. 6133 DHelfrich dh040513.aml



Legend

Fence

SWMUs 227, 229 (Outfall Ditches)

SWMU 48 (HE Drain & Septic System)

SWMU 45 (Liquid Discharge)

Figure A-8
Aerial Photograph showing SWMUs 45, 48, 227, & 229 October, 1995

0 125 250
Scale In Feet

0 30 60
Scale In Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

840857.02100000A14

Mapid=040515 04/19/04 SNL EGIS ORG. 6133 DHelfrich dh040515.aml

Legend

- Fence
- 10-foot Contour
- SWMU 45 (Liquid Discharge)
- Area A Pit

Figure A-9
Aerial Photograph showing SWMU 45 Location of Area A Pit

0 60 120
Scale in Feet

0 14.4 28.8
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

840857.02100000A15

From aerial photographs, the trench depth is estimated to have been approximately 5 feet; no debris is visible in the 1959 photograph. The lateral estimates of the 15-foot-wide by 35-foot-long pit are clearly known (Ebert & Associates November 1994). The trench was filled in sometime before 1964.

<u>Magnetic Anomaly Trenches</u>

The Magnetic Anomaly Trenches were open in 1964. This is probably the time when the scrap metal was dumped there. The trenches were excavated in 1995, and a small amount of construction debris (mostly rebar and wire) was removed.

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Copland, J.R. (Sandia National Laboratories/New Mexico), November 2003. Memorandum to S.S. Collins, "Evaluation of future fieldwork at SWMU 45 with regards to a recent review of confidential interviews and historical aerial photographs," Tijeras Arroyo Operable Unit 1309, Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico, November 11, 2003.

DOE, see U.S. Department of Energy.

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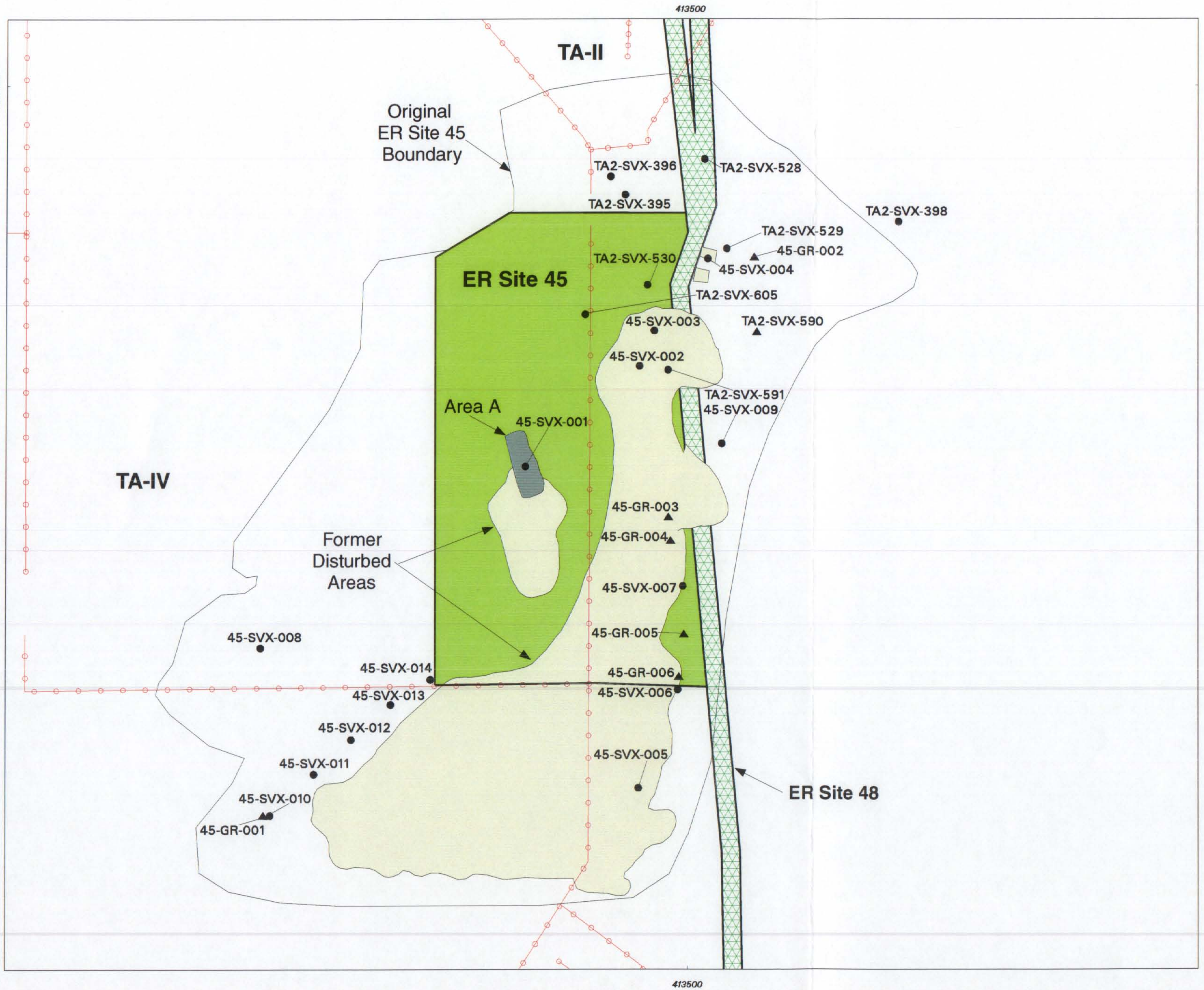
Attachment B

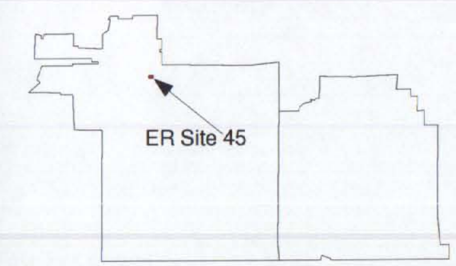
ATTACHMENT B
SWMU 45
Final Versions of Figures 3-2 and 3-3



Legend

- ▲ Scoping-Sampling Location (45-GR-001 Series)
- ● Soil-Vapor (Petrex) Location (45-SVX-001 Series & TA2-SVX-395 Series)
- Fence
- Original ER Site 45 Boundary
- ER Site 45
- ER Site 48
- Former Disturbed Areas (4) (Ebert & Associates, 1994)
- Area A (Ebert & Associates, 1994)

0 60 120
Scale in Feet
0 20 40
Scale in Meters



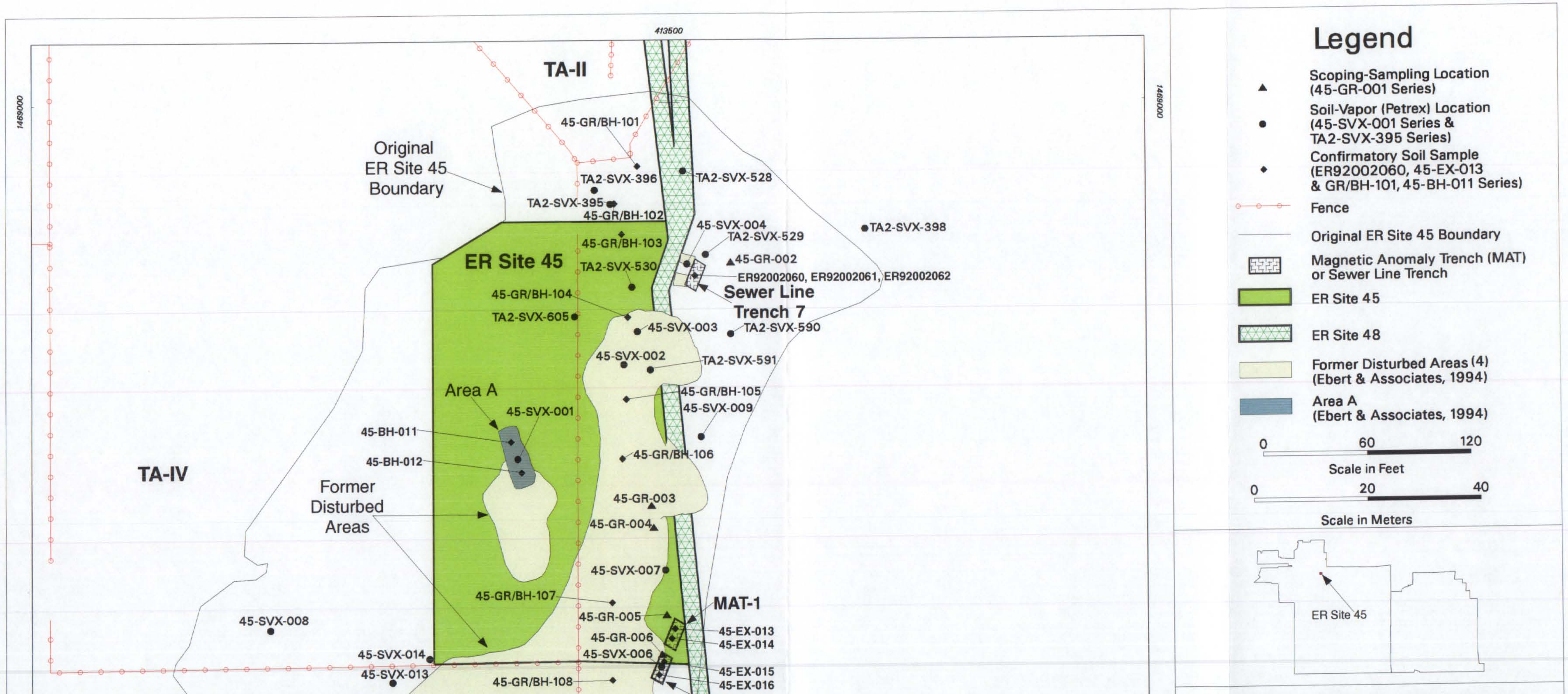
Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Figure 3-2
Scoping-Sampling and Soil-Vapor Sampling Locations at ER Site 45

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone, 1927 North American Horizontal Datum, 1929 North American Vertical Datum

	1:720	MAPID=970629a
Unclassified	DRAFT	SNL GIS ORG. 6682
dahelfr	dh970629a.aml	07/22/97

840857.02100000 B2



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Figure 3-3
All Sampling Locations at ER Site 45

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone, 1927 North American Horizontal Datum, 1929 North American Vertical Datum

	1:720	MAPID=970629b
Unclassified	DRAFT	SNL GIS ORG. 6682
dahelfr	dh970629b.aml	07/22/97

840857.02100000 B1

Attachment C

ATTACHMENT C
Summary of Previously Submitted Off-Site Analytical Results for SWMU 45

Table C-1
Summary of Confirmatory Soil Sampling, VOC Analytical Results
September 1994–February 2001

Sample Attributes			VOCs (EPA Method 8240/SW846 8260[a]) (µg/kg)		
Record Number[b]	ER Sample ID	Sample Depth (ft)	Acetone	2-Butanone	Methylene chloride
0805-2[c]	229-01-B	3	**9 J**	**6 J**	ND (5)
0805-2	229-02-B	3	ND (10)	**6 J**	ND (5)
0805-2	229-02-B	3(D)	ND (10)	**6 J**	ND (5)
2862[d]	45-BH104-1-S-04	1	ND (10)	ND (10)	ND (5)
2862	45-BH109-1-S-04	1	ND (10)	ND (10)	ND (5)
2863[d]	45-BH011-1-S-04	1	ND (10)	ND (10)	ND (5)
2863	45-EX014-3-S-04	3	ND (10)	ND (10)	ND (5)
604300[e]	TJAOU-229-GR-05-14.0-S	14	ND (1)	ND (0.76)	**1.06 JB**
Quality Assurance/Quality Control Samples (µg/L)					
604300	TJAOU-229-GR-EB-001	NA	ND (0.82)	ND	**0.933 JB (5)**
604300	TJAOU-229-GR-TB-001	NA	ND (0.82)	ND	**0.998 JB (5)**

Bold indicates detected analytes.
[a]EPA November 1986.
[b]Analysis request/chain-of-custody record.
[c]Samples associated with Record Number 0805-2 were collected in September 1994.
[d]Samples associated with Record Numbers 2862 and 2863 were collected in October 1995.
[e]Samples associated with Record Number 604300 were collected in March 2001.

B = Analyte present in laboratory method blank.
BH = Borehole.
DU = Duplicate sample.
EB = Equipment blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
EX = Excavation.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J = Estimated concentration.
J ( ) = The reported value is greater than or equal to the MDL but is less than the practical quantitation limit, shown in parentheses.
MDL = Method detection limit.
µg/kg = Microgram(s) per kilogram.
µg/L = Microgram(s) per liter.
NA = Not applicable.
ND = Not detected, MDL not given.
ND ( ) = Not detected above the MDL, shown in parentheses.
S = Surface soil.
TB = Trip blank.
TJAOU = Tijeras Arroyo Operable Unit.
VOC = Volatile organic compound.

Table C-2
Summary of VOC Analytical Detection Limits
1994–1995

Analyte	Method Detection Limit (µg/kg)
Acetone	10
Benzene	5
Bromodichloromethane	5
Bromoform	5
Bromomethane	10
2-Butanone	10
Carbon disulfide	5
Carbon tetrachloride	5
Chlorobenzene	5
Chloroethane	10
2-Chloroethyl vinyl ether	10
Chloroform	5
Chloromethane	10
Dibromochloromethane	5
1,1-Dichloroethane	5
1,2-Dichloroethane	5
1,1-Dichloroethene	5
1,2-Dichloroethene	5
1,2-Dichloropropane	5
cis-1,3-Dichloropropene	5
trans-1,3-Dichloropropene	5
Ethylbenzene	5
2-Hexanone	10
4-Methyl-2-pentanone	10
Methylene chloride	5
Styrene	5
1,1,2,2-Tetrachloroethane	5
Tetrachloroethene	5
Toluene	5
1,1,1-Trichloroethane	5
1,1,2-Trichloroethane	5
Trichloroethene	5
Vinyl acetate	10
Vinyl chloride	10
Xylene	5

µg/kg = Microgram(s) per kilogram.
VOC = Volatile organic compound.

Table C-3
Summary of VOC Analytical Detection Limits
2001

Analyte	Method Detection Limit (µg/kg)
Acetone	1–1.3
Benzene	0.11–0.39
Bromodichloromethane	0.07–0.35
Bromoform	0.36–0.62
Bromomethane	0.31–0.89
2-Butanone	0.76–1.1
Carbon disulfide	0.27–0.62
Carbon tetrachloride	0.14–0.26
Chlorobenzene	0.12–0.4
Chloroethane	0.28–0.56
Chloroform	0.12–0.47
Chloromethane	0.23–0.35
Dibromochloromethane	0.41–0.59
1,2-Dichlorobenzene	0.87
1,3-Dichlorobenzene	0.52
1,4-Dichlorobenzene	0.39
1,1-Dichloroethane	0.21–0.41
1,2-Dichloroethane	0.14–0.27
1,1-Dichloroethene	0.262–0.68
1,2-Dichloroethene	0.61
cis-1,2-Dichloroethene	0.41
trans-1,2-Dichloroethene	0.37
1,2-Dichloropropane	0.1–0.32
cis-1,3-Dichloropropene	0.15–0.28
trans-1,3-Dichloropropene	0.24–0.53
Ethylbenzene	0.35–0.38
2-Hexanone	0.94–1.3
4-Methyl-2-pentanone	0.9–1.34
Methylene chloride	0.44–2.6
Styrene	0.2–0.32
1,1,2,2-Tetrachloroethane	0.3–0.73
Tetrachloroethene	0.2–0.4
Toluene	0.5–0.59
1,1,1-Trichloroethane	0.11–0.29
1,1,2-Trichloroethane	0.36–0.77
Trichloroethene	0.06–0.72
Vinyl acetate	0.77
Vinyl chloride	0.3–0.64
Xylene	0.82–1.05

µg/kg = Microgram(s) per kilogram.
VOC = Volatile organic compound.

Table C-4
Summary of Confirmatory Soil Sampling, SVOC Analytical Results
September 1994–February 2001

Sample Attributes			SVOCs (EPA Method 8270/SW846 8270[a]) (µg/kg)			
Record Number[b]	ER Sample ID	Sample Depth (ft)	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Chrysene
0805-2[c]	229-01-A	0.5	**71 J**	**50 J**	**160 J**	**110 J**
0805-2	229-01-A	0.5(D)	**6 J**	**92 J**	**160 J**	**120 J**
0805-2	229-01-B	3	ND (330)	ND (330)	ND (330)	ND (330)
604300[d]	TJAOU-229-GR-05-14.0-S	14	ND (5.99)	ND (2)	ND (2.33)	ND (6.33)
Quality Assurance/Quality Control Samples (µg/L)						
604300	TJAOU-229-GR-EB-001	NA	ND	ND	ND	ND

Sample Attributes			SVOCs (EPA Method 8270/SW846 8270[a]) (µg/kg)			
Record Number[b]	ER Sample ID	Sample Depth (ft)	Fluoranthene	Phenanthrene	Pyrene	bis(2-Ethylhexyl) phthalate
0805-2[c]	229-01-A	0.5	**230 J**	**170 J**	**190 J**	ND (330)
0805-2	229-01-A	0.5(D)	**200 J**	**180 J**	**280 J**	ND (330)
0805-2	229-01-B	3	**53 J**	**49 J**	**44 J**	**170 J**
604300[d]	TJAOU-229-GR-05-14.0-S	14	ND (3.33)	ND (4)	ND (8.66)	ND (6.99)
Quality Assurance/Quality Control Samples (µg/L)						
604300	TJAOU-229-GR-EB-001	NA	ND (0.12)	ND (0.12)	ND (0.14)	ND (0.04)

Bold indicates detected analytes.
[a]EPA November 1986.
[b]Analysis request/chain-of-custody record.
[c]Samples associated with Record Number 0805-2 were collected in September 1994.
[d]Samples associated with Record Number 604300 were collected in March 2001.

DU = Duplicate sample.
EB = Equipment blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J = Estimated concentration.
J ( ) = The reported value is greater than or equal to the MDL but is less than the practical quantitation limit, shown in parentheses.
MDL = Method detection limit.
µg/kg = Microgram(s) per kilogram.
µg/L = Microgram(s) per liter.
ND = Not detected, MDL not given.
ND ( ) = Not detected above the MDL, shown in parentheses.
S = Surface soil.
SVOC = Semivolatile organic compound.
TJAOU = Tijeras Arroyo Operable Unit.

Table C-5
Summary of SVOC Analytical Detection Limits
1994–1995

Analyte	Method Detection Limit (µg/kg)
Acenaphthene	330
Acenaphthylene	330
Anthracene	330
Benzidine	2660
Benzo(a)anthracene	330
Benzo(a)pyrene	330
Benzo(b)fluoranthene	330
Benzo(g,h,i)perylene	330
Benzo(k)fluoranthene	330
Benzoic acid	1670
Benzyl alcohol	330
4-Bromophenyl phenyl ether	330
Butylbenzyl phthalate	330
4-Chlorobenzenamine	330
bis(2-Chloroethoxy)methane	330
bis(2-Chloroethyl)ether	330
4-Chloro-3-methylphenol	330
2-Chloronaphthalene	330
2-Chlorophenol	330
4-Chlorophenyl phenyl ether	330
Chrysene	330
o-Cresol	330
p-Cresol	330
Di-n-butyl phthalate	330
Di-n-octyl phthalate	330
Dibenz[a,h]anthracene	330
Dibenzofuran	330
1,2-Dichlorobenzene	330
1,3-Dichlorobenzene	330
1,4-Dichlorobenzene	330
3,3'-Dichlorobenzidine	330
2,2'-Dichlorodiisopropyl ether	330
2,4-Dichlorophenol	330
Diethylphthalate	330
2,4-Dimethylphenol	330
Dimethylphthalate	330
Dinitro-o-cresol	1670
2,4-Dinitrophenol	1670
2,4-Dinitrotoluene	330
2,6-Dinitrotoluene	330
1,2-Diphenylhydrazine	330
bis(2-Ethylhexyl) phthalate	330
Fluoranthene	330
Fluorene	330
Hexachlorobenzene	330

Refer to footnotes at end of table.

Table C-5 (Concluded)
Summary of SVOC Analytical Detection Limits
1994–1995

Analyte	Method Detection Limit (µg/kg)
Hexachlorobutadiene	330
Hexachlorocyclopentadiene	330
Hexachloroethane	330
Indeno(1,2,3-cd)pyrene	330
Isophorone	330
2-Methylnaphthalene	330
Naphthalene	330
2-Nitroaniline	1670
3-Nitroaniline	1670
4-Nitroaniline	1670
Nitrobenzene	330
2-Nitrophenol	330
4-Nitrophenol	1670
n-Nitrosodiphenylamine	330
n-Nitrosodipropylamine	330
Pentachlorophenol	1670
Phenanthrene	330
Phenol	330
Pyrene	330
1,2,4-Trichlorobenzene	330
2,4,5-Trichlorophenol	330
2,4,6-Trichlorophenol	330

µg/kg = Microgram(s) per kilogram.
SVOC = Semivolatile organic compound.

Table C-6
Summary of SVOC Analytical Detection Limits
2001

Analyte	Method Detection Limit (µg/kg)
Acenaphthene	4–16
Acenaphthylene	3.66–16
Anthracene	4.66–18
Benzo(a)anthracene	5.99–23
Benzo(a)pyrene	2–19
Benzo(b)fluoranthene	2.33–38
Benzo(g,h,i)perylene	5–100
Benzo(k)fluoranthene	5–19
4-Bromophenyl phenyl ether	4.66–22
Butylbenzyl phthalate	12.7–26
Carbazole	5–20
4-Chlorobenzenamine	31–58.9
bis(2-Chloroethoxy)methane	5.99–21
bis(2-Chloroethyl)ether	6.66–13
bis-Chloroisopropyl ether	15–37.1
4-Chloro-3-methylphenol	27–36.6
2-Chloronaphthalene	16–34
2-Chlorophenol	5–14
4-Chlorophenyl phenyl ether	3.33–18
Chrysene	6.33–14
o-Cresol	19–47.6
p-Cresol	5.66
Di-n-butyl phthalate	20.6–28
Di-n-octyl phthalate	8.99–140
Dibenz[a,h]anthracene	2.66–81
Dibenzofuran	2.66–22
1,2-Dichlorobenzene	4.33–12
1,3-Dichlorobenzene	3.33–12
1,4-Dichlorobenzene	5.99–14
3,3'-Dichlorobenzidine	23–143
2,4-Dichlorophenol	7.99–26
Diethylphthalate	19.6–41
2,4-Dimethylphenol	28–71.9
Dimethylphthalate	11.7–20
Dinitro-o-cresol	16–62
2,4-Dinitrophenol	15–64
2,4-Dinitrotoluene	5–18
2,6-Dinitrotoluene	3–20
Diphenyl amine	15.7
bis(2-Ethylhexyl) phthalate	6.99–34
Fluoranthene	3.33–23
Fluorene	3–19
Hexachlorobenzene	4.66–18
Hexachlorobutadiene	6.66–12
Hexachlorocyclopentadiene	33–71

Refer to footnotes at end of table.

Table C-6 (Concluded)
Summary of SVOC Analytical Detection Limits
2001

Analyte	Method Detection Limit (µg/kg)
Hexachloroethane	4.33–16
Indeno(1,2,3-cd)pyrene	6.66–17
Isophorone	2.33–18
2-Methylnaphthalene	4–15
4-Methylphenol	51
Naphthalene	3.33–15
2-Nitroaniline	38–80.9
3-Nitroaniline	26–86.6
4-Nitroaniline	22–83.9
Nitrobenzene	18–36.6
2-Nitrophenol	19–46.3
4-Nitrophenol	21–42
n-Nitrosodiphenylamine	21
n-Nitrosodipropylamine	20–33
Pentachlorophenol	60.9–120
Phenanthrene	4–16
Phenol	3.66–87
Pyrene	8.66–22
1,2,4-Trichlorobenzene	4.66–17
2,4,5-Trichlorophenol	30–42.3
2,4,6-Trichlorophenol	24.6–31

µg/kg = Microgram(s) per kilogram.
SVOC = Semivolatile organic compound.

Table C-7
Summary of Confirmatory Soil Sampling, Metals Analytical Results
September 1994–February 2001

Sample Attributes			Metals (EPA Method 6010/6020/7196/7471/7741/SW846 3050/SW846 7471[a]) (mg/kg)									
Record Number[b]	ER Sample ID	Sample Depth (ft)	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium (VI)	Cobalt	Copper
0805-2	229-01-A	0.5	5,000	**9.6**	5.1	100	0.35	**1.4**	5.2	ND (0.1)	4.3	10
0805-2	229-01-B	3	3,900	**7.1**	1.6	73	0.3	**1.3**	4	ND (0.1)	3.9	6.4
0805-2	229-02-A	0.5	2,600	**5.7**	1.7	120	ND (0.25)	**1.1**	2.7	ND (0.1)	3.3	7.2
0805-2	229-02-B	3	8,700	**17**	**6.7**	**280**	0.63	**2.4**	8.6	ND (0.1)	6.8	17
2862	45-BH104-1-S-03	1	NR	NR	**6**	116	NR	ND (0.5)	8	NR	NR	NR
2862	45-BH109-1-S-03	1	NR	NR	**9**	130	NR	ND (0.5)	12	NR	NR	NR
2862	45-GR105-0-SS-02	0	NR	NR	**9**	111	NR	ND (0.5)	10	NR	NR	NR
2862	45-GR110-0-SS-02	0	NR	NR	**11**	**219**	NR	ND (0.5)	9	NR	NR	NR
2863	45-BH011-1-S-03	1	NR	NR	**10**	176	NR	ND (0.5)	12	NR	NR	NR
2863	45-EX014-3-S-03	3	NR	NR	**9**	143	NR	ND (0.5)	9	NR	NR	NR
604300	TJAOU-229-GR-05-14.0-S	14	NR	NR	4.06	**239**	NR	ND (0.013)	6.81	NR	NR	NR
Background Concentration[c] (surface/subsurface)			NC	3.9/3.9	5.6/4.4	200/200	0.8/0.8	<1/0.9	17.3/12.8	NC	7.1/8.8	17/17
Quality Assurance/Quality Control Samples (mg/L)												
604300	TJAOU-229-GR-EB-001	NA	NR	NR	ND (0.00457)	0.00044 J (0.005)	NR	ND (0.00025)	ND (0.00078)	NR	NR	NR

Refer to footnotes at end of table.

Table C-7 (Concluded)
Summary of Confirmatory Soil Sampling, Metals Analytical Results
September 1994–February 2001

Sample Attributes			Metals (EPA Method 6010/6020/7196/7471/7741/SW846 3050/SW846 7471[a]) (mg/kg)									
Record Number[b]	ER Sample ID	Sample Depth (ft)	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
0805-2	229-01-A	0.5	9,300	11	210	ND (0.04)	5.9	ND (0.25)	ND (0.5)	ND (0.5)	15	36
0805-2	229-01-B	3	7,900	10	180	ND (0.04)	4.6	ND (0.25)	ND (0.5)	ND (0.5)	13	25
0805-2	229-02-A	0.5	5,300	9.3	190	ND (0.04)	3.9	ND (0.25)	ND (0.5)	ND (0.5)	13	20
0805-2	229-02-B	3	11,000	**32**	320	ND (0.04)	10	ND (0.25)	ND (0.5)	ND (0.5)	19	60
2862	45-BH104-1-S-03	1	NR	9	NR	**2.19**	NR	ND (10)	ND (1)	NR	NR	NR
2862	45-BH109-1-S-03	1	NR	**740**	NR	ND (0.02)	NR	ND (10)	ND (1)	NR	NR	NR
2862	45-GR105-0-SS-02	0	NR	28	NR	**0.7**	NR	ND (10)	ND (1)	NR	NR	NR
2862	45-GR110-0-SS-02	0	NR	8	NR	ND (0.02)	NR	ND (10)	ND (1)	NR	NR	NR
2863	45-BH011-1-S-03	1	NR	6	NR	ND (0.02)	NR	ND (10)	ND (1)	NR	NR	NR
2863	45-EX014-3-S-03	3	NR	**59**	NR	ND (0.02)	NR	ND (10)	ND (1)	NR	NR	NR
604300	TJAOU-229-GR-05-14.0-S	14	NR	3.39	NR	0.00492 J	NR	0.36 J	ND (0.0578)	NR	NR	NR
Background Concentration[c] (surface/subsurface)			NC	39/11.2	NC	<0.25/<0.1	25.4/25.4	<1/<1	<1/<1	<1.1/<1.1	33/33	76/76
Quality Assurance/Quality Control Samples (mg/L)												
604300	TJAOU-229-GR-EB-001	NA	NR	ND (0.00344)	NR	ND (0.00007)	NR	ND (0.00309)	ND (0.0002)	NR	NR	NR

Bold indicates detected analytes that exceed background concentration levels.

[a]EPA November 1986.

[b]Analysis request/chain-of-custody record.

[c]Dinwiddie September 1997, North Area Supergroup.

BH = Borehole.
EB = Equipment blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
EX = Excavation
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J = Estimated concentration.
J ( ) = The reported value is greater than or equal to the MDL but is less than the practical quantitation limit, shown in parentheses.
MDL = Method detection limit.
mg/kg = Milligram(s) per kilogram.
NC = Not calculated.
ND ( ) = Not detected above the MDL, shown in parentheses.
NR = Not reported.
S = Surface soil.
SS = Subsurface soil.
TJAOU = Tijeras Arroyo Operable Unit.

Table C-8
Summary of Metals Analytical Detection Limits
1994–1995

Analyte	Method Detection Limit (mg/kg)
Aluminum	10
Antimony	3
Arsenic	0.5–5
Barium	1–10
Beryllium	0.25
Cadmium	0.25–0.5
Calcium	250
Chromium	1
Chromium (VI)	0.1
Cobalt	2.5
Copper	1.2
Iron	5
Lead	2–5
Magnesium	250
Manganese	0.75
Mercury	0.02–0.04
Nickel	2
Potassium	250
Selenium	0.25–10
Silver	0.5–1
Sodium	250
Thallium	0.5
Vanadium	2.5
Zinc	1

mg/kg = Milligram(s) per kilogram.

Table C-9
Summary of Metals Analytical Detection Limits
2001

Analyte	Method Detection Limit (mg/kg)
Aluminum	2.7
Antimony	3.5
Arsenic	0.137–0.23
Barium	0.0148–0.42
Beryllium	0.012
Cadmium	0.013–0.27
Calcium	21.6
Chromium	0.218–0.31
Cobalt	0.38
Copper	0.26
Iron	1.2
Lead	0.14–0.17
Magnesium	2.9
Manganese	0.063
Mercury	0.00455–0.017
Nickel	1.6
Potassium	123
Selenium	0.135–0.21
Silver	0.0578–0.48
Sodium	6.5
Thallium	0.36
Vanadium	0.26
Zinc	0.2

mg/kg = Milligram(s) per kilogram.

Table C-10
Summary of Gamma Spectroscopy Analytical Results
September 1994–February 2001

Sample Attributes			Activity (pCi/g)							
			Cesium-137		Thorium-232		Uranium-235		Uranium-238	
Record Number[a]	ER Sample ID	Sample Depth (ft)	Result	Error[b]	Result	Error[b]	Result	Error[b]	Result	Error[b]
0805-1	229-01-A	0.5	ND (0.22)	0.12	NR	--	NR	--	0.73	0.16
0805-1	229-01-B	3	NR	--	NR	--	NR	--	0.57	0.1
02864	45-BH-011-1-S-05	1	ND (0.0369)	--	0.789	0.244	**ND (0.236)**	--	ND (1.29)	--
02864	45-EX-014-3-S-05	3	0.0732	0.0195	0.657	0.156	**ND (0.202)**	--	ND (1.15)	--
04444	45-BH-104-1-S-05	1	ND (0.0307)	--	0.678	0.161	**ND (0.210)**	--	ND (1.16)	--
04444	45-BH-109-1-S-05	1	0.146	0.0292	0.595	0.139	**ND (0.191)**	--	ND (1.07)	--
604300	TJAOU-229-GR-05-14.0-S	14	ND (0.0262)	0.015	0.546	0.0773	**ND (0.181)**	0.133	ND (1.27)	1.19
604301	TJAOU-229-GR-05-14.0-S	14	ND (0.0366)	--	0.477	0.26	**ND (0.198)**	--	ND (0.558)	--
604301	TJAOU-229-GR-05-19.0-S	19	ND (0.0347)	--	0.541	0.287	0.108	0.172	ND (0.543)	--
Background Concentration[c] (surface/subsurface)			0.836/0.084	NA	1.54/1.54	NA	0.18/0.18	NA	1.3/1.3	NA
Quality Assurance/Quality Control Samples (pCi/L)										
604300	TJAOU-229-GR-EB-001	NA	2.61 U	3.86	0.683 U	7.01	3.28 U	13.6	64.3 U	155

Bold indicates detected analytes that exceed background concentration levels.
[a]*Analysis request/chain-of-custody record.*
[b]Two standard deviations about the mean detected activity.
[c]Dinwiddie September 1997, North Area Supergroup.

ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
MDL = Method detection limit.
NA = Not applicable.
ND ( ) = Not detected above the MDL, shown in parentheses.
NR = Not reported.
pCi/g = Picocurie(s) per gram.
S = Surface soil.
TJAOU = Tijeras Arroyo Operable Unit.
U = The analyte was analyzed for but was not detected.
-- = Error not calculated for nondetect results.

Attachment D

ATTACHMENT D
Summary of Environmental Investigation
Conducted for the RSI Response for SWMU 45

SWMU 45
SUMMARY OF ENVIRONMENTAL INVESTIGATION CONDUCTED FOR THE RESPONSE TO THE REQUEST FOR SUPPLEMENTAL INFORMATION

A meeting between Sandia National Laboratories/New Mexico and the New Mexico Environment Department (NMED) staff in November 2003 clarified several Request for Supplemental Information issues, including the NMED's fieldwork request. The fieldwork, which was conducted in February 2004, consisted of a Geoprobe™ investigation involving the collection of confirmatory soil samples at the Area A Pit.

Field Activities

Two boreholes, 45-BH-13 and 45-BH-14, were drilled and sampled with a Geoprobe™ to investigate the Area A rectangular pit that was evident in a 1959 aerial photograph. This area is now overlain by an asphalt parking lot, and two transport containers cover most of the southern portion of the pit. The location of the two boreholes and the transport containers, shown on Figure D-1, prevented the Geoprobe™ from positioning over the southern edge of the pit. As a result, Borehole 45-BH-14 was drilled approximately 5 feet west of the southwest corner of the pit.

Each borehole was continuously cored. Borehole 45-BH-13 was cored to a total depth of 12 feet below ground surface (bgs); Borehole 45-BH-14 was cored to a total depth of 10 feet bgs. Native soil was encountered at 7 feet bgs in Borehole 45-BH-13, which indicated the bottom of the pit in that area. Native soil was encountered at 2 feet bgs in Borehole 45-BH-14, which indicated that this borehole probably intercepted the edge of the pit. Soil samples were collected from 2 to 3 and 8 to 10 feet bgs in Borehole 45-BH-13, and from 1 to 2 and 8 to 10 feet bgs in Borehole 45-BH-14. No waste or debris was visible in any of the core samples (SNL/NM Logbook ER-093).

Analytical Results Summary

A total of five soil samples, which included one duplicate sample, were sent to Severn Trent Laboratories. The soil samples were analyzed for volatile organic compounds, semivolatile organic compounds, Target Analyte List metals, and gamma-emitting radionuclides. Soil concentrations for the constituents detected are summarized in Tables D-1, D-3, D-5, and D-7 and complete results and corresponding method detection limits are presented in Tables D-2, D-4, and D-6.

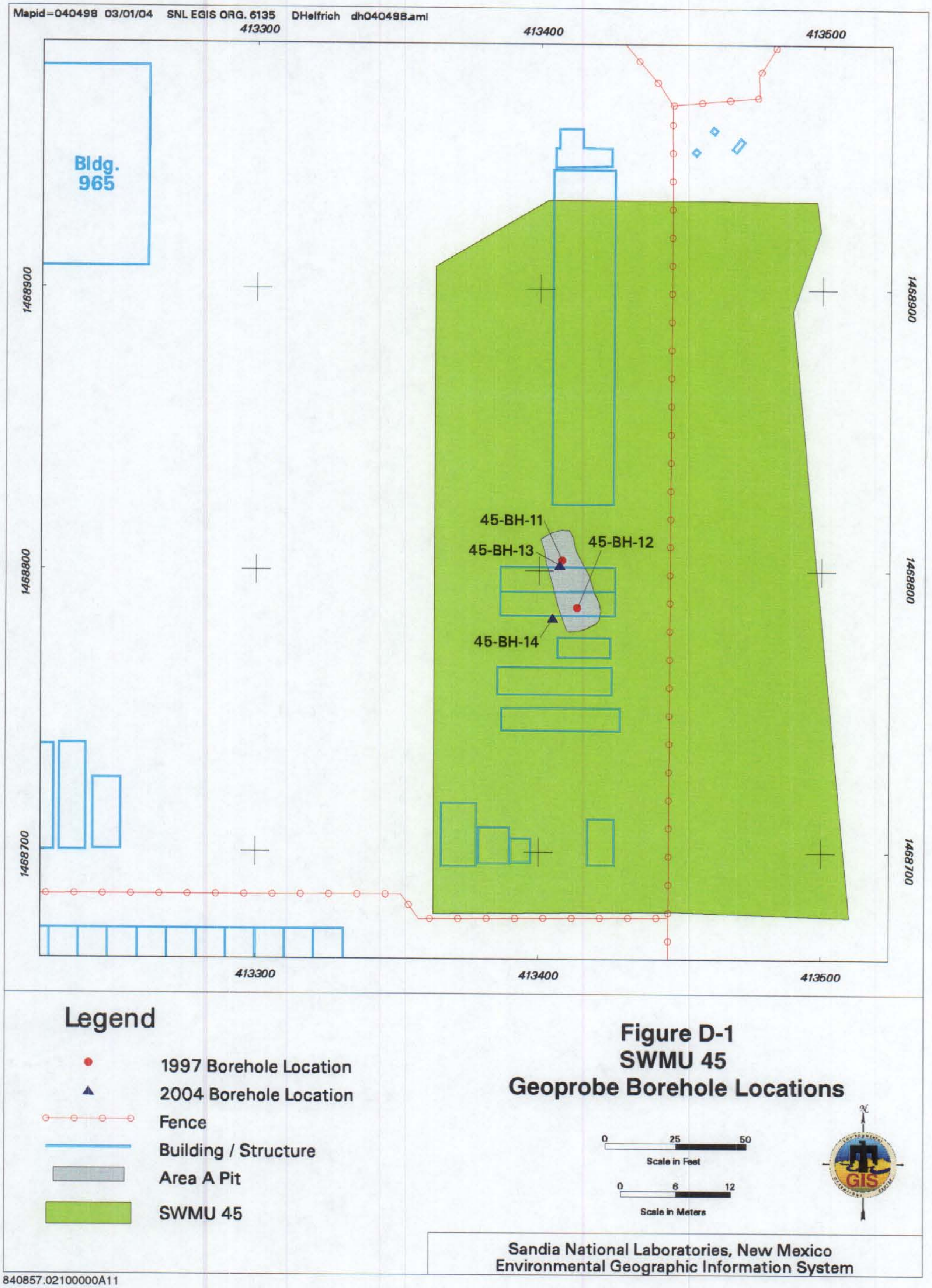


Figure D-1
SWMU 45
Geoprobe Borehole Locations

Table D-1
Summary of Confirmatory Soil Sampling, VOC Analytical Results
February 2004

Sample Attributes			VOCs (EPA Method 8260B[a]) (μg/kg)	
Record Number[b]	ER Sample ID	Sample Depth (ft)	Acetone	Methylene Chloride
607218	45-BH-13-2-3-SS	3	**6.2 JB**	**11 B**
607218	45-BH-13-8-DU	8	**8.6 JB**	**11 B**
607218	45-BH-13-8-SS	8	**7 JB**	**11 B**
607218	45-BH-14-8-SS	8	**4.5 JB**	**13 B**
Quality Assurance/Quality Control Samples (all in μg/L)				
607218	45-BH-EB	NA	**2.9 J (20)**	ND (2.6)
607218	45-BH-TB	NA	**1.7 J (20)**	ND (2.6)

Note: Due to a laboratory oversight, one soil sample collected for VOC analysis (45-BH-14-1-SS) was instead analyzed for SVOCs and RCRA metals.
Bold indicates detected analytes.
[a]EPA November 1986.
[b]Analysis request/chain-of-custody record.
B = Analyte present in laboratory method blank.
BH = Borehole.
DU = Duplicate sample.
ER = Environmental Restoration.
EPA = U.S. Environmental Protection Agency.
ft = Foot (feet).
ID = Identification.
J = Estimated concentration.
MDL = Method detection limit.
μg/kg = Microgram(s) per kilogram.
ND ( ) = Not detected above the MDL, shown in parentheses.
SS = Soil sample.
VOC = Volatile organic compound.

Table D-2
Summary of VOC Analytical Detection Limits
February 2004

Analyte	Method Detection Limit (µg/kg)
Acetone	1–1.3
Benzene	0.11–0.39
Bromodichloromethane	0.07–0.35
Bromoform	0.36–0.62
Bromomethane	0.31–0.89
2-Butanone	0.76–1.1
Carbon disulfide	0.27–0.62
Carbon tetrachloride	0.14–0.26
Chlorobenzene	0.12–0.4
Chloroethane	0.28–0.56
Chloroform	0.12–0.47
Chloromethane	0.23–0.35
Dibromochloromethane	0.41–0.59
1,2-Dichlorobenzene	0.87
1,3-Dichlorobenzene	0.52
1,4-Dichlorobenzene	0.39
1,1-Dichloroethane	0.21–0.41
1,2-Dichloroethane	0.14–0.27
1,1-Dichloroethene	0.262–0.68
1,2-Dichloroethene	0.61
cis-1,2-Dichloroethene	0.41
trans-1,2-Dichloroethene	0.37
1,2-Dichloropropane	0.1–0.32
cis-1,3-Dichloropropene	0.15–0.28
trans-1,3-Dichloropropene	0.24–0.53
Ethylbenzene	0.35–0.38
2-Hexanone	0.94–1.3
4-Methyl-2-pentanone	0.9–1.34
Methylene chloride	0.44–2.6
Styrene	0.2–0.32
1,1,2,2-Tetrachloroethane	0.3–0.73
Tetrachloroethene	0.2–0.4
Toluene	0.5–0.59
1,1,1-Trichloroethane	0.11–0.29
1,1,2-Trichloroethane	0.36–0.77
Trichloroethene	0.06–0.72
Vinyl acetate	0.77
Vinyl chloride	0.3–0.64
Xylene	0.82–1.05

µg/kg = Microgram(s) per kilogram.
VOC = Volatile organic compound.

Table D-3
Summary of Confirmatory Soil Sampling, SVOC Analytical Results
February 2004

Sample Attributes			SVOCs (EPA Method 8270C[a]) (μg/kg)	
Record Number[b]	ER Sample ID	Sample Depth (ft)	Di-n-butyl phthalate	Pyrene
607218	45-BH-13-2-3-SS	3	**69 J**	ND (22)
607218	45-BH-13-8-10-DU	10	ND (28)	ND (22)
607218	45-BH-13-8-10-SS	10	**120 J**	ND (22)
607218	45-BH-14-1-2-SS	2	**180 J**	**74 J**
607218	45-BH-14-8-10-SS	10	**130 J**	ND (22)
Quality Assurance/Quality Control Samples (all in μg/L)				
607218	45-BH-EB	NA	ND (0.47)	ND (0.46)

Bold indicates detected analytes.
[a]EPA November 1986.
[b]Analysis request/chain-of-custody record.
BH = Borehole.
DU = Duplicate sample.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
J = Estimated concentration.
J ( ) = The reported value is greater than or equal to the MDL but is less than the practical quantitation limit, shown in parentheses.
MDL = Method detection limit.
μg/kg = Microgram(s) per kilogram.
μg/L = Microgram(s) per liter.
ND ( ) = Not detected above the MDL, shown in parentheses.
SS = Soil sample.
SVOC = Semivolatile organic compound.

Table D-4
Summary of SVOC Analytical Detection Limits
February 2004

Analyte	Method Detection Limit (µg/kg)
Acenaphthene	4–16
Acenaphthylene	3.66–16
Anthracene	4.66–18
Benzo(a)anthracene	5.99–23
Benzo(a)pyrene	2–19
Benzo(b)fluoranthene	2.33–38
Benzo(g,h,i)perylene	5–100
Benzo(k)fluoranthene	5–19
4-Bromophenyl phenyl ether	4.66–22
Butylbenzyl phthalate	12.7–26
Carbazole	5–20
4-Chlorobenzenamine	31–58.9
bis(2-Chloroethoxy)methane	5.99–21
bis(2-Chloroethyl)ether	6.66–13
bis-Chloroisopropyl ether	15–37.1
4-Chloro-3-methylphenol	27–36.6
2-Chloronaphthalene	16–34
2-Chlorophenol	5–14
4-Chlorophenyl phenyl ether	3.33–18
Chrysene	6.33–14
o-Cresol	19–47.6
p-Cresol	5.66
Di-n-butyl phthalate	20.6–28
Di-n-octyl phthalate	8.99–140
Dibenz[a,h]anthracene	2.66–81
Dibenzofuran	2.66–22
1,2-Dichlorobenzene	4.33–12
1,3-Dichlorobenzene	3.33–12
1,4-Dichlorobenzene	5.99–14
3,3'-Dichlorobenzidine	23–143
2,4-Dichlorophenol	7.99–26
Diethylphthalate	19.6–41
2,4-Dimethylphenol	28–71.9
Dimethylphthalate	11.7–20
Dinitro-o-cresol	16–62
2,4-Dinitrophenol	15–64
2,4-Dinitrotoluene	5–18
2,6-Dinitrotoluene	3–20
Diphenyl amine	15.7
bis(2-Ethylhexyl) phthalate	6.99–34
Fluoranthene	3.33–23
Fluorene	3–19
Hexachlorobenzene	4.66–18
Hexachlorobutadiene	6.66–12
Hexachlorocyclopentadiene	33–71

Refer to footnotes at end of table.

Table D-4 (Concluded)
Summary of SVOC Analytical Detection Limits
February 2004

Analyte	Method Detection Limit (µg/kg)
Hexachloroethane	4.33–16
Indeno(1,2,3-cd)pyrene	6.66–17
Isophorone	2.33–18
2-Methylnaphthalene	4–15
4-Methylphenol	51
Naphthalene	3.33–15
2-Nitroaniline	38–80.9
3-Nitroaniline	26–86.6
4-Nitroaniline	22–83.9
Nitrobenzene	18–36.6
2-Nitrophenol	19–46.3
4-Nitrophenol	21–42
n-Nitrosodiphenylamine	21
n-Nitrosodipropylamine	20–33
Pentachlorophenol	60.9–120
Phenanthrene	4–16
Phenol	3.66–87
Pyrene	8.66–22
1,2,4-Trichlorobenzene	4.66–17
2,4,5-Trichlorophenol	30–42.3
2,4,6-Trichlorophenol	24.6–31

µg/kg = Microgram(s) per kilogram.
SVOC = Semivolatile organic compound.

Table D-5
Summary of Confirmatory Soil Sampling, Metals Analytical Results
February 2004

Sample Attributes			Metals (EPA Method 6010B/7471A[a]) (mg/kg)								
Record Number[b]	ER Sample ID	Sample Depth (ft)	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper
607218	45-BH-13-2-3-SS	3	7,160 B	ND (3.5)	4	**218**	0.48 JB	ND (0.27)	6.6	5.9	7.5
607218	45-BH-13-8-10-DU	10	6,930 B	ND (3.5)	2.5	132	0.43 JB	ND (0.27)	7.3	5.4	7.7
607218	45-BH-13-8-10-SS	10	5,510 B	ND (3.5)	2	76.4	0.39 JB	ND (0.27)	5.5	4.2 J	6.4
607218	45-BH-14-1-2-SS	2	7,270 B	ND (3.5)	3.9	116	0.44 JB	ND (0.27)	7.2	5	8.9
607218	45-BH-14-8-10-SS	10	4,210 B	ND (3.5)	1.4	49.4	0.33 JB	ND (0.27)	4.8	4.1 J	6.2
Background Concentration[c] (surface/subsurface)			NC	3.9/3.9	5.6/44	200/200	0.8/0.8	<1/0.9	17.3/12.8	7.1/8.8	17/17
Quality Assurance/Quality Control Samples (all in mg/L)											
607218	45-BH-EB	NA	NR	NR	ND (0.0015)	ND (0.00093)	0.00032 JB (0.005)	ND (0.002)	ND (0.002)	NR	NR

Sample Attributes			Metals (EPA Method 6010B/7471A[a]) (mg/kg)									
Record Number[b]	ER Sample ID	Sample Depth (ft)	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
607218	45-BH-13-2-3-SS	3	12,700	4.8	174	ND (0.017)	7.5	0.36 J	ND (0.48)	0.75 J	26.3	24 B
607218	45-BH-13-8-10-DU	10	13,200	5.7	233	ND (0.017)	7.6	0.3 J	ND (0.48)	0.87 J	22.5	33.2 B
607218	45-BH-13-8-10-SS	10	9,510	4.5	198	ND (0.017)	6	0.24 J	ND (0.48)	0.62 J	15.9	27.4 B
607218	45-BH-14-1-2-SS	2	11,400	5.2	165	ND (0.017)	7.7	0.28 J	ND (0.48)	0.6 J	24.3	26.2 B
607218	45-BH-14-8-10-SS	10	11,300	4.5	268	ND (0.017)	4.9	0.26 J	ND (0.48)	0.48 J	19.8	22.9 B
Background Concentration[c] (surface/subsurface)			NC	39/11.2	NC	<0.25/<0.1	25.4/25.4	<1/<1	<1/<1	<1.1/<1.1	33/33	76/76
Quality Assurance/Quality Control Samples (all in mg/L)												
607218	45-BH-EB	NA	NR	ND (0.0018)	NR	ND (0.0001)	NR	ND (0.0013)	ND (0.006)	NR	NR	NR

Bold indicates detected analytes that exceed background concentration levels.
[a]EPA November 1986.
[b]Analysis request/chain-of-custody record.
[c]Dinwiddie September 1997, North Area Supergroup.

B = Analyte present in laboratory method blank.
BH = Borehole.
DU = Duplicate sample.
ER = Environmental Restoration.
EPA = U.S. Environmental Protection Agency.
ft = Foot (feet).
ID = Identification.
J = The associated value is an estimated quantity.
MDL = Method detection limit.
mg/kg = Milligram(s) per kilogram.
mg/L = Milligram(s) per liter.
NC = Not calculated.
ND ( ) = Not detected above the MDL, shown in parentheses.
NR = Not reported.
SS = Soil sample.

Table D-6
Summary of Metals Analytical Detection Limits
February 2004

Analyte	Method Detection Limit (mg/kg)
Aluminum	2.7
Antimony	3.5
Arsenic	0.137–0.23
Barium	0.0148–0.42
Beryllium	0.012
Cadmium	0.013–0.27
Calcium	21.6
Chromium	0.218–0.31
Cobalt	0.38
Copper	0.26
Iron	1.2
Lead	0.14–0.17
Magnesium	2.9
Manganese	0.063
Mercury	0.00455–0.017
Nickel	1.6
Potassium	123
Selenium	0.135–0.21
Silver	0.0578–0.48
Sodium	6.5
Thallium	0.36
Vanadium	0.26
Zinc	0.2

mg/kg = Milligram(s) per kilogram.

Table D-7
Summary of Gamma Spectroscopy Analytical Results
February 2004

Sample Attributes			Activity (pCi/g)							
			Cesium-137		Thorium-232		Uranium-235		Uranium-238	
Record Number[a]	ER Sample ID	Sample Depth (ft)	Result	Error[b]	Result	Error[b]	Result	Error[b]	Result	Error[b]
607218	45-BH-13-2-3-SS	3	0.034 U	0.02	0.78	0.15	0.16 U	0.031	0.79	0.72
607218	45-BH-13-8-10-DU	10	0.037 U	0.022	0.71	0.13	0.15 U	0.047	0.68 U	0.55
607218	45-BH-13-8-10-SS	10	0.036 U	0.024	0.82	0.18	0.18 U	0.038	0.95	0.47
607218	45-BH-14-1-2-SS	2	0.036 U	0.021	0.81	0.13	0.17 U	0.044	0.77 U	0.44
607218	45-BH-14-8-10-SS	10	0.033 U	0.019	0.79	0.15	0.14 U	0.028	0.98	0.7
Background Concentration[c] (surface/subsurface)			0.836/0.084	NA	1.54/1.54	NA	0.18/0.18	NA	1.3/1.3	NA

[a]Analysis request/chain-of-custody record.
[b]Two standard deviations about the mean detected activity.
[c]Dinwiddie September 1997, North Area Supergroup.

BH = Borehole.
DU = Duplicate sample.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
NA = Not applicable.
pCi/g = Picocurie(s) per gram.
SS = Subsurface soil.
U = The analyte was analyzed for but not detected.

References

Copland, J.R. (Sandia National Laboratories/New Mexico), February 2004. Observations recorded during Geoprobe™ investigation (Sandia National Laboratories/New Mexico), Tijeras Arroyo Operable Unit 1309, Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico. Logbook ER-093, p. 17, February 25, 2004.

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

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

Attachment E

ATTACHMENT E
Risk Assessment Report for SWMU 45

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SWMU 45: RISK ASSESSMENT REPORT

I. Site Description and History

Solid Waste Management Unit (SWMU) 45 covers 0.78 acres along the northern rim of Tijeras Arroyo near the northeast corner of Technical Area (TA)-IV and the southern apex of TA-II. A single discharge of water led to the identification of SWMU 45 in the Comprehensive Environmental Assessment and Response Program (DOE 1987). In February of 1985, a Sandia National Laboratories/New Mexico (SNL/NM) employee observed that a tank truck was discharging about 500 to 1,000 gallons of brownish water onto the ground surface east of TA-IV (SNL/NM September 1997). The employee asked the truck driver what he was doing; he replied "discharging water." The tank truck did not have SNL/NM or military markings. The location of the discharge appeared wet from February 12 through February 15, 1985.

In the mid-1990s, portions of the confidential interviews associated with the identification of SWMU 45 apparently had been filed improperly at the Environmental Safety and Health and Security Records Center and unfortunately were not available when the SWMU 45 proposal for no further action (NFA) (SNL/NM September 1997) was submitted to the New Mexico Environment Department (NMED). The portions of the interviews related to SWMU 45 were discovered in the fall of 2003. By integrating the new interview information with historical aerial photographs and findings from the Environmental Restoration (ER) Project SWMUs 227 and 229 Notice of Deficiency response (SNL/NM July 2003), the previously undisclosed water-discharge location can now be identified and reported for the first time.

By correlating the comments from SNL/NM employees with an ER staff member's field sketch, a strong inference was made that the "brownish water discharge" occurred at a ditch located within 50 feet of the manhole. The only ditch located within a 50-foot radius of the manhole is the ER SWMU 229 outfall ditch.

A trench, known as the Area A Pit, was identified using historical aerial photographs. A review of various aerial photographs contained in the report by Ebert & Associates, Inc. (November 1994) indicated that a total of four trenches existed around the perimeter of TA-II: one at the southern apex (i.e., the Area A Pit), two at the eastern apex, and one at the northern apex. The trenches are believed to have been used for security purposes as "hull down defilade firing positions" for Army tanks with unobstructed views of TA-II and the surrounding area (Copland October 2003).

SWMU 45 is located on land that the U.S. Department of Energy (DOE) leases from Kirtland Air Force Base (KAFB). The topography is nearly flat, with an elevation of approximately 5,400 feet above mean sea level. The site is not fenced. SWMU 45 is located in a relatively remote setting where the only foot traffic consists of the occasional jogger and walker.

The annual precipitation at KAFB is 8.1 inches (NOAA 1990). No springs or perennial surface-water bodies are located within 2 miles of SWMU 45. The site is situated approximately 1,600 feet northwest of the active channel of Tijeras Arroyo and outside of the 100-year floodplain. Tijeras Arroyo is the most significant storm-water drainage feature on KAFB and originates in Tijeras Canyon, which is bounded by the Sandia Mountains to the north and the Manzano Mountains to the south. The arroyo contains a drainage basin that captures runoff from Tijeras Canyon and various storm-water channels at KAFB, SNL/NM, and southeast

Albuquerque. The arroyo eventually drains into the Rio Grande, approximately 8 miles west of SWMU 45.

The soil at SWMU 45 is poorly developed with high alkalinity. The subsurface geology consists of unconsolidated alluvial and colluvial deposits derived from the Sandia and Manzanita Mountains. These upper Santa Fe Group deposits consist of sediment ranging from clay to gravel derived from the granitic rocks of the Sandia Mountains and greenstone, limestone, and quartzite derived from the Manzanita Mountains. The depth to Pennsylvanian strata and/or Precambrian basement beneath TA-IV is approximately 3,000 feet below ground surface (bgs).

Groundwater data for SWMU 45 was obtained from the Tijeras Arroyo Groundwater (TAG) Investigation. The hydrogeologic setting of the TAG study area is dominated by two water-bearing zones, the perched system and the regional aquifer, both of which are present within the upper Santa Fe Group. The perched system is not used as a water supply source. However, the City of Albuquerque, KAFB, and the Veterans Administration use the regional aquifer for a water supply.

At SWMU 45, the depth to the perched system is approximately 300 feet bgs. However, the site extends across the southwestern boundary of the perched system, which covers approximately 3.5 square miles in the central part of the TAG study area. The direction of groundwater flow in the perched system is to the southeast. Discontinuous, yet overlapping multiple lenses of unsaturated alluvial fan sediment serve as a perching horizon beneath the perched system and above the regional aquifer. The depth to the regional aquifer is approximately 500 feet bgs. The direction of groundwater flow in the regional aquifer is principally to the northwest towards several water supply wells. The nearest water supply well (KAFB-1) is located approximately 1.5 miles northwest of the site. Groundwater from the perched system merges with the regional aquifer southeast of Tijeras Arroyo. The regional aquifer extends across the entire TAG study area and the Albuquerque Basin.

The area surrounding SWMU 45 originally consisted of desert grassland habitat, but this has been highly disturbed by various construction activities (IT February 1995). The site is mostly barren but has some limited vegetation consisting of ruderal species, such as Russian thistle (tumbleweed). Grasslands are the dominant plant community west of SWMU 45 and include species such as blue and black grama and western cheatgrass (IT February 1995). The indigenous wildlife includes reptiles, birds, and small mammals. However, wildlife use is limited by the degree of disturbance and proximity to operational facilities. The site was surveyed for sensitive species in 1994 (IT February 1995); no threatened or endangered species, nor any other species of concern, were identified in the vicinity of SWMU 45. No riparian or wetland habitats are present within 4 miles of the site. No significant archaeological artifacts or cultural resources have been identified in the vicinity of SWMU 45 (Hoagland September 1994).

II. Data Quality Objectives

The data quality objectives (DQOs) for SWMU 45 were presented in four documents: 1) the "Sampling and Analysis Plan [SAP] for Eleven Sites in Tijeras Arroyo Operable Unit" (SNL/NM June 1995), 2) the SAP for Site 45 (SNL/NM October 1995), 3) the SAP for SWMUs 227 and 229 (SNL/NM February 2001), and 4) the SWMU 45 Field Implementation Plan (FIP) (SNL/NM February 2004). These plans identified the site-specific confirmatory locations, sample depths, sampling procedures, and analytical requirements. The DQOs also outlined the quality assurance (QA)/quality control (QC) requirements necessary for producing defensible analytical data suitable for risk assessment purposes. In accordance with each plan, confirmatory soil samples were collected at each of the following areas within SWMU 45:

- Liquid Discharge Area
- West End of SWMU 229 Outfall Ditch
- Exploratory Excavation at Waste-Water Discharge Point
- Area A Trench
- Magnetic Anomaly Trenches

The first three areas were sampled to evaluate the distribution of soil contamination resulting from the 1985 "brownish water discharge" that was the basis for identifying the area as SWMU 45. The Area A Trench and Magnetic Anomaly Trenches were identified as separate features also requiring investigation.

As shown in Table 1, four confirmatory sampling events provide the analytical data relevant to SWMU 45. Sample locations, depth ranges, and collection techniques are also listed in Table 1. The first event was conducted as part of the 1995 SWMU 45 confirmatory sampling. The second event was the SWMU 229 confirmatory sampling, which was conducted in 1994. The third event was the 2001 SWMU 229 exploratory excavation and confirmatory sampling. The five SWMU 229 sample locations listed in Table 1 are relevant to SWMU 45 because these sample locations are situated on the eastern end of SWMU 45 near where the liquid discharge occurred. The western boundary of SWMU 229 overlaps the eastern boundary of SWMU 45. The SWMU 229 sample locations therefore serve to characterize the liquid discharge at SWMU 45. The fourth event was the 2004 SWMU 45 Geoprobe™ investigation.

Table 2 presents the analytes and corresponding analytical laboratory that performed the analyses for each sampling event.

Highlights of the SWMU 45 analytical results for the three sampling events include:

- Six metals (antimony, arsenic, barium, lead, cadmium, and mercury) were detected at levels above background concentrations. A seventh metal (selenium) was not detected; however, it was reported as a concentration that is one-half the detection limit, which is above the background concentration for selenium.

- No radionuclides were detected at levels above background activities but some minimum detectable activity (MDA) values exceeded background levels.

- Low concentrations of three volatile organic compounds (VOCs) (acetone, 2-butanone, and methylene chloride) were detected.

- Low concentrations of nine semivolatile organic compounds (SVOCs) were detected.

Table 1
Soil Sampling Locations for SWMU 45 Risk Assessment

Sampling Event	Date Performed	Soil Sample Locations	Sample Depth Range (ft bgs)	Collection Technique
SWMU 45 Confirmatory Sampling	1995	Area A Pit (buried trench):		
		45-BH-11	0.0–1.0	Split-spoon sampler
		Liquid Discharge Area:		
		45-GR-105	0.0–0.5	Hand trowel
		45-GR-110	0.0–0.5	
		45-BH-104	0.0–1.0	
		45-BH-109	0.0–1.0	
		Magnetic Anomaly Trenches:		
		45-EX-014	3.0	Backhoe bucket
SWMU 229 Confirmatory Sampling	1994	West End of Outfall Ditch:		
		229-01-A	0.0–0.5	Hand trowel
		229-01-B	0.5–3.0	
		229-02-A	0.0–0.5	
		229-02-B	0.5–3.0	
SWMU 229 Exploratory Excavation	2001	Exploratory Excavation at Waste-Water Discharge Point:		
		TJAOU-229-GR-05	14.0–20.0	Backhoe bucket
SWMU 45 Geoprobe™ Characterization	2004	Area A Pit (buried trench):		
		45-BH-13	2.0–10.0	Split-spoon sampler
		45-BH-14	1.0–10.0	

bgs = Below ground surface.
BH = Borehole.
EX = Excavation.
ft = Foot (feet).
GR = Grab sample.
SWMU = Solid Waste Management Unit.
TJAOU = Tijeras Arroyo Operable Unit.

Table 2
Analytes and Analytical Laboratories

Sampling Event	Sample Locations	Analytes	Laboratory
SWMU 45 Geoprobe™ Characterization	Area A Pit (buried trench): 45-BH-13 45-BH-14	VOCs, SVOCs, TAL Metals Gamma Spectroscopy	Severn Trent Laboratories
SWMU 45 Confirmatory Sampling	Area A Pit (buried trench): 45-BH-11	VOCs, RCRA Metals Gamma Spectroscopy	Core Laboratories RPSD Laboratory
	Liquid-Discharge Area: 45-GR-105 45-GR-110 45-BH-104 45-BH-109		
	Magnetic Anomaly Trenches: 45-EX-014		
SWMU 229 Confirmatory Sampling	West End of Outfall Ditch: 229-01-A 229-01-B 229-02-A 229-02-B	VOCs, SVOCs, RCRA Metals Gamma Spectroscopy	Environmental Control Technology RPSD Laboratory
SWMU 229 Exploratory Excavation	Exploratory Excavation at Waste-Water Discharge Point: TJAOU-229-GR-05	VOCs, SVOCs, RCRA Metals Gamma Spectroscopy	General Engineering Laboratories, Inc. RPSD Laboratory

BH = Borehole.
EX = Excavation.
GR = Grab sample.
RCRA = Resource Conservation and Recovery Act.
RPSD = Radiation Protection Sample Diagnostics.
SVOC = Semivolatile organic compound.
SWMU = Solid Waste Management Unit.
TAL = Target Analyte List.
TJAOU = Tijeras Arroyo Operable Unit.
VOC = Volatile organic compound.

A total of 63 analyses are applicable to SWMU 45 (Table 3). As shown in Table 3, the QA/QC analyses consisted of 6 duplicates, 7 equipment blanks, and 2 VOC trip blanks. For each of the three sampling events, the duplicate soil samples were collected at ratios complying with the ER Project Quality Assurance Project Plan. The aqueous VOC trip blanks were supplied by the off-site analytical laboratory. The equipment (aqueous rinsate) blanks were prepared in the field as part of the sampling effort. No significant QA/QC problems were identified in the analyses for the duplicate, equipment blank, or VOC trip blank samples.

Table 4 summarizes the analytical methods and the data quality requirements from the SWMU 45 FIP (SNL/NM February 2004). The confirmatory analytical data were reviewed and verified/validated according to "Data Validation Procedure for Chemical and Radiochemical Data," in SNL/NM ER Project Administrative Operating Procedure (AOP) 00-03 (SNL/NM December 1999). In addition, the Radiation Protection Sample Diagnostics (RPSD) Laboratory

Table 3
Number of Off-Site Analyses for
Soil Samples Collected at SWMU 45
1995, 2001, and 2004

Sample Type	Metals[a]	VOCs	SVOCs	Radionuclides[b]	Number of Analyses
Soil	15	10	10	13	48
Duplicate	1	2	2	1	6
Equipment Blank	2	2	2	1	7
VOC Trip Blank	–	2	–	–	2
Total Samples	18	16	14	15	63

[a]Includes analyses for TAL or RCRA metals and chromium and chromium-VI.
[b]Includes gamma-emitting radionuclides.
RCRA = Resource Conservation and Recovery Act.
SVOC = Semivolatile organic compound.
SWMU = Solid Waste Management Unit.
TAL = Target Analyte List.
VOC = Volatile organic compound.
– = Not analyzed.

Table 4
Summary of Data Quality Requirements and Total Number of Analyses
(Off-Site and On-Site) for Confirmatory Soil Samples Relevant to SWMU 45

Analytical Method[a]	Data Quality Level	Analyses from Off-Site Laboratory[b]	Analyses from On-Site Laboratory[c]
Metals (RCRA/TAL) EPA Method 6010/7000	Defensible	16	–
VOCs EPA Method 8260	Defensible	12	–
SVOCs EPA Method 8270	Defensible	12	–
Gamma Spectroscopy HASL 300 or EPA Method 901.1	Defensible	5	9
Total number of analyses[d]		45	9

[a]EPA November 1986.
[b]GEL provided the off-site analyses.
[c]RPSD Laboratory provided the on-site analyses.
[d]Includes duplicate samples, but not other QA/QC samples such as equipment blanks or VOC trip blanks.
EPA = U.S. Environmental Protection Agency.
GEL = General Engineering Laboratories, Inc.
HASL = Health and Safety Lab Method.
QA = Quality assurance.
QC = Quality control.
RCRA = Resource Conservation and Recovery Act.
RPSD = Radiation Protection Sample Diagnostics.
SVOC = Semivolatile organic compound.
SWMU = Solid Waste Management Unit.
TAL = Target Analyte List.
VOC = Volatile organic compound.
– = Not analyzed.

reviewed all gamma spectroscopy results according to "Laboratory Data Review Guidelines," Procedure No. RPSD-02-11, Issue No. 2 (SNL/NM July 1996). Data packages from each of the analytical laboratories were determined to be defensible and acceptable for use in this risk assessment. 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 45 is based upon an initial conceptual model validated with confirmatory sampling at the site. The initial conceptual model was developed from archival site research, site inspections, and soil sampling. The quality of the data specifically used to determine the nature, migration rate, and extent of contamination is described in the following sections.

III.2 Nature of Contamination

Both the nature of contamination and the potential for the degradation of constituents of concern (COCs) at SWMU 45 are evaluated using laboratory analyses of the soil samples. The analytical requirements included analyses for VOCs, SVOCs, Resource Conservation and Recovery Act and Target Analyte List metals, as well as radionuclides by gamma spectroscopy. The analytes and methods listed in Tables 3 and 4 are appropriate to characterize the COCs and potential degradation products at SWMU 45.

III.3 Rate of Contaminant Migration

SWMU 45 is an inactive site; therefore, all primary sources of COCs have been eliminated. As a result, only secondary sources of COCs potentially remain in the soil in the form of adsorbed COCs. The rate of COC migration from soil is therefore predominantly dependent upon precipitation and occasional surface-water flow. Data available from the TAG Investigation (SNL/NM November 2002); numerous SNL/NM monitoring programs for air, water, and radionuclides; and meteorological monitoring are adequate for characterizing the rate of COC migration at SWMU 45.

III.4 Extent of Contamination

Soil samples were collected from the surface and subsurface at SWMU 45 in order to determine the vertical and horizontal extent of contamination. Soil samples were collected from the surface to a maximum depth of 20 feet bgs during the drilling and excavation activities. Extensive surface soil sampling was conducted within the boundaries of the surface. These soil samples are considered to be representative of the soil and sufficient to determine the vertical extent, if any, of COCs.

In summary, the design of the confirmatory soil sampling plan was appropriate and adequate to determine the nature, migration rate, and extent of residual COCs in the surface and subsurface soil at SWMU 45.

IV. Comparison of COCs to Background Screening Levels

Site history and characterization activities are used to identify potential COCs. The response to the NMED Request for Supplemental Information describes the identification of COCs and the sampling that was conducted in order to determine the concentration levels of those COCs across SWMU 45. Generally, COCs evaluated in this risk assessment include all detected organic, inorganic, and radiological COCs for which samples were analyzed. When the detection limit of an organic compound is too high (i.e., could possibly cause an adverse effect to human health or the environment), the compound is retained. Nondetected organic compounds 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 uses only the maximum concentration value of each COC found for the entire site. The SNL/NM maximum background concentration (Dinwiddie September 1997) was selected to provide the background screen listed in Tables 5 through 8.

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

Tables 5 and 6 list the nonradiological COCs for the human health and ecological risk assessments at SWMU 45, respectively. Tables 7 and 8 list the radiological COCs for the human health and ecological risk assessments, respectively. All tables show the associated SNL/NM maximum background concentration values (Dinwiddie September 1997). Section VI.4 discusses the results presented in Tables 5 and 7; Sections VII.2 and VII.3 discuss the results presented in Tables 6 and 8.

V. Fate and Transport

The primary releases of COCs at SWMU 45 were to the surface soil resulting from the discharge of effluents from an unidentified tanker truck. Wind, water, and biota are natural mechanisms of COC transport from the primary release point; however, none of these are considered to be of potential significance as transport mechanisms at this site. Because this was a single event, additional water infiltration is not expected. Infiltration of precipitation is essentially nonexistent at SWMU 45, as virtually all of the moisture either drains away from the site or evaporates. Because groundwater at this site is approximately 500 feet bgs, the potential for COCs to reach groundwater through the unsaturated zone above the water table is extremely low.

Table 5
Nonradiological COCs for Human Health Risk Assessment at SWMU 45 with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log K_{ow}

COC	Maximum Concentration (All Samples) (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)
Inorganic						
Aluminum	8,700	69,957[c]	Yes	1,305[d]	–	**Yes**
Antimony	17	3.9	**No**	16,000[e]	–	**Yes**
Arsenic	11	4.4	**No**	44[f]	–	**Yes**
Barium	280	200	**No**	170[g]	–	**Yes**
Beryllium	0.63	0.80	Yes	19[f]	–	No
Cadmium	2.4	0.9	**No**	64[f]	–	**Yes**
Chromium, total	12	17.3	Yes	16[f]	–	No
Chromium (VI)	0.05[h]	NC	**Unknown**	16[f]	–	No
Cobalt	6.8	7.1	Yes	10,000[i]	–	**Yes**
Copper	17	17	Yes	6[f]	–	No
Lead	740	11.2	**No**	49[f]	–	**Yes**
Manganese	320	831[c]	Yes	100,000[i]	–	**Yes**
Mercury	2.19	<0.1	**No**	5,500[f]	–	**Yes**
Nickel	10	25.4	Yes	47[f]	–	**Yes**
Selenium	5[h]	<1	**No**	800[e]	–	**Yes**
Silver	0.5[h]	<1	Yes	0.5[f]	–	No
Thallium	0.87 J	<1.1	Yes	119[f]	–	**Yes**
Vanadium	26.3	33	Yes	3,000[g]	–	**Yes**
Zinc	60	76	Yes	47[f]	–	**Yes**
Organic						
Acetone	0.009 J	NA	**NA**	0.69[j]	-0.24[j]	No
2-Butanone	0.006 J	NA	**NA**	1[j]	0.29[j]	No
Benzo(a)anthracene	0.071 J	NA	**NA**	10,000[k]	5.61[k]	**Yes**
Benzo(a)pyrene	0.092 J	NA	**NA**	3,000[g]	6.04[g]	**Yes**
Benzo(b)fluoranthene	0.16 J	NA	**NA**	–	6.124[k]	**Yes**

Refer to footnotes at end of table.

Table 5 (Concluded)
Nonradiological COCs for Human Health Risk Assessment at SWMU 45 with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log K_{ow}

COC	Maximum Concentration (All Samples) (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)
Chrysene	0.12 J	NA	**NA**	18,000[j]	5.91[j]	**Yes**
Di-n-butyl phthalate	0.18 J	NA	**NA**	6,761[l]	4.61[k]	**Yes**
bis(2-Ethylhexyl) phthalate	0.17 J	NA	**NA**	851[l]	7.6[k]	**Yes**
Fluoranthene	0.23 J	NA	**NA**	12,302[j]	4.90[j]	**Yes**
Methylene chloride	0.0011 J	NA	**NA**	5[l]	1.25[l]	No
Phenanthrene	0.18 J	NA	**NA**	23,800[f]	4.63[f]	**Yes**
Pyrene	0.28 J	NA	**NA**	36,300[f]	5.32[j]	**Yes**

Note: **Bold** indicates the COCs that exceed the background screening values and/or are bioaccumulators.
[a]Dinwiddie September 1997, North Area Supergroup.
[b]NMED March 1998.
[c]USGS 1994.
[d]Wren and Stephenson 1991.
[e]Callahan et al. 1979.
[f]Yanicak March 1997.
[g]Neumann 1976.
[h]Parameter was not detected. Concentration is one-half of the highest detection limit.
[i]Vanderploeg et al. 1975.
[j]Howard 1990.
[k]Micromedex, Inc., 1998.
[l]Howard 1989.

BCF = Bioconcentration factor.
COC = Constituent of concern.
J = Estimated concentration.
K_{ow} = Octanol-water partition coefficient.
Log = Logarithm (base 10).
mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
NC = Not calculated.
NMED = New Mexico Environment Department.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.
USGS = U.S. Geological Survey.
– = Information not available.

Table 6
Nonradiological COCs for Ecological Risk Assessment at SWMU 45 with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log K_{ow}

COC	Maximum Concentration (Samples ≤ 5 ft bgs) (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)
Inorganic						
Aluminum	8,700	69,957[c]	Yes	1,305[d]	–	**Yes**
Antimony	17	3.9	**No**	16,000[e]	–	**Yes**
Arsenic	11	4.4	**No**	44[f]	–	**Yes**
Barium	280	200	**No**	170[g]	–	**Yes**
Beryllium	0.63	0.80	Yes	19[f]	–	No
Cadmium	2.4	0.9	**No**	64[f]	–	**Yes**
Chromium, total	12	17.3	Yes	16[f]	–	No
Chromium (VI)	0.05[h]	NC	**Unknown**	16[f]	–	No
Cobalt	6.8	7.1	Yes	10,000[i]	–	**Yes**
Copper	17	17	Yes	6[f]	–	No
Lead	740	11.2	**No**	49[f]	–	**Yes**
Manganese	320	831[c]	Yes	100,000[i]	–	**Yes**
Mercury	2.19	<0.1	**No**	5,500[f]	–	**Yes**
Nickel	10	25.4	Yes	47[f]	–	**Yes**
Selenium	5[h]	<1	**No**	800[e]	–	**Yes**
Silver	0.5[h]	<1	Yes	0.5[f]	–	No
Thallium	0.75 J	<1.1	Yes	119[f]	–	**Yes**
Vanadium	26.3	33	Yes	3,000[g]	–	**Yes**
Zinc	60	76	Yes	47[f]	–	**Yes**
Organic						
Acetone	0.009 J	NA	**NA**	0.69[j]	-0.24[j]	No
2-Butanone	0.006 J	NA	**NA**	1[j]	0.29[j]	No
Benzo(a)anthracene	0.071 J	NA	**NA**	10,000[k]	5.61[k]	**Yes**
Benzo(a)pyrene	0.092 J	NA	**NA**	3,000[g]	6.04[g]	**Yes**
Benzo(b)fluoranthene	0.16 J	NA	**NA**	–	6.124[k]	**Yes**

Refer to footnotes at end of table.

Table 6 (Concluded)
Nonradiological COCs for Ecological Risk Assessment at SWMU 45 with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log K_{ow}

COC	Maximum Concentration (Samples ≤ 5 ft bgs) (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)
Chrysene	0.12 J	NA	**NA**	18,000[j]	5.91[j]	**Yes**
Di-n-butyl phthalate	0.18 J	NA	**NA**	6,761[l]	4.61[k]	**Yes**
bis(2-Ethylhexyl) phthalate	0.17 J	NA	**NA**	851[l]	7.6[k]	**Yes**
Fluoranthene	0.23 J	NA	**NA**	12,302[j]	4.90[j]	**Yes**
Phenanthrene	0.18 J	NA	**NA**	23,800[f]	4.63[f]	**Yes**
Pyrene	0.28 J	NA	**NA**	36,300[f]	5.32[j]	**Yes**

Note: **Bold** indicates the COCs that exceed the background screening values and/or are bioaccumulators.
[a]Dinwiddie September 1997, North Area Supergroup.
[b]NMED March 1998.
[c]USGS 1994.
[d]*Wren and Stephenson 1991.*
[e]Callahan et al. 1979.
[f]*Yanicak March 1997.*
[g]Neumann 1976.
[h]Parameter was not detected. Concentration is one-half of the highest detection limit.
[i]Vanderploeg et al. 1975.
[j]Howard 1990.
[k]Micromedex, Inc., 1998.
[l]Howard 1989.

BCF = Bioconcentration factor.
bgs = Below ground surface.
COC = Constituent of concern.
ft = Foot (feet).
J = Estimated concentration.
K_{ow} = Octanol-water partition coefficient.
Log = *Logarithm (base 10).*
mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
NC = Not calculated.
NMED = New Mexico Environment Department.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.
USGS = U.S. Geological Survey.
– = *Information not available.*

Table 7
Radiological COCs for Human Health Risk Assessment at SWMU 45 with Comparison to the Associated SNL/NM Background Screening Value and BCF

COC	Maximum Activity (All Samples) (pCi/g)[a]	SNL/NM Background Activity (pCi/g)[b]	Is Maximum COC Activity Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (Maximum Aquatic)	Is COC a Bioaccumulator?[c] (BCF >40)
Cs-137	**ND (0.22)**	0.084	**No**	3,000[d]	**Yes**
Th-232	0.79	1.54	Yes	3,000[e]	**Yes**
U-235	**ND (0.236)**	0.18	**No**	900[e]	**Yes**
U-238	ND (1.29)	1.3	Yes	900[e]	**Yes**

Note: **Bold** indicates COCs that exceed background screening values and/or are bioaccumulators.
[a]Value listed is the greater of either the maximum detection or the highest MDA.
[b]Dinwiddie September 1997, North Area Supergroup.
[c]NMED March 1998.
[d]Whicker and Schultz 1982.
[e]Baker and Soldat 1992.

BCF = Bioconcentration factor.
COC = Constituent of concern.
MDA = Minimum detectable activity.
ND ( ) = Not detected above the MDA, shown in parentheses.
ND ( ) = Not detected, but the MDA (shown in parentheses) exceeds background activity.
NMED = New Mexico Environment Department.
pCi/g = Picocurie(s) per gram.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.

Table 8
Radiological COCs for Ecological Risk Assessment at SWMU 45 with Comparison to the Associated SNL/NM Background Screening Value and BCF

COC	Maximum Activity (Samples ≤ 5 ft bgs) (pCi/g)[a]	SNL/NM Background Activity (pCi/g)[b]	Is Maximum COC Activity Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (Maximum Aquatic)	Is COC a Bioaccumulator?[c] (BCF >40)
Cs-137	**ND (0.22)**	0.084	**No**	3,000[d]	**Yes**
Th-232	0.79	1.54	Yes	3,000[e]	**Yes**
U-235	**ND (0.236)**	0.18	**No**	900[e]	**Yes**
U-238	ND (1.29)	1.3	Yes	900[e]	**Yes**

Note: **Bold** indicates COCs that exceed background screening values and/or are bioaccumulators.
[a]Value listed is the greater of either the maximum detection or the highest MDA.
[b]Dinwiddie September 1997, North Area Supergroup.
[c]NMED March 1998.
[d]Whicker and Schultz 1982.
[e]Baker and Soldat 1992.
BCF = Bioconcentration factor.
bgs = Below ground surface.
COC = Constituent of concern.
ft = Foot (feet).
MDA = Minimum detectable activity.
ND ( ) = Not detected, above the MDA, shown in parentheses.
ND ( ) = Not detected, but the MDA (shown in parentheses) exceeds background activity.
NMED = New Mexico Environment Department.
pCi/g = Picocurie(s) per gram.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.

The COCs at SWMU 45 include both inorganic and organic constituents. The inorganic COCs include both radiological and nonradiological analytes. The inorganic COCs are elemental in form and are not considered to be degradable. Transformations of these inorganic constituents could 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). Radiological COCs will undergo decay to stable isotopes or radioactive daughter elements. However, because of the long half-lives of the radiological COCs (Cs-137 and U-235), the aridity of the environment at this site, and the lack of potential contact with biota, none of these mechanisms are expected to result in significant losses or transformations of the inorganic COCs.

The organic COCs at SWMU 45 include VOCs and SVOCs. Organic constituents may be degraded through 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. Because of the depth of the COCs in the soil, the loss of VOCs through volatilization is expected to be moderate.

Table 9 summarizes the fate and transport processes that can occur at SWMU 45. COCs at this site include organic analytes as well as radiological and nonradiological inorganic analytes. Wind, surface water, and biota are considered to be of low significance as potential transport mechanisms at this site. Significant leaching into the subsurface soil is unlikely, and leaching into the groundwater at this site is highly unlikely. The potential for transformation of COCs is low, and loss through decay of the radiological COCs is insignificant because of their long half-lives.

Table 9
Summary of Fate and Transport at SWMU 45

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

SWMU = Solid Waste Management Unit.

VI. Human Health Risk Assessment

VI.1 Introduction

The human health risk 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 is a screening procedure that 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 carried forward in the risk assessment process.
Step 4.	Toxicological parameters are identified and referenced for COCs that were not eliminated during the screening procedure.
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), 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 site description and history for SWMU 45. 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 45 has been designated with a future land-use scenario of industrial (DOE et al. September 1995) (see Appendix 1 for default exposure pathways and parameters). However, the residential land-use scenario is also considered in the pathway analysis. 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. Soil ingestion is included for the radiological COCs as well. The dermal pathway is included for the nonradiological COCs because of the potential for the receptor to be exposed to contaminated soil. No water pathways to the groundwater are considered; depth to groundwater at SWMU 45 is approximately 500 feet bgs. No intake routes through plant, meat, or milk ingestion are considered appropriate for either the industrial or residential land-use scenarios. Figure 1 shows the conceptual site model flow diagram for SWMU 45.

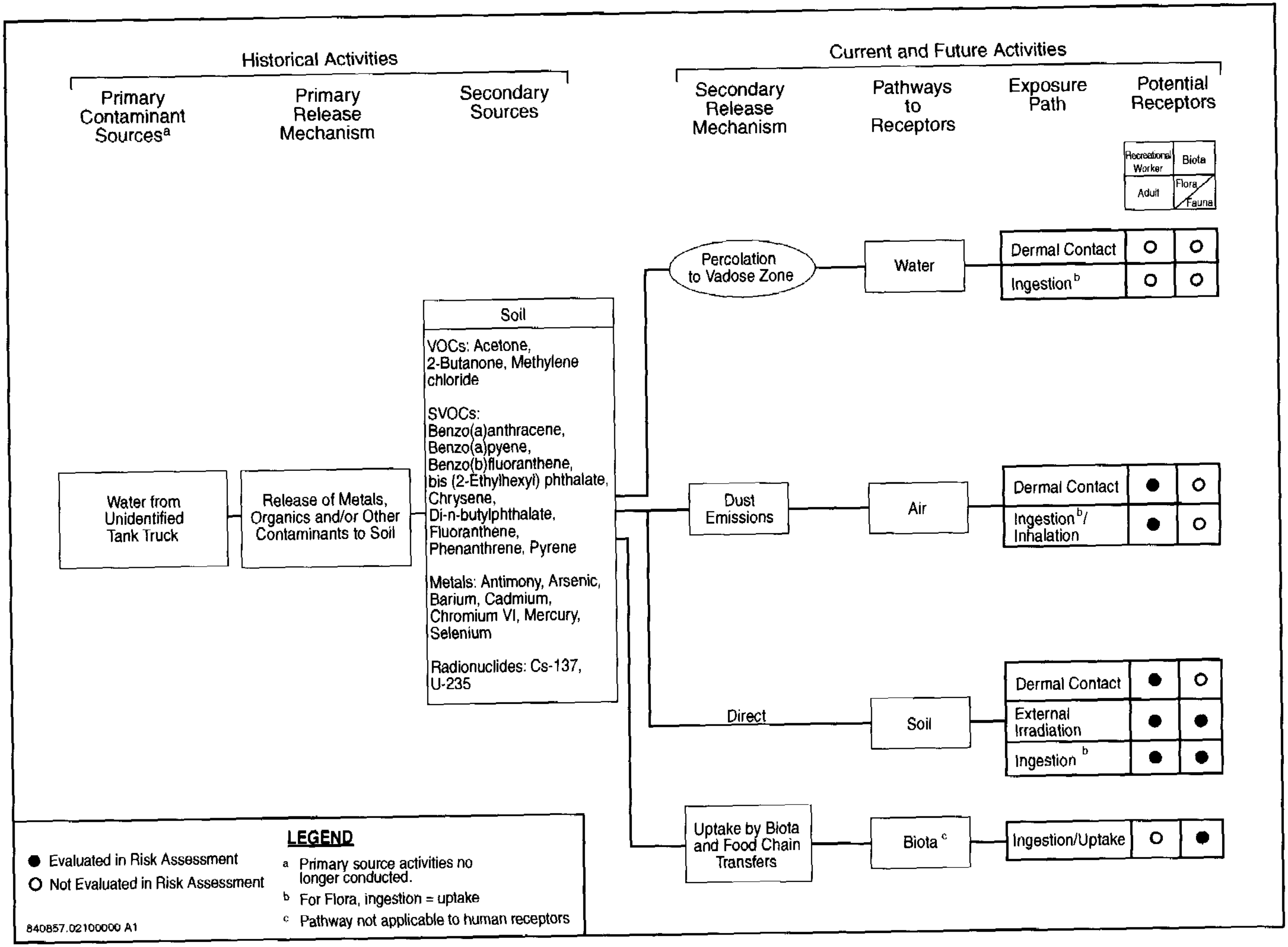

Figure 1

Conceptual Site Model Flow Diagram for SWMU 45, Liquid Discharge Site

Pathway Identification

Nonradiological Constituents	Radiological Constituents
Soil ingestion	Soil ingestion
Inhalation (dust)	Inhalation (dust)
Dermal contact	Direct gamma

VI.4 Step 3. Background Screening Procedure

This section discusses Step 3, the background screening procedure, which compares the maximum COC concentration to the background screening level. The methodology and results are described in the following sections.

VI.4.1 Methodology

Maximum concentrations of nonradiological COCs are compared to the approved SNL/NM maximum screening levels for this area. The SNL/NM maximum background concentration was selected to provide the background screen in Table 5 and 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 calculated background screening level are considered in further risk assessment analyses.

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

VI.4.2 Results

Tables 5 and 7 show the SWMU 45 maximum COC concentrations that were compared to the SNL/NM maximum background values (Dinwiddie September 1997) for the human health risk assessment. For the nonradiological COCs, seven constituents were measured at concentrations greater than the background screening values. One constituent does not have a quantified background screening concentration; therefore, it is unknown whether this COC exceeds the background value. Twelve nonradiological COCs are organic compounds that do not have corresponding background screening values.

The maximum concentration value for lead is 740 milligrams (mg)/kilogram (kg) and the upper confidence limit (UCL) of the mean concentration is 257 mg/kg (Appendix 2). The EPA intentionally does not provide any human health toxicological data on lead; therefore, no risk parameter values could be calculated. However, the NMED guidance for lead screening concentrations for construction and industrial land-use scenarios are 750 and 1,500 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). Both the maximum concentration of lead for construction and industrial land-use scenarios and the 95% UCL of the mean concentration for the residential land-use scenario at this site are less than the screening values; therefore, lead is eliminated from further consideration in the human health risk assessment.

For the radiological COCs, two constituents (Cs-137 and U-235) had MDA or detected values greater than the background screening levels. The greater of either the maximum detection or the highest MDA is conservatively used in the risk assessment.

VI.5 Step 4. Identification of Toxicological Parameters

Tables 10 and 11 list the COCs retained in the risk assessment and provide the values for the available toxicological information. The toxicological values for the nonradiological COCs presented in Table 10 were obtained from the Integrated Risk Information System (IRIS) (EPA 2003), the Health Effects Assessment Summary Tables (HEAST) (EPA 1997a), the Technical Background Document for Development of Soil Screening Levels (NMED December 2000), Risk Assessment Information System (ORNL 2003), and the EPA Region 6 electronic database (EPA 2002a). Dose conversion factors (DCFs) used in determining the excess TEDE values for radiological COCs for the individual pathways are 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 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 excess cancer risk for both the potential nonradiological COCs and associated background for the industrial and residential land-use scenarios. The incremental TEDE and incremental estimated cancer risk are provided for the background-adjusted radiological COCs for both industrial and residential land-use scenarios.

Table 10
Toxicological Parameter Values for SWMU 45 Nonradiological COCs

COC	RfD_o (mg/kg-d)	Confidence[a]	RfD_{inh} (mg/kg-d)	Confidence[a]	SF_o $(mg/kg\text{-}d)^{-1}$	SF_{inh} $(mg/kg\text{-}d)^{-1}$	Cancer Class[b]	ABS
Inorganic								
Antimony	4E-4[c]	L	–	–	–	–	–	0.01[d]
Arsenic	3E-4[c]	M	–	–	1.5E+0[c]	1.5E+1[e]	A	0.03[d]
Barium	7E-2[c]	M	1.4E-4[f]	–	–	–	D	0.01[d]
Cadmium	5E-4[c]	H	5.7E-5[e]	–	–	6.3E+0[c]	B1	0.001[d]
Chromium VI	3E-3[c]	L	2.3E-6[c]	L	–	4.2E+1[e]	A	0.01[d]
Mercury	3E-4[f]	–	8.6E-5[c]	M	–	–	D	0.01[d]
Selenium	5E-3[c]	H	–	–	–	–	D	0.01[d]
Organic								
Acetone	1E-1[c]	L	1E-1[e]	–	–	–	D	0.01[g]
2-Butanone	6E-1[c]	L	2.9E-1[c]	L	–	–	D	0.1[d]
Benzo(a)anthracene	–	–	–	–	7.3E-1[e]	3.1E-1[e]	B2	0.13[d]
Benzo(a)pyrene	–	–	–	–	7.3E+0[c]	3.1E+0[c]	B2	0.13[d]
Benzo(b)fluoranthene	–	–	–	–	7.3E-1[e]	3.1E-1[e]	B2	0.13[d]
Chrysene	–	–	–	–	7.3E-3[e]	3.1E-3[e]	B2	0.13[d]
Di-n-butyl phthalate	1E-1[c]	L	1E-1[e]	–	–	–	D	0.1[d]
bis(2-Ethylhexyl) phthalate	2E-2[c]	–	2E-2[e]	–	1.4E-2[e]	1.4E-2[e]	–	0.01[g]
Fluoranthene	4E-2[c]	L	4E-2[e]	–	–	–	D	0.13[d]
Methylene chloride	6E-2[c]	M	8.6E-1[f]	–	7.5E-3[c]	1.6E-3[c]	B2	0.1[d]
Phenanthrene[h]	3E-1[c]	L	3E-1[e]	–	–	–	D	0.1[d]
Pyrene	3E-2[c]	L	3E-2[e]	–	–	–	D	0.1[d]

[a]Confidence associated with IRIS (EPA 2003) database values. Confidence: L = low, M = medium, H = high.

[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989) taken from IRIS (EPA 2003):

- A = Human carcinogen.
- B1 = Probable human carcinogen. Limited human data are available.
- B2 = Probable human carcinogen. Sufficient evidence in animals and inadequate or no evidence in humans.
- D = Not classifiable as to human carcinogenicity.

[c]Toxicological parameter values from IRIS electronic database (EPA 2003).

[d]Toxicological parameter values from NMED (December 2000).

[e]Toxicological parameter values from EPA Region 6 electronic database (EPA 2002a).

[f]Toxicological parameter values from HEAST (EPA 1997a).

Table 10 (Concluded)
Toxicological Parameter Values for SWMU 45 Nonradiological COCs

[g]Toxicological parameter values from Risk Assessment Information System (ORNL 2003).

[h]Toxicological parameter values for phenanthrene could not be found. Anthracene was used as a surrogate.

ABS	= Gastrointestinal absorption coefficient.
COC	= Constituent of concern.
EPA	= U.S. Environmental Protection Agency.
HEAST	= Health Effects Assessment Summary Tables.
IRIS	= Integrated Risk Information System.
mg/kg-d	= Milligram(s) per kilogram-day.
$(mg/kg\text{-}d)^{-1}$	= Per milligram per kilogram-day.
NMED	= New Mexico Environment Department.
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 11
Toxicological Parameter Values for SWMU 45 Radiological COCs Obtained from RESRAD Risk Coefficients[a]

COC	SF_o (1/pCi)	SF_{inh} (1/pCi)	SF_{ev} (g/pCi-yr)	Cancer Class[b]
Cs-137	3.2E-11	1.9E-11	2.1E-06	A
U-235	4.7E-11	1.3E-08	2.7E-07	A

[a]Yu et al. 1993a.
[b]EPA 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-year.
SF_{ev} = External volume exposure slope factor.
SF_{inh} = Inhalation slope factor.
SF_o = Oral (ingestion) slope factor.
SWMU = Solid Waste Management Unit.

VI.6.1 Exposure Assessment

Appendix 1 provides the equations and parameter input values used to calculate intake values and subsequent HI and excess cancer risk values for the individual exposure pathways. The appendix shows parameters for both industrial and residential land-use scenarios. The equations for nonradiological COCs are based upon the Risk Assessment Guidance for Superfund (RAGS) (EPA 1989). Parameters are based upon information from the RAGS (EPA 1989), the Technical Background Document for Development of Soil Screening Levels (NMED December 2000), as well as other EPA and NMED guidance documents. The parameters 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 for this site is industrial, risk and TEDE values for a residential land-use scenario are also presented.

VI.6.2 Risk Characterization

Table 12 shows an HI of 0.08 for the SWMU 45 nonradiological COCs and an estimated excess cancer risk of 7E-6 for the designated industrial land-use scenario. The numbers presented include exposure from soil ingestion, dermal contact, and dust and volatile inhalation for nonradiological COCs. Table 13 shows an HI of 0.03 and an estimated excess cancer risk of 3E-6 for the SWMU 45 associated background constituents under the designated industrial land-use scenario.

Table 12
Risk Assessment Values for SWMU 45 Nonradiological COCs

COC	Maximum Concentration (All Samples) (mg/kg)	Industrial Land-Use Scenario[a]		Residential Land-Use Scenario[a]	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Inorganic					
Antimony	17	0.04	–	0.56	–
Arsenic	11	0.04	7E-6	0.51	3E-5
Barium	280	0.00	–	0.05	–
Cadmium	2.4	0.00	8E-10	0.06	2E-9
Chromium VI	0.05[b]	0.00	1E-10	0.00	2E-10
Mercury	2.19	0.00	–	0.00	–
Selenium	5[b]	0.00	–	0.02	–
Organic					
Acetone	0.009 J	0.00	–	0.00	–
2-Butanone	0.006 J	0.00	–	0.00	–
Benzo(a)anthracene	0.071 J	0.00	3E-8	0.00	1E-7
Benzo(a)pyrene	0.092 J	0.00	4E-7	0.00	1E-6
Benzo(b)fluoranthene	0.16 J	0.00	8E-8	0.00	3E-7
Chrysene	0.12 J	0.00	6E-10	0.00	2E-9
Di-n-butyl phthalate	0.18 J	0.00	–	0.00	–
bis(2-Ethylhexyl) phthalate	0.17 J	0.00	9E-10	0.00	4E-9
Fluoranthene	0.23 J	0.00	–	0.00	–
Methylene chloride	0.0011 J	0.00	6E-11	0.00	1E-10
Phenanthrene	0.18 J	0.00	–	0.00	–
Pyrene	0.28 J	0.00	–	0.00	–
Total		**0.08**	**7E-6**	**1.20**	**3E-5**

[a]EPA 1989.
[b]Maximum concentration is one-half of the detection limit.
COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
J = Concentration was qualified as an estimated value.
mg/kg = Milligram(s) per kilogram.
SWMU = Solid Waste Management Unit.
– = Information not available.

Table 13
Risk Assessment Values for SWMU 45 Nonradiological Background Constituents

COC	Background Concentration[a] (mg/kg)	Industrial Land-Use Scenario[b]		Residential Land-Use Scenario[b]	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Antimony	3.9	0.01	–	0.13	–
Arsenic	4.4	0.02	3E-6	0.20	1E-5
Barium	200	0.00	–	0.04	–
Cadmium	0.9	0.00	3E-10	0.02	6E-10
Chromium VI	NC	–	–	–	–
Mercury	<0.1	–	–	–	–
Selenium	<1	–	–	–	–
Total		**0.03**	**3E-6**	**0.39**	**1E-5**

[a]Dinwiddie September 1997, North Area Supergroup.
[b]EPA 1989.
COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
mg/kg = Milligram(s) per kilogram.
NC = Not calculated.
SWMU = Solid Waste Management Unit.
– = Information not available.

For the radiological COCs, contribution from the direct gamma exposure pathway is included. For the industrial land-use scenario, a TEDE is calculated for an individual on the site that results in an incremental TEDE of 8.7E-2 millirem (mrem)/year (yr). In accordance with EPA guidance found in Office of Solid Waste and Emergency Response (OSWER) Directive No. 9200.4-18 (EPA 1997b), an incremental TEDE of 15 mrem/yr is used for the probable land-use scenario (industrial in this case); the calculated dose value for SWMU 45 for the industrial land-use scenario is well below this guideline. The estimated excess cancer risk is 1.2E-6.

The HI is 1.20 with an estimated excess cancer risk of 3E-5 for the nonradiological COCs under the residential land-use scenario (Table 12). The numbers in the table include exposure from soil ingestion, dermal contact, and dust inhalation. Although the EPA (1991) guidelines generally recommend that inhalation not be included in a residential land-use scenario, this pathway is included because of the potential for soil in Albuquerque, New Mexico, to be eroded and for dust to be present in predominantly residential areas. Based upon the nature of local soil, other exposure pathways are not evaluated (see Appendix 1). Table 13 shows an HI of 0.39 and an estimated excess cancer risk of 1E-5 for the associated background constituents at SWMU 45 under the residential land-use scenario.

For the radiological COCs, the incremental TEDE for the residential land-use scenario is 2.1E-1 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 45 for the residential land-use scenario is well below this guideline. Consequently, SWMU 45 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 3.5E-6. The excess cancer risk from the nonradiological and radiological COCs should be summed to provide risk estimates for persons exposed to both types of carcinogenic contaminants, as noted in OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act] Sites with Radioactive Contamination" (EPA 1997b). This summation is tabulated in Section VI.9, "Summary."

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

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

For the nonradiological COCs under the industrial land-use scenario, the HI is 0.08 (lower than the numerical guideline of 1 suggested in the RAGS [EPA 1989]). The excess cancer risk is 7E-6. NMED guidance states that cumulative excess lifetime cancer risk must be less than 1E-5 (Bearzi January 2001); thus the excess cancer risk for this site is below the suggested acceptable risk value. This assessment also determines risks by evaluating background concentrations of the potential nonradiological COCs for both the industrial and residential land-use scenarios. The 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 constituents that do not have quantified background concentrations are assumed to have a hazard quotient (HQ) of 0.00. The incremental HI is 0.05 and the estimated incremental cancer risk is 4.70E-6 for the industrial land-use scenario. These incremental risk calculations indicate insignificant risk to human health from nonradiological COCs considering an industrial land-use scenario.

For the radiological COCs under the industrial land-use scenario, the incremental TEDE is 8.7E-2 mrem/yr, which is significantly lower than EPA's numerical guideline of 15 mrem/yr (EPA 1997b). The incremental estimated excess cancer risk is 1.2E-6.

For the nonradiological COCs under the residential land-use scenario, the calculated HI is 1.20 which is above the numerical guidance. The excess cancer risk is 3E-5. NMED guidance states that cumulative excess lifetime cancer risk must be less than 1E-5 (Bearzi January 2001); thus the excess cancer risk for this site is above the suggested acceptable risk value. The incremental HI is 0.81 and the estimated incremental cancer risk is 1.88E-5 for the residential land-use scenario. The incremental HI value indicates insignificant risk to human health from nonradiological COCs considering a residential land-use scenario.

Although both the HI and estimated excess cancer risk values are above the NMED guidelines for the residential land-use scenario, maximum concentrations were used in the risk calculation. Because the site has been adequately characterized, average concentrations are more representative of actual site conditions. Using the UCL of the mean, or mean concentration, summarized in Appendix 2, for the main contributors to excess cancer risk and hazards (antimony [5.35 mg/kg] and arsenic [5.43 mg/kg]) reduces the total HI and estimated excess cancer risk to 0.56 and 1.59E-5, respectively. The incremental HI and incremental excess cancer risk are reduced to 0.17 and 4.57E-6, respectively. When the UCL concentration exceeds the maximum on-site concentration for a given COC, the mean concentration is used in the risk calculation. Thus, by using realistic concentrations in the risk calculations that more accurately depict actual site conditions, both the total and incremental HI and the incremental excess cancer risk values are below NMED guidelines.

The incremental TEDE for a residential land-use scenario from the radiological components is 2.1E-1 mrem/yr, which is significantly lower 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 3.5E-6.

VI.8 Step 7. Uncertainty Discussion

The determination of the nature, rate, and extent of contamination at SWMU 45 is based upon the initial conceptual model that was validated with confirmatory sampling conducted across the site. The DQOs contained in the SAPs (SNL/NM June 1995, SNL/NM October 1995, SNL/NM February 2001) and FIP (SNL/NM February 2004) are appropriate for use in risk assessments. The data collected, based upon sample location, density, and depth, are representative of the site. The analytical requirements and results satisfy the DQOs. The confirmatory analytical data were reviewed and verified/validated according to "Data Validation Procedure for Chemical and Radiochemical Data," in SNL/NM ER Project AOP 00-03 (SNL/NM December 1999). In addition, the RPSD Laboratory reviewed all gamma spectroscopy results according to "Laboratory Data Review Guidelines," Procedure No. RPSD-02-11, Issue No. 2 (SNL/NM July 1996). Data packages from each of the analytical laboratories were determined to be defensible and acceptable for use in this risk assessment. Therefore, the DQOs have been fulfilled and no uncertainty is associated with the data quality used to perform the risk assessment for SWMU 45.

Because of the location, history, and future land use, there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in performing the risk assessment analysis. Based upon the COCs found in near-surface soil and the location and physical characteristics of the site, there is low uncertainty in the exposure pathways relevant to the analysis.

An RME approach is used to calculate the risk assessment values. Specifically, the parameter values in the calculations are conservative and calculated intakes may be overestimated. Maximum measured values of COC concentrations are used to provide conservative results.

Table 10 shows the uncertainties (confidence levels) in nonradiological toxicological parameter values. There is a mixture of estimated values and values from the IRIS (EPA 2003), HEAST (EPA 1997a), the Technical Background Document for Development of Soil Screening Levels (NMED December 2000), and the Risk Assessment Information System (ORNL 2003) and EPA Region 6 (EPA 2002a) electronic databases. Where values are not provided, information is not available from the HEAST (EPA 1997a), IRIS (EPA 2003), Technical Background Document for Development of Soil Screening Levels (NMED December 2000), the Risk Assessment Information System (ORNL 2003) or the EPA regions (EPA 2002a, EPA 2002b, EPA 2002c). Because of the conservative nature of the RME approach, uncertainties in toxicological values are not expected to change the conclusion from the risk assessment analysis.

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

For the radiological COCs, the conclusion of the risk assessment is that potential effects on human health for both industrial and residential land-use scenarios are within guidelines and 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 45 contains identified COCs consisting of some organic, inorganic, and radiological compounds. Because of the location of the site, the designated industrial land-use scenario, and the nature of contamination, potential exposure pathways identified for this site include soil ingestion, dermal contact, and dust inhalation for chemical COCs and soil ingestion, dust inhalation, and direct gamma exposure for radionuclides. The same exposure pathways are applied to the residential land-use scenario.

Using conservative assumptions and an RME approach to risk assessment, calculations for the nonradiological COCs show that for the industrial land-use scenario the HI (0.08) is significantly lower than the accepted numerical guidance from the EPA. The estimated excess cancer risk is 7E-6. Thus, excess cancer risk is also below the acceptable risk value provided by the NMED for an industrial land-use scenario (Bearzi January 2001). The incremental HI is 0.05 and the incremental excess cancer risk is 4.70E-6 for the industrial land-use scenario. The incremental risk calculations indicate insignificant risk to human health for the industrial land-use scenario.

Using conservative assumptions and an RME approach to risk assessment, calculations for the nonradiological COCs show that for the residential land-use scenario the HI (1.20) is above the accepted numerical guidance from the EPA. The estimated excess cancer risk is 3E-5. Thus, excess cancer risk is above the acceptable risk value provided by the NMED for a residential land-use scenario (Bearzi January 2001). The incremental HI is 0.81 and the incremental excess cancer risk is 1.88E-5 for the residential land-use scenario.

Although both the HI and estimated excess cancer risk values are above the NMED guidelines for the residential land-use scenario, maximum concentrations were used in the risk calculation. Because the site has been adequately characterized, average concentrations are more representative of actual site conditions. Using the UCL of the mean, or mean concentrations, summarized in Appendix 2, for the main contributors to excess cancer risk and hazards (antimony [5.35 mg/kg] and arsenic [5.43 mg/kg]) reduces the total HI and estimated excess cancer risk to 0.56 and 1.59E-5, respectively. The incremental HI and incremental excess cancer risk are reduced to 0.17 and 4.57E-6, respectively. Thus, by using realistic concentrations in the risk calculations that more accurately depict actual site conditions, both the total and incremental HI and the incremental excess cancer risk values are below NMED guidelines.

The incremental TEDE and corresponding estimated cancer risk from the radiological COCs are much lower than EPA guidance values. The estimated TEDE is 8.7E-2 mrem/yr for the industrial land-use scenario, which is much lower than the EPA's numerical guidance of 15 mrem/yr (EPA 1997b). The corresponding incremental estimated cancer risk value is 1.2E-6 for the industrial land-use scenario. Furthermore, the incremental TEDE for the residential land-use scenario that results from a complete loss of institutional control is 2.1E-1 mrem/yr with an associated risk of 3.5E-6. The guideline for this scenario is 75 mrem/yr (SNL/NM February 1998). Therefore, SWMU 45 is eligible for unrestricted radiological release.

The summation of the nonradiological and radiological carcinogenic risks is tabulated in Table 14.

Table 14
Summation of Incremental Nonradiological and Radiological Risks from SWMU 45

Scenario	Nonradiological Risk	Radiological Risk	Total Risk
Industrial	4.70E-6	1.2E-6	5.9E-6
Residential	4.57E-6[a]	3.5E-6	8.1E-6

[a]Incremental risk calculated using the UCL of the mean, or mean concentrations, for the main contributors to the risk.
SWMU = Solid Waste Management Unit.
UCL = Upper confidence limit.

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 both the industrial and residential land-use scenarios.

VII. Ecological Risk 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 45. A component of the NMED Risk-Based Decision Tree (NMED March 1998) is to conduct an ecological assessment that corresponds with that presented in EPA's Ecological RAGS (EPA 1997c). The current methodology is tiered and contains an initial scoping assessment followed by a more detailed risk assessment. Initial components of NMED's decision tree (a discussion of DQOs, data assessment, and evaluations of bioaccumulation as well as 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 risk assessment whereby a more quantitative estimate of ecological risk is conducted. Although this assessment is conservative in the estimation of ecological risks, ecological relevance and professional judgment are also used as recommended by the EPA (1998) 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 constituents associated with site activities. Included in this section are an evaluation of existing data and a comparison of maximum detected concentrations to background concentrations, examination of bioaccumulation potential, and fate and transport potential. A scoping risk-management decision (Section VII.2.4) summarizes the scoping results and assesses the need for further examination of potential ecological impacts.

VII.2.1 Data Assessment

As indicated in Section IV (Tables 6 and 8), constituents in the soil within the 0- to 5-foot depth interval that are identified as COPECs for this site include the following:

- Antimony
- Arsenic
- Barium
- Cadmium
- Chromium VI
- Lead
- Mercury
- Selenium
- Acetone
- 2-Butanone
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Chrysene
- Di-n-butyl phthalate
- bis(2-Ethylhexyl) phthalate
- Fluoranthene
- Phenanthrene
- Pyrene
- Cs-137
- U-235

VII.2.2 Bioaccumulation

Among the COPECs listed in Section VII.2.1, the following are considered to have bioaccumulation potential in aquatic environments (Section IV, Tables 6 and 8):

- Antimony
- Arsenic
- Barium
- Cadmium

- Lead
- Mercury
- Selenium
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Chrysene
- Di-n-butyl phthalate
- bis(2-Ethylhexyl) phthalate
- Fluoranthene
- Phenanthrene
- Pyrene
- Cs-137
- U-235

However, as directed by the 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 migrate from the source of contamination to other media or biota is discussed in Section V. As noted in Table 9 (Section V), wind, surface water, and biota (food chain uptake) are expected to be of low significance as transport mechanisms for COPECs at this site. Degradation, transformation, and radiological decay of the COPECs are also expected to be of low significance.

VII.2.4 Scoping Risk-Management Decision

Based upon information gathered through the scoping assessment, it is concluded that complete ecological pathways may be associated with this site and that COPECs also exist at the site. As a consequence, a detailed ecological risk assessment is deemed necessary to predict the potential level of ecological risk associated with the site.

VII.3 Risk Assessment

As concluded in Section VII.2.4, both complete ecological pathways and COPECs are associated with SWMU 45. The ecological risk 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 risk 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.
- Risk Assessment Scientific/Management Decision Point—presents the decision to risk managers based upon the results of the risk assessment.

VII.3.1 Problem Formulation

Problem formulation is the initial stage of the risk 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 an ecological risk assessment) are presented in "Predictive Ecological Risk Assessment Methodology, Environmental Restoration Program, Sandia National Laboratories, New Mexico" (IT July 1998) and are not duplicated here.

VII.3.1.1 Ecological Pathways and Setting

SWMU 45 is less than 1 acre in size and located in an area dominated by grassland habitat. The site is partially paved and open to use by wildlife. No threatened or endangered species exist at this site (IT February 1995), and no surface-water bodies, seeps, or springs are associated with the site.

Complete ecological pathways may exist at this site through the exposure of plants and wildlife to COPECs in the soil. It is 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 is 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 is considered insignificant. Inhalation and dermal contact also are 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

Discharge of waste water from an unidentified tank truck is the primary source of COPECs at SWMU 45. All COPECs identified for this site are listed in Section VII.2 and include both radiological and nonradiological analytes. The analytes were screened against background concentrations and those that exceed the approved SNL/NM background screening levels (Dinwiddie September 1997) for the area are considered to be COPECs. All organic analytes detected in the soil and inorganic constituents with uncertain background levels are retained as COPECs. Nonradiological inorganic constituents that are essential nutrients, such as iron, magnesium, calcium, potassium, and sodium, are not included in this risk assessment as set forth by the EPA (1989). In order to provide conservatism, this ecological risk assessment is based upon the maximum soil concentrations of the COPECs measured in the upper 5 feet of soil at this site. Tables 6 and 8 present the maximum concentrations for the COPECs.

VII.3.1.3 Ecological Receptors

A nonspecific perennial plant has been 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*) are used to represent wildlife use. Because of its opportunistic food habits, the deer mouse is used to represent a mammalian herbivore, omnivore, and insectivore. The burrowing owl represents 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 the nonradiological COPECs, direct uptake from the soil is considered the only significant route of exposure for terrestrial plants. Exposure modeling for the wildlife receptors is limited to food and soil ingestion pathways. Inhalation and dermal contact are considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Drinking water is also considered an insignificant pathway because of the lack of surface water at this site. The deer mouse is 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 is 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 deer mice would be equivalent to the exposure consisting of only omnivorous deer mice, the diet of the burrowing owl is modeled with intake of omnivorous deer mice only. Both species are modeled with soil ingestion comprising 2 percent of the total dietary intake. Table 15 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).

Table 15
Exposure Factors for Ecological Receptors at SWMU 45

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

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

Although home range is also included in this table, exposures for this risk assessment are 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 the upper 5 feet of soil are used to conservatively estimate potential exposures and risks to plants and wildlife at this site.

For the radiological dose-rate calculations, the deer mouse is modeled as an herbivore (100 percent of its diet as plants), and the burrowing owl is modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Both are modeled with soil ingestion comprising 2 percent of the total dietary intake. Receptors are exposed to radiation both internally and externally from Cs-137 and U-235. Internal and external dose rates to the deer mouse and the burrowing owl are approximated using modified dose-rate models from the 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 Cs-137 and U-235 in soil.

Table 16 provides the transfer factors used in modeling the concentrations of COPECs through the food chain. Table 17 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 18 shows 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 is 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 45.

Table 16
Transfer Factors Used in Exposure Models for COPECs at SWMU 45

COPEC	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor
Inorganic			
Antimony	2.0E-1[a]	1.0E+0[b]	1.0E-3[c]
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]
Cadmium	5.5E-1[a]	6.0E-1[d]	5.5E-4[a]
Chromium VI	4.0E-2[c]	1.3E-1[e]	3.0E-2[c]
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]
Selenium	5.0E-1[c]	1.0E+0[b]	1.0E-1[c]
Organic[f]			
Acetone	5.3E+1	1.3E+1	1.0E-8
2-Butanone	2.6E+1	1.4E+1	3.7E-8
Benzo(a)anthracene	2.2E-2	2.5E+1	1.1E-2
Benzo(a)pyrene	1.1E-2	2.7E+1	3.8E-2
Benzo(b)fluoranthene	6.2E-3	2.8E+1	1.1E-1
Chrysene	1.5E-2	2.6E+1	2.3E-2
Di-n-butyl phthalate	8.4E-2	2.2E+1	1.1E-3
bis(2-Ethylhexyl) phthalate	1.6E-3	3.2E+1	1.3E+0
Fluoranthene	5.7E-2	2.3E+1	2.1E-3
Phenanthrene	8.9E-2	2.2E+1	9.6E-4
Pyrene	3.3E-2	2.4E+1	5.8E-3

[a]Baes et al. 1984.
[b]Default value.
[c]NCRP January 1989.
[d]Stafford et al. 1991.
[e]Ma 1982.
[f]Soil-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 based upon relationship of the transfer factor to the Log K_{ow} value of compound.
COPEC = Constituent of potential ecological concern.
K_{ow} = Octanol-water partition coefficient.
Log = Logarithm (base 10).
NCRP = National Council on Radiation Protection and Measurements.
SWMU = Solid Waste Management Unit.

Table 17
Media Concentrations[a] for COPECs at SWMU 45

COPEC	Soil (Maximum)[a]	Plant Foliage[b]	Soil Invertebrate[b]	Deer Mouse Tissues[c]
Inorganic				
Antimony	9.6E+0	1.9E+0	9.6E+0	1.9E-2
Arsenic	1.1E+1	4.4E-1	1.1E+1	3.7E-2
Barium	2.8E+2	4.2E+1	2.8E+2	1.0E-1
Cadmium	2.4E+0	1.3E+0	1.4E+0	2.5E-3
Chromium VI	5.0E-2[d]	4.0E-3	1.3E-2	9.8E-4
Lead	7.4E+2	6.7E+1	3.0E+1	1.6E-1
Mercury	2.2E+0	2.2E+0	2.2E+0	1.7E+0
Selenium	5.0E+0[d]	2.2E+0	2.2E+0	1.7E+0
Organic				
Acetone	9.0E-3[e]	4.8E-1	1.2E-1	9.7E-9
2-Butanone	6.0E-3[e]	1.6E-1	8.2E-2	1.4E-8
Benzo(a)anthracene	7.1E-2[e]	1.6E-3	1.8E+0	3.2E-2
Benzo(a)pyrene	9.2E-2[e]	1.0E-3	2.4E+0	1.4E-1
Benzo(b)fluoranthene	1.6E-1[e]	9.9E-4	4.5E+0	7.9E-1
Chrysene	1.2E-1[e]	1.8E-3	3.1E+0	1.1E-1
Di-n-butyl phthalate	1.8E-1[e]	1.5E-2	4.0E+0	6.7E-3
bis(2-Ethylhexyl) phthalate	1.7E-1[e]	2.7E-4	5.4E+0	1.1E+1
Fluoranthene	2.3E-1[e]	1.3E-2	5.3E+0	1.8E-2
Phenanthrene	1.8E-1[e]	1.6E-2	4.0E+0	6.1E-3
Pyrene	2.8E-1[e]	9.1E-3	6.8E+0	6.1E-2

[a]In 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.
[b]Product of the soil concentration and the corresponding transfer factor.
[c]Based upon the deer mouse with an omnivorous diet. Product of the average concentration 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).
[d]Analyte not detected. Maximum concentration is one-half of the detection limit.
[e]Estimated value.
COPEC = Constituent of potential ecological concern.
SWMU = Solid Waste Management Unit.

Table 18
Toxicity Benchmarks for Ecological Receptors at SWMU 45

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							
Antimony	5	mouse	0.125	0.132	–	–	–
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
Cadmium	3	rat[i]	1.0	1.9	mallard	1.45	1.45
Chromium VI	1	rat	3.28	6.42	–	–	–
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
Selenium	1	rat	0.2	0.391	screech owl	0.44	0.44
Organic							
Acetone	–	rat	10	19.6	–	–	–
2-Butanone	–	rat	1,771	3,465	–	–	–
Benzo(a)anthracene	18	mouse	1	1.058	–	–	–
Benzo(a)pyrene	18	mouse	1	1.058	–	–	–
Benzo(b)fluoranthene	18	mouse	1	1.058	–	–	–
Chrysene	18	mouse	1	1.058	–	–	–
Di-n-butyl phthalate	200	mouse	550	582.2	ringed dove	0.11	0.11
bis(2-Ethylhexyl) phthalate	–	mouse	18.3	19.37	ringed dove	1.1	1.1
Fluoranthene	18	mouse	12.5	13.23	–	–	–
Phenanthrene	18	mouse	1	1.058	–	–	–
Pyrene	18	mouse	7.5	7.939	–	–	–

Refer to footnotes at end of table.

Table 18 (Concluded)
Toxicity Benchmarks for Ecological Receptors at SWMU 45

[a]In milligrams per kilogram soil dry weight.
[b]Efroymson et al. 1997.
[c]Body weights (in kilograms) for the NOAEL conversion are as follows: lab mouse, 0.030; lab rat, 0.350, (except where noted).
[d]Sample et al. 1996, except where noted.
[e]In milligrams per kilogram body weight per day.
[f]Based upon NOAEL conversion methodology presented in Sample et al. (1996), using a deer mouse body weight of 0.0239 kilogram and a mammalian scaling factor of 0.25.
[g]Based upon NOAEL conversion methodology presented in Sample et al. (1996). The avian scaling factor of 0.0 was used, making the NOAEL independent of body weight.
[h]Body weight: 0.435 kilogram.
[i]Body weight: 0.303 kilogram.
COPEC = Constituent of potential ecological concern.
NOAEL = No-observed-adverse-effect level.
SWMU = Solid waste management unit.
– = Insufficient toxicity data.

VII.3.4 Risk Characterization

Maximum concentrations in soil and estimated dietary exposures are compared to plant and wildlife benchmark values, respectively. Table 19 presents the results of these comparisons. HQs are used to quantify the comparison with benchmarks for plant and wildlife exposure.

HQs for plants exceed unity for antimony, arsenic, lead, mercury, and selenium. For the omnivorous and insectivorous deer mice, HQs exceed unity for antimony, arsenic, barium, mercury, and selenium. When mercury is assumed to be entirely in organic form, the HQs for both the deer mouse (all dietary regimes) and the burrowing owl exceed unity; however, these values do not exceed unity when the mercury is assumed to be in inorganic form. Because of a lack of sufficient toxicity information, HQs for plants could not be determined for three of the eleven organic COPECs. Similarly for the burrowing owl, HQs could not be determined for antimony, chromium VI, and all of the organic COPECs except bis(2-ethylhexyl) phthalate and di-n-butyl phthalate. As directed by the NMED, HIs are calculated for each of the receptors (the HI is the sum of chemical-specific HQs for all pathways for a given receptor). All receptors have total HIs greater than unity, with a maximum HI of 40 for the insectivorous deer mouse.

Tables 20 and 21 summarize the internal and external dose-rate model results for Cs-137 and U-235 for the deer mouse and burrowing owl, respectively. The total radiation dose rate to the deer mouse is predicted to be 2.0E-5 rad/day and that for the burrowing owl is 1.6E-5 rad/day. The dose rates for the deer mouse and the burrowing owl are lower 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 45. These uncertainties result from assumptions used in calculating risk that could overestimate or underestimate 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. Conservatisms incorporated into this risk assessment include the use of maximum analyte concentrations measured in soil samples 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 Cs-137 and U-235 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.

Table 19
HQs for Ecological Receptors at SWMU 45

COPEC	Plant HQ[a]	Deer Mouse HQ[a] (Herbivorous)	Deer Mouse HQ[a] (Omnivorous)	Deer Mouse HQ[a] (Insectivorous)	Burrowing Owl HQ[a]
Inorganic					
Antimony	**1.9E+0**	**2.5E+0**	**7.0E+0**	**1.2E+1**	–
Arsenic	**1.1E+0**	7.7E-1	**6.9E+0**	**1.3E+1**	5.6E-3
Barium	5.6E-1	7.0E-1	**2.5E+0**	**4.2E+0**	3.1E-2
Cadmium	8.0E-1	1.1E-1	1.2E-1	1.2E-1	3.9E-3
Chromium VI	5.0E-2	7.5E-5	1.3E-4	1.8E-4	–
Lead	**1.5E+1**	8.1E-1	6.3E-1	4.4E-1	4.3E-1
Mercury (organic)	**7.3E+0**	**5.6E+0**	**5.6E+0**	**5.6E+0**	**3.1E+1**
Mercury (inorganic)	**7.3E+0**	2.5E-2	2.5E-2	2.5E-2	4.4E-1
Selenium	**5.0E+0**	**1.1E+0**	**1.6E+0**	**2.1E+0**	3.3E-1
Organic					
Acetone	–	3.8E-3	2.4E-3	9.2E-4	–
2-Butanone	–	7.1E-6	5.4E-6	3.7E-6	–
Benzo(a)anthracene	3.9E-3	4.4E-4	1.3E-1	2.6E-1	–
Benzo(a)pyrene	5.1E-3	4.2E-4	1.8E-1	3.6E-1	–
Benzo(b)fluoranthene	8.9E-3	6.2E-4	3.3E-1	6.6E-1	–
Chrysene	6.7E-3	6.2E-4	2.3E-1	4.6E-1	–
Di-n-butyl phthalate	9.0E-4	5.0E-6	5.4E-4	1.1E-3	1.0E-2
bis(2-Ethylhexyl) phthalate	–	2.9E-5	2.2E-2	4.3E-2	**1.1E+0**
Fluoranthene	1.3E-2	2.1E-4	3.1E-2	6.3E-2	–
Phenanthrene	1.0E-2	2.9E-3	3.0E-1	5.9E-1	–
Pyrene	1.6E-2	2.9E-4	6.7E-2	1.3E-1	–
HI[b]	**3.2E+01**	**1.2E+01**	**2.6E+01**	**4.0E+01**	**3.3E+01**

[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.

Table 20
Total Dose Rates for the Deer Mouse
Exposed to Radionuclides at SWMU 45

Radionuclide	Maximum Activity (pCi/g)	Total Dose (rad/day)
Cs-137	**0.17**	1.3E-5
U-235	**0.236**	6.4E-6
Total Dose		2.0E-5

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

Table 21
Total Dose Rates for the Burrowing Owl
Exposed to Radionuclides at SWMU 45

Radionuclide	Maximum Activity (pCi/g)	Total Dose (rad/day)
Cs-137	**0.17**	1.1E-5
U-235	**0.236**	4.9E-6
Total Dose		1.6E-5

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

Although the HQs for selenium exceed unity for plants and the herbivorous, omnivorous, and insectivorous deer mice (5, 1.1, 1.6, and 2.1, respectively), it should be noted that selenium was not detected in any of the soil samples collected from 0- to 5-foot depth interval (Table 6). For this reason, the exposure point concentration for selenium is based upon one-half the detection limit for this analyte. Although the potential for risk to these two receptors from exposure to selenium cannot be ruled out, the conservative estimates of that risk based upon this exposure point concentration are low. Therefore, it is considered unlikely that actual concentrations of selenium at this site are sufficient to pose a risk to ecological receptors.

The assumption of an area use factor of 1.0 is a source of uncertainty for the burrowing owl at this site. Because SWMU 45 is 0.78 acres in size and the home range of the burrowing owl is 35 acres, an area use factor of approximately 0.022 would be justified for this receptor. This is sufficient to reduce the burrowing owl HQ for organic mercury from 31 to 0.69 and for bis(2-ethylhexyl) phthalate from 1.1 to 0.025.

It should further be noted that for the deer mouse and burrowing owl, HQs for mercury only exceed unity when based upon the highly conservative assumption that all mercury at this site is in organic form. Because the exposure point concentration (2.19 mg/kg) is measured as total mercury, this likely represents a mixture of both organic and inorganic forms of mercury, probably dominated by mercury in inorganic form. When the mercury at the site is assumed to be in inorganic form, the HQs for the deer mouse and burrowing owl are 0.025 and 0.44, respectively, indicating no risk to these receptors.

A further source of uncertainty associated with the prediction of ecological risks at this site is the use of the maximum measured concentrations to evaluate exposure and risk. This results in a conservative exposure scenario that does not necessarily reflect actual site conditions. To evaluate the potential effect on risk predictions by the use of the maximum concentrations as exposure point concentrations, UCLs of the mean or mean soil concentrations (Appendix 2) were calculated for antimony (mean 7.2 mg/kg), arsenic (UCL 9.9 mg/kg), barium (UCL 199 mg/kg), and lead (mean 71.2 mg/kg). When the 95% UCL concentration exceeds the maximum on-site concentration for a given COPEC, the mean concentration is used for this uncertainty discussion. The UCL concentration for barium is less than its background screening level (200 mg/kg), indicating that average barium exposures to both plants and the deer mouse at this site are within background levels. The UCL concentrations for lead reduce the HQs for exposures to plants to 11, indicating low average risk to this receptor. Using the UCL concentrations for barium and lead reduces all of the deer mouse HQs to levels below 10, with the exception of arsenic (11), indicating low average risk to this receptor from these COPECs.

Based upon this uncertainty analysis, the potential for ecological risks at SWMU 45 is expected to be low. HQs greater than unity were predicted; however, closer examination of the exposure assumptions reveals an overestimation of risk primarily attributed to conservative toxicity benchmarks; the use of maximum concentrations, maximum bioavailability, and maximum area use to estimate exposure; and the contribution of background risk.

VII.3.6 Risk Interpretation

Ecological risks associated with SWMU 45 are estimated through a risk assessment that incorporates site-specific information when available. Initial predictions of potential risk to plants from exposure to several metals were based upon maximum measured soil concentrations, highly conservative plant toxicity benchmarks, and assumptions of high bioavailability. Actual risk to this receptor is expected to be low based upon more realistic exposure assumptions. Predictions of potential risk to the deer mouse from exposures to antimony, arsenic, barium, mercury, and selenium can also be attributed to conservative exposure assumptions. For the burrowing owl, the initial prediction of risk from exposure to mercury and bis(2-ethylhexyl) phthalate result from the assumption of 100-percent area use by this receptor. A more realistic assumption of area use for this receptor results in HQs of only 0.69 and 0.025, respectively. The very small size of this site (0.78 acres) also limits the potential for significant risk to ecological receptors, particularly at the population or community levels. Based upon this final analysis, the potential for ecological risks associated with SWMU 45 is expected to be low.

VII.3.7 Risk 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 more thoroughly assess actual ecological risk at the site. 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) uses a default set of exposure routes and associated default parameter values 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 are invoked for risk assessments unless site-specific information suggests other parameter values. Because many SNL/NM solid waste management units (SWMUs) 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 facilitates the risk assessments and subsequent review.

The default exposure routes and parameter values used 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 will use these default exposure routes and parameter values in future risk assessments.

At SNL/NM, all SWMUs exist within the boundaries of the Kirtland Air Force Base. Approximately 240 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 and the biological resources present. When evaluating potential human health risk the current or reasonably foreseeable land use negotiated and approved for the specific SWMU/AOC, aggregate, or watershed will be used. The following references generally document these land uses: *Workbook: Future Use Management Area 2 (DOE et al. September 1995); Workbook: Future Use Management Area 1 (DOE et al. October 1995); Workbook: Future Use Management Areas 3, 4, 5, and 6 (DOE and USAF January 1996); Workbook: Future Use Management Area 7 (DOE and USAF March 1996)*. 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. Therefore, 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 1989) 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, there is currently no consumption of fish, shellfish, fruits, vegetables, meat, eggs, or dairy products that originate on site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

For the industrial and recreational land-use scenarios, SNL/NM ER has, therefore, excluded the following five 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
- Dermal contact with chemicals in water

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

Based upon this evaluation, for future risk assessments the exposure routes that will be considered are shown in Table 1.

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 (nonradiological constituents only) soil only	Dermal contact (nonradiological constituents only) soil only	Dermal contact (nonradiological constituents only) soil only
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	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 may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land-use scenarios. The general equation for calculating potential intakes via these routes is shown below. The equations are taken from "Assessing Human Health Risks Posed by Chemicals: Screening-Level Risk Assessment" (NMED March 2000) and "Technical Background Document for Development of Soil Screening Levels" (NMED December 2000). Equations from both documents are based upon the "Risk Assessment Guidance for Superfund" (RAGS): Volume 1 (EPA 1989, 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). RESRAD is the only code designated by the U.S. Department of Energy (DOE) in DOE Order 5400.5 for the evaluation of radioactively contaminated sites (DOE 1993). The Nuclear Regulatory Commission (NRC) has approved the use of RESRAD for dose evaluation by licensees involved in decommissioning, NRC staff evaluation of waste disposal requests, and dose evaluation of sites being reviewed by NRC staff. EPA Science Advisory Board reviewed the RESRAD model. EPA used RESRAD in their rulemaking on radiation site cleanup regulations. RESRAD code has been verified, undergone several benchmarking analyses, and been included in the International Atomic Energy Agency's VAMP and BIOMOVS II projects to compare environmental transport models.

Also shown are the default values SNL/NM ER will use in RME risk assessment calculations for industrial, recreational, and residential land-use 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) or by directly accessing the RESRAD websites at: http://web.ead.anl.gov/resrad/home2/ or http://web.ead.anl.gov/resrad/documents/.

Generic Equation for Calculation of Risk Parameter Values

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

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

= C x (CR x EFD/BW/AT) x Toxicity Effect (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.

For nonradiological constituents of concern (COCs), 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. For radionuclides, the calculated radiation exposure, expressed as TEDE is compared directly to the exposure guidelines of 15 millirem per year (mrem/year) for industrial and recreational future use and 75 mrem/year for the unlikely event that institutional control of the site is lost and the site is used for residential purposes (EPA 1997).

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk of 1E-5 for nonradiological 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 from radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site. This estimated dose is used to calculate an assumed risk. However, this calculated risk is presented for illustration purposes only, not to determine compliance with regulations.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA 1989) and are outlined below. The RESRAD Manual (ANL 1993) describes similar equations for the calculation of radiological exposures.

Soil Ingestion

A receptor can ingest soil or dust directly by working in the contaminated soil. Indirect ingestion can occur from sources such as unwashed hands introducing contaminated soil to food that is then eaten. An estimate of intake from ingesting soil will be calculated as follows:

$$I_s = \frac{C_s * IR * CF * EF * ED}{BW * AT}$$

where:

I_s = Intake of contaminant from soil ingestion (milligrams [mg]/kilogram [kg]-day)
C_s = Chemical concentration in soil (mg/kg)
IR = Ingestion rate (mg soil/day)
CF = Conversion factor (1E-6 kg/mg)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged) (days)

It should be noted that it is conservatively assumed that the receptor only ingests soil from the contaminated source.

Soil Inhalation

A receptor can inhale soil or dust directly by working in the contaminated soil. An estimate of intake from inhaling soil will be calculated as follows (EPA August 1997):

$$I_s = \frac{C_s * IR * EF * ED * \left(\frac{1}{VF} or \frac{1}{PEF}\right)}{BW * AT}$$

where:

I_s = Intake of contaminant from soil inhalation (mg/kg-day)
C_s = Chemical concentration in soil (mg/kg)
IR = Inhalation rate (cubic meters [m^3]/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
VF = soil-to-air volatilization factor (m^3/kg)
PEF = particulate emission factor (m^3/kg)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged) (days)

Soil Dermal Contact

$$D_a = \frac{C_s * CF * SA * AF * ABS * EF * ED}{BW * AT}$$

where:

D_a = Absorbed dose (mg/kg-day)
C_s = Chemical concentration in soil (mg/kg)
CF = Conversion factor (1E-6 kg/mg)
SA = Skin surface area available for contact (cm^2/event)
AF = Soil to skin adherence factor (mg/cm^2)
ABS = Absorption factor (unitless)
EF = Exposure frequency (events/year)

ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged) (days)

Groundwater Ingestion

A receptor can ingest water by drinking it or through using household water for cooking. An estimate of intake from ingesting water will be calculated as follows (EPA August 1997):

$$I_w = \frac{C_w * IR * EF * ED}{BW * AT}$$

where:

I_w = Intake of contaminant from water ingestion (mg/kg/day)
C_w = Chemical concentration in water (mg/liter [L])
IR = Ingestion rate (L/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged) (days)

Groundwater Inhalation

The amount of a constituent taken into the body via exposure to volatilization from showering or other household water uses will be evaluated using the concentration of the constituent in the water source (EPA 1991 and 1992). An estimate of intake from volatile inhalation from groundwater will be calculated as follows (EPA 1991):

$$I_w = \frac{C_w * K * IR_i * EF * ED}{BW * AT}$$

where:

I_w = Intake of volatile in water from inhalation (mg/kg/day)
C_w = Chemical concentration in water (mg/L)
K = volatilization factor (0.5 L/m^3)
IR_i = Inhalation rate (m^3/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged—days)

For volatile compounds, volatilization from groundwater can be an important exposure pathway from showering and other household uses of groundwater. This exposure pathway will only be evaluated for organic chemicals with a Henry's Law constant greater than $1x10^{-5}$ and with a molecular weight of 200 grams/mole or less (EPA 1991).

Tables 2 and 3 show the default parameter values suggested for use by SNL/NM at SWMUs, based upon the selected land-use scenarios for nonradiological and radiological COCs, respectively. References are given at the end of the table indicating the source for the chosen parameter values. SNL/NM uses default values that are consistent with both regulatory guidance and 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 will use the described default exposure routes and parameter values 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 NMED has requested this scenario to be considered to provide perspective of the risk under the more restrictive land-use scenario. 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. 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 Nonradiological Exposure Parameter Values for Various Land-Use scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure Frequency (day/yr)	250[a,b]	8.7 (4 hr/wk for 52 wk/yr)[a,b]	350[a,b]
Exposure Duration (yr)	25[a,b,c]	30[a,b,c]	30[a,b,c]
Body Weight (kg)	70[a,b,c]	70 Adult[a,b,c] 15 Child[a,b,c]	70 Adult[a,b,c] 15 Child[a,b,c]
Averaging Time (days) for Carcinogenic Compounds (= 70 yr x 365 day/yr) for Noncarcinogenic Compounds (= ED x 365 day/yr)	25,550[a,b] 9,125[a,b]	25,550[a,b] 10,950[a,b]	25,550[a,b] 10,950[a,b]
Soil Ingestion Pathway			
Ingestion Rate (mg/day)	100[a,b]	200 Child[a,b] 100 Adult[a,b]	200 Child[a,b] 100 Adult[a,b]
Inhalation Pathway			
Inhalation Rate (m^3/day)	20[a,b]	15 Child[a] 30 Adult[a]	10 Child[a] 20 Adult[a]
Volatilization Factor (m^3/kg)	Chemical Specific	Chemical Specific	Chemical Specific
Particulate Emission Factor (m^3/kg)	1.36E9[a]	1.36E9[a]	1.36E9[a]
Water Ingestion Pathway			
Ingestion Rate (liter/day)	2.4[a]	2.4[a]	2.4[a]
Dermal Pathway			
Skin Adherence Factor (mg/cm^2)	0.2[a]	0.2 Child[a] 0.07 Adult[a]	0.2 Child[a] 0.07 Adult[a]
Exposed Surface Area for Soil/Dust (cm^2/day)	3,300[a]	2,800 Child[a] 5,700 Adult[a]	2,800 Child[a] 5,700 Adult[a]
Skin Adsorption Factor	Chemical Specific	Chemical Specific	Chemical Specific

[a]Technical Background Document for Development of Soil Screening Levels (NMED 2000).
[b]Risk Assessment Guidance for Superfund, Vol. 1, Part B (EPA 1991).
[c]Exposure Factors Handbook (EPA August 1997).
ED = Exposure duration.
EPA = U.S. Environmental Protection Agency.
hr = Hour(s).
kg = Kilogram(s).
m = Meter(s).
mg = Milligram(s).
NA = Not available.
wk = Week(s).
yr = Year(s).

Table 3
Default Radiological Exposure Parameter Values for Various Land-Use scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure Frequency	8 hr/day for 250 day/yr	4 hr/wk for 52 wk/yr	365 day/yr
Exposure Duration (yr)	25[a,b]	30[a,b]	30[a,b]
Body Weight (kg)	70 Adult[a,b]	70 Adult[a,b]	70 Adult[a,b]
Soil Ingestion Pathway			
Ingestion Rate	100 mg/day[c]	100 mg/day[c]	100 mg/day[c]
Averaging Time (days) (= 30 yr x 365 day/yr)	10,950[d]	10,950[d]	10,950[d]
Inhalation Pathway			
Inhalation Rate (m^3/yr)	7,300[d,e]	10,950[e]	7,300[d,e]
Mass Loading for Inhalation g/m^3	1.36 E-5[d]	1.36 E-5[d]	1.36 E-5[d]
Food Ingestion Pathway			
Ingestion Rate, Leafy Vegetables (kg/yr)	NA	NA	16.5[c]
Ingestion Rate, Fruits, Non-Leafy Vegetables & Grain (kg/yr)	NA	NA	101.8[b]
Fraction Ingested	NA	NA	0.25[b,d]

[a]Risk Assessment Guidance for Superfund, Vol. 1, Part B (EPA 1991).
[b]Exposure Factors Handbook (EPA August 1997).
[c]EPA Region VI guidance (EPA 1996).
[d]For radionuclides, RESRAD (ANL 1993).
[e]SNL/NM (February 1998).
EPA = U.S. Environmental Protection Agency.
g = Gram(s)
hr = Hour(s).
kg = Kilogram(s).
m = Meter(s).
mg = Milligram(s).
NA = Not applicable.
wk = Week(s).
yr = Year(s).

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APPENDIX 2
CALCULATION OF THE UPPER CONFIDENCE LIMITS OF MEAN CONCENTRATIONS

For conservatism, Sandia National Laboratories/New Mexico uses the maximum concentration of the constituents of concern (COCs) for initial risk calculation. If the maximum concentrations produce risk above New Mexico Environment Department (NMED) guidelines, conservatism with this approach is evaluated and, if appropriate, a more realistic approach is applied. When the site has been adequately characterized, an estimate of the mean concentration of the COCs is more representative of actual site conditions. The NMED has proposed the use of the 95% upper confidence limit (UCL) of the mean to represent average concentrations at a site (NMED December 2000). The 95, 97.5, or 99% UCL is calculated according to NMED guidance (Tharp June 2002) using the U.S. Environmental Protection Agency ProUCL program (EPA April 2002). Attached are the outputs from that program and the calculated UCLs used in the risk analysis.

References

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ATTACHMENT

SWMU 45 Human Health	
Summary Statistics for	Antimony
Number of Samples	9
Minimum	1.75
Maximum	17
Mean	5.35
Median	1.75
Standard Deviation	5.265097
Variance	27.72125
Coefficient of Variation	0.98413
Skewness	1.574664
Shapiro-Wilk Test Statisitic	0.781906
Shapiro-Wilk 5% Critical Value	0.829
Data not Lognormal at 5% Significance Level	
Data not Normal: Try Non-parametric UCL	
99 % UCL (Assuming Normal Data)	
Student's-t	10.43338
99 % UCL (Adjusted for Skewness)	
Adjusted-CLT	11.24815
Modified-t	10.58691
99 % Non-parametric UCL	
CLT	9.432816
Jackknife	10.43338
Standard Bootstrap	9.238893
Bootstrap-t	17.99068
Chebyshev (Mean, Std)	22.81235

SWMU 45 Human Health

Summary Statistics for	Arsenic
Number of Samples	16
Minimum	1.4
Maximum	11
Mean	5.43125
Median	4.55
Standard Deviation	3.304486
Variance	10.91963
Coefficient of Variation	0.608421
Skewness	0.333338
99 % UCL (Assuming Normal Data)	
Student's-t	7.581215
99 % UCL (Adjusted for Skewness)	
Adjusted-CLT	7.488763
Modified-t	7.592689
99 % Non-parametric UCL	
CLT	7.353096
Jackknife	7.581215
Standard Bootstrap	7.305887
Bootstrap-t	7.908526
Chebyshev (Mean, Std)	13.65105

Summary Statistics for	ln(Arsenic)
Minimum	0.336472
Maximum	2.397895
Mean	1.480961
Standard Deviation	0.709823
Variance	0.503848
Shapiro-Wilk Test Statisitic	0.912083
Shapiro-Wilk 5% Critical Value	0.887
Data are Lognormal at 5% Significance Level	
Estimates Assuming Lognormal Distribution	
MLE Mean	5.656949
MLE Standard Deviation	4.578561
MLE Coefficient of Variation	0.809369
MLE Skewness	2.958308
MLE Median	4.397167
MLE 80% Quantile	8.010561
MLE 90% Quantile	10.94719
MLE 95% Quantile	14.13451
MLE 99% Quantile	22.91997
MVU Estimate of Median	4.328412
MVU Estimate of Mean	5.550914
MVU Estimate of Std. Dev.	4.212364
MVU Estimate of SE of Mean	1.042589
UCL Assuming Lognormal Distribution	
Confidence Level not supported for H-Statistic	
99% Chebyshev (MVUE) UCL	15.92454
99% Chebyshev (MVUE) UCL	15.92454

SWMU 45 Human Health	
Summary Statistics for	Lead
Number of Samples	16
Minimum	3.39
Maximum	740
Mean	58.77438
Median	8.5
Standard Deviation	182.2528
Variance	33216.08
Coefficient of Variation	3.100889
Skewness	3.956817
Shapiro-Wilk Test Statisitic	0.765007
Shapiro-Wilk 5% *Critical Value*	0.887
Data not Lognormal at 5% Significance Level	
Data not Normal: Try Non-parametric UCL	
95 % UCL (Assuming Normal Data)	
Student's-t	138.6489
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	181.8785
Modified-t	146.1608
95 % Non-parametric UCL	
CLT	133.7192
Jackknife	138.6489
Standard Bootstrap	130.9726
Bootstrap-t	1214.217
Chebyshev (Mean, Std)	257.3798

SWMU 45 Ecological

Summary Statistics for	Antimony
Number of Samples	6
Minimum	1.75
Maximum	17
Mean	7.15
Median	6.4
Standard Deviation	5.717517
Variance	32.69
Coefficient of Variation	0.799653
Skewness	1.047161
95 % UCL (Assuming Normal Data)	
Student's-t	11.85346
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	12.05559
Modified-t	12.01977
95 % Non-parametric UCL	
CLT	10.98936
Jackknife	11.85346
Standard Bootstrap	10.53713
Bootstrap-t	14.44985
Chebyshev (Mean, Std)	17.3244

Summary Statistics for	ln(Antimony)
Minimum	0.559616
Maximum	2.833213
Mean	1.652461
Standard Deviation	0.922652
Variance	0.851286
Shapiro-Wilk Test Statisitic	0.901611
Shapiro-Wilk 5% Critical Value	0.788
Data are Lognormal at 5% Significance Level	
Estimates Assuming Lognormal Distribution	
MLE Mean	7.989311
MLE Standard Deviation	9.257462
MLE Coefficient of Variation	1.158731
MLE Skewness	5.031972
MLE Median	5.219813
MLE 80% Quantile	11.38278
MLE 90% Quantile	17.08274
MLE 95% Quantile	23.8128
MLE 99% Quantile	44.63638
MVU Estimate of Median	4.858776
MVU Estimate of Mean	7.321882
MVU Estimate of Std. Dev.	6.735867
MVU Estimate of SE of Mean	2.723006
UCL Assuming Lognormal Distribution	
95% H-UCL	42.10064
95% Chebyshev (MVUE) UCL	19.19119
99% Chebyshev (MVUE) UCL	34.41545
Recommended UCL to use:	
H-UCL	

SWMU 45 Ecological

Summary Statistics for	Arsenic
Number of Samples	13
Minimum	1.6
Maximum	11
Mean	6.230769
Median	6
Standard Deviation	3.147323
Variance	9.905641
Coefficient of Variation	0.505126
Skewness	-0.00882
95 % UCL (Assuming Normal Data)	
Student's-t	7.786546
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	7.664298
Modified-t	7.786191
95 % Non-parametric UCL	
CLT	7.666579
Jackknife	7.786546
Standard Bootstrap	7.607515
Bootstrap-t	7.829858
Chebyshev (Mean, Std)	10.0357

Summary Statistics for	ln(Arsenic)
Minimum	0.470004
Maximum	2.397895
Mean	1.673035
Standard Deviation	0.634348
Variance	0.402397
Shapiro-Wilk Test Statisitic	0.884192
Shapiro-Wilk 5% Critical Value	0.866
Data are Lognormal at 5% Significance Leve	
Estimates Assuming Lognormal Distribution	
MLE Mean	6.515825
MLE Standard Deviation	4.586165
MLE Coefficient of Variation	0.70385
MLE Skewness	2.460242
MLE Median	5.328316
MLE 80% Quantile	9.107144
MLE 90% Quantile	12.03925
MLE 95% Quantile	15.12785
MLE 99% Quantile	23.30175
MVU Estimate of Median	5.246396
MVU Estimate of Mean	6.40044
MVU Estimate of Std. Dev.	4.244758
MVU Estimate of SE of Mean	1.170485
UCL Assuming Lognormal Distribution	
95% H-UCL	9.904233
95% Chebyshev (MVUE) UCL	11.50247
99% Chebyshev (MVUE) UCL	18.04662
Recommended UCL to use:	
H-UCL	

SWMU 45 Ecological

Summary Statistics for	Barium
Number of Samples	13
Minimum	73
Maximum	280
Mean	157
Median	130
Standard Deviation	63.15061
Variance	3988
Coefficient of Variation	0.402233
Skewness	0.703212
95 % UCL (Assuming Normal Data)	
Student's-t	188.2165
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	189.4594
Modified-t	188.7858
95 % Non-parametric UCL	
CLT	185.8093
Jackknife	188.2165
Standard Bootstrap	185.2403
Bootstrap-t	192.6424
Chebyshev (Mean, Std)	233.3454

Summary Statistics for	ln(Barium)
Minimum	4.290459
Maximum	5.63479
Mean	4.983501
Standard Deviation	0.396227
Variance	0.156996
Shapiro-Wilk Test Statisitic	0.948842
Shapiro-Wilk 5% Critical Value	0.866
Data are Lognormal at 5% Significance Leve	
Estimates Assuming Lognormal Distribution	
MLE Mean	157.9059
MLE Standard Deviation	65.10446
MLE Coefficient of Variation	0.412299
MLE Skewness	1.306985
MLE Median	145.9846
MLE 80% Quantile	204.0393
MLE 90% Quantile	242.9007
MLE 95% Quantile	280.1414
MLE 99% Quantile	366.913
MVU Estimate of Median	145.1054
MVU Estimate of Mean	156.8971
MVU Estimate of Std. Dev.	63.28357
MVU Estimate of SE of Mean	17.53473
UCL Assuming Lognormal Distribution	
95% H-UCL	198.5587
95% Chebyshev (MVUE) UCL	233.3292
99% Chebyshev (MVUE) UCL	331.3655
Recommended UCL to use:	
Student's-t or H-UCL	

SWMU 45 Ecological	
Summary Statistics for	Lead
Number of Samples	13
Minimum	3.39
Maximum	740
Mean	71.20692
Median	9.3
Standard Deviation	201.5613
Variance	40626.96
Coefficient of Variation	2.830642
Skewness	3.567735
Shapiro-Wilk Test Statisitic	0.807852
Shapiro-Wilk 5% Critical Value	0.866
Data not Lognormal at 5% Significance Level	
Data not Normal: Try Non-parametric UCL	
99 % UCL (Assuming Normal Data)	
Student's-t	221.0829
99 % UCL (Adjusted for Skewness)	
Adjusted-CLT	310.2657
Modified-t	230.3023
99 % Non-parametric UCL	
CLT	201.2569
Jackknife	221.0829
Standard Bootstrap	194.5418
Bootstrap-t	2097.728
Chebyshev (Mean, Std)	827.4352

Attachment F

ATTACHMENT F
Site Conceptual Model for SWMU 45

SOLID WASTE MANAGEMENT UNIT 45
SITE CONCEPTUAL MODEL

Solid Waste Management Unit (SWMU) 45 covers 0.78 acres along the northern rim of Tijeras Arroyo near the northeast corner of Technical Area (TA)-IV and the southern apex of TA-II. A single discharge of water led to the identification of SWMU 45 in the Comprehensive Environmental Assessment and Response Program (DOE 1987). In February of 1985, a Sandia National Laboratories/New Mexico (SNL/NM) employee observed that a tank truck was discharging about 500 to 1,000 gallons of brownish water onto the ground surface east of TA-IV (confidential interview, 1993). The employee asked the truck driver what he was doing; he replied "discharging water." The tank truck did not have SNL/NM or military markings. The location of the discharge appeared wet from February 12 through February 15, 1985.

In the mid-1990s, portions of the confidential interviews associated with the identification of SWMU 45 apparently had been filed improperly at the Environmental Safety and Health and Security Records Center and unfortunately were not available when the SWMU 45 proposal for no further action (SNL/NM September 1997) was submitted to the New Mexico Environment Department. The portions of the interviews related to SWMU 45 were discovered in the fall of 2003. By integrating the new interview information with historical aerial photographs and findings from the Environmental Restoration (ER) SWMUs 227/229 Notice of Deficiency response (SNL/NM July 2003), the previously undisclosed water discharge location can now be identified and reported for the first time.

By correlating the comments from SNL/NM employees with an ER staff member's field sketch, a strong inference was made that the "brownish water discharge" occurred at a ditch located within 50 feet of the manhole. The only ditch located within a 50-foot radius of the manhole is the ER SWMU 229 outfall ditch.

A trench, known as the Area A Pit, was identified using historical aerial photographs. A review of various aerial photographs contained in the report by Ebert & Associates, Inc. (November 1994) indicated that a total of four trenches existed around the perimeter of TA-II: one at the southern apex (i.e., the Area A Pit), two at the eastern apex, and one at the northern apex. The trenches are believed to have been used for security purposes as "hull down defilade firing positions" for Army tanks with unobstructed views of TA-II and the surrounding area.

Operational History

The Tijeras Arroyo Operable Unit manages SWMU 45. Other Operable Units also have provided relevant information for the site. Two sources of information not previously available have been compiled. First, interview notes were used to identify the water discharge location as the nearby SWMU 229 outfall ditch. Second, a recent review of historical aerial photographs has identified the likely purpose of the Area A Pit as a "hull down defilade firing positions" for Army tanks with unobstructed views of TA-II and the surrounding area. No other activity has occurred at the site.

Constituents of Concern

Process knowledge indicates that the potential constituents of concern for SWMU 45 consist of:

- Volatile organic compounds (VOCs)
- Semivolatile organic compounds (SVOCs)
- Metals

Confirmatory Sampling

Between 1994 and 2004, three confirmatory sampling events provided the analytical data relevant to SWMU 45. Confirmatory soil samples were collected from three sub areas within SWMU 45:

- Liquid Discharge Area
- Area A Pit (buried trench)
- Magnetic Anomaly Trenches

The first event was conducted as part of the 1995 SWMU 45 Confirmatory Sampling in which samples were collected from all three sub areas. The second event was the SWMU 229 Confirmatory Sampling, which was conducted in 1994 and 2001. Five of the SWMU 229 sample locations are relevant to SWMU 45 because these sample locations are situated on the eastern end of SWMU 45 where the liquid discharge occurred. The SWMU 229 sample locations therefore serve to characterize the liquid discharge at SWMU 45. The third event was the 2004 SWMU 45 Geoprobe™ investigation in which soil samples were collected from within the Area A Pit.

Highlights of the SWMU 45 analytical results for the three sampling events include:

- Six metals (antimony, arsenic, barium, cadmium, lead, and mercury) were detected at levels above background concentrations. A seventh metal (selenium) was not detected; however, in the Risk Assessment Report (Attachment E), it was reported as a concentration that is one-half the detection limit, which is above the background concentration for selenium.

- No radionuclides were detected at levels above background activities but several minimum detectable activity values were above background levels.

- Low concentrations of three VOCs (acetone, 2-butanone, and methylene chloride) were detected.

- Low concentrations of nine SVOCs were detected.

Physical Setting

SWMU 45 is located on land that the U.S. Department of Energy leases from Kirtland Air Force Base (KAFB). The topography is nearly flat, with an elevation of approximately 5,400 feet above mean sea level. The site is not fenced. The western half of SWMU 45, inside the TA-IV fence, is paved; the eastern half of SWMU 45, outside the TA-IV fence, is not paved and is infrequently visited.

The annual precipitation at KAFB is 8.1 inches (NOAA 1990). No springs or perennial surface-water bodies are located within 2 miles of SWMU 45. The site is situated approximately 1,600 feet northwest of the active channel of Tijeras Arroyo and outside of the 100-year floodplain. Tijeras Arroyo is the most significant storm-water drainage feature on KAFB and originates in Tijeras Canyon, which is bounded by the Sandia Mountains to the north and the Manzano Mountains to the south. The arroyo contains a drainage basin that captures runoff from Tijeras Canyon and various storm-water channels at KAFB, SNL/NM, and southeast Albuquerque. The arroyo eventually drains into the Rio Grande, approximately 8 miles west of SWMU 45.

The soil at SWMU 45 is poorly developed with high alkalinity. The subsurface geology consists of unconsolidated alluvial and colluvial deposits derived from the Sandia and Manzanita Mountains. These upper Santa Fe Group deposits consist of sediment ranging from clay to gravel derived from the granitic rocks of the Sandia Mountains, and greenstone, limestone, and quartzite derived from the Manzanita Mountains. The depth to Pennsylvanian strata and/or Precambrian basement beneath TA-IV is approximately 3,000 feet below ground surface (bgs).

Groundwater data for SWMU 45 was obtained from the Tijeras Arroyo Groundwater (TAG) Investigation. The hydrogeologic setting of the TAG study area is dominated by two water-bearing zones, the perched system and the regional aquifer, both of which are present within the upper Santa Fe Group. The perched system is not used as a water supply source. However, the City of Albuquerque, KAFB, and the Veterans Administration use the regional aquifer for a water supply.

At SWMU 45, the depth to the perched system is approximately 300 feet bgs. However, the site extends across the southwestern boundary of the perched system, which covers approximately 3.5 square miles in the central part of the TAG study area. The direction of groundwater flow in the perched system is to the southeast. Discontinuous, yet overlapping multiple lenses of unsaturated alluvial fan sediment serve as a perching horizon beneath the perched system and above the regional aquifer. The depth to the regional aquifer is approximately 500 feet bgs. The direction of groundwater flow in the regional aquifer is principally to the northwest towards several water supply wells. The nearest water supply well (KAFB-1) is located approximately 1.5 miles northwest of the site. Groundwater from the perched system merges with the regional aquifer southeast of Tijeras Arroyo. The regional aquifer extends across the entire TAG study area and the Albuquerque Basin.

The area surrounding SWMU 45 originally consisted of desert grassland habitat, but this has been highly disturbed by various construction activities (IT 1995). The site is mostly barren but has some limited vegetation consisting of ruderal species, such as Russian thistle (tumbleweed). Grasslands are the dominant plant community west of SWMU 45 and include species such as blue and black grama and western cheatgrass (IT 1995). The indigenous wildlife includes reptiles, birds, and small mammals. However, wildlife use is limited by the degree of disturbance and proximity to operational facilities. The site was surveyed for sensitive species in 1994 (IT 1995); no threatened or endangered species, nor any other species of concern, were identified in the vicinity of SWMU 45. No riparian or wetland habitats are present within 4 miles of the site. No significant archaeological artifacts or cultural resources have been identified in the vicinity of SWMU 45 (Hoagland September 1994).

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