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

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LIQUID DISCHARGE
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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.

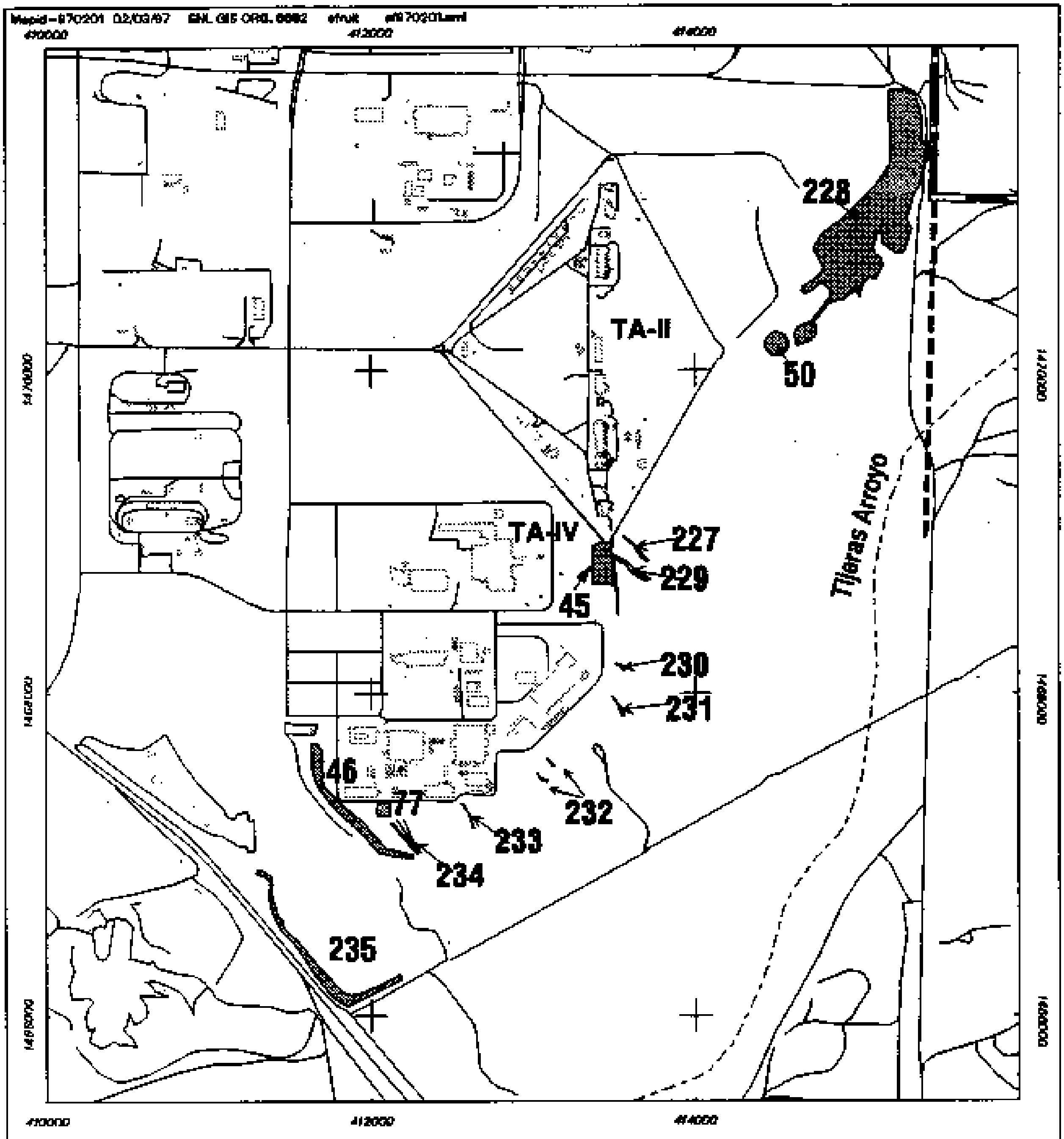
1.1 Description of ER Site 45

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

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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

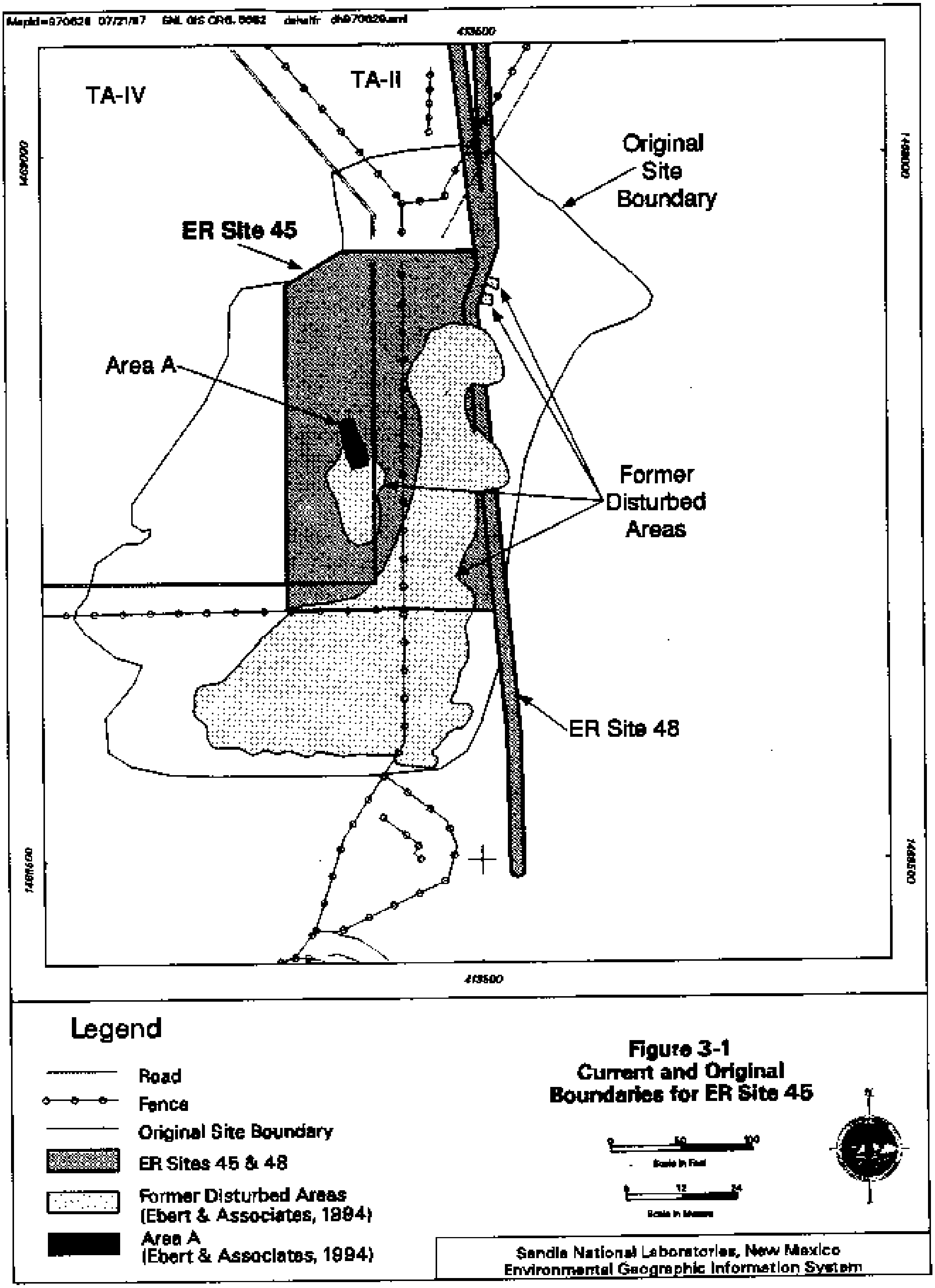


Figure 3-1
Current and Original Boundaries for ER Site 45

- 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 depth 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,

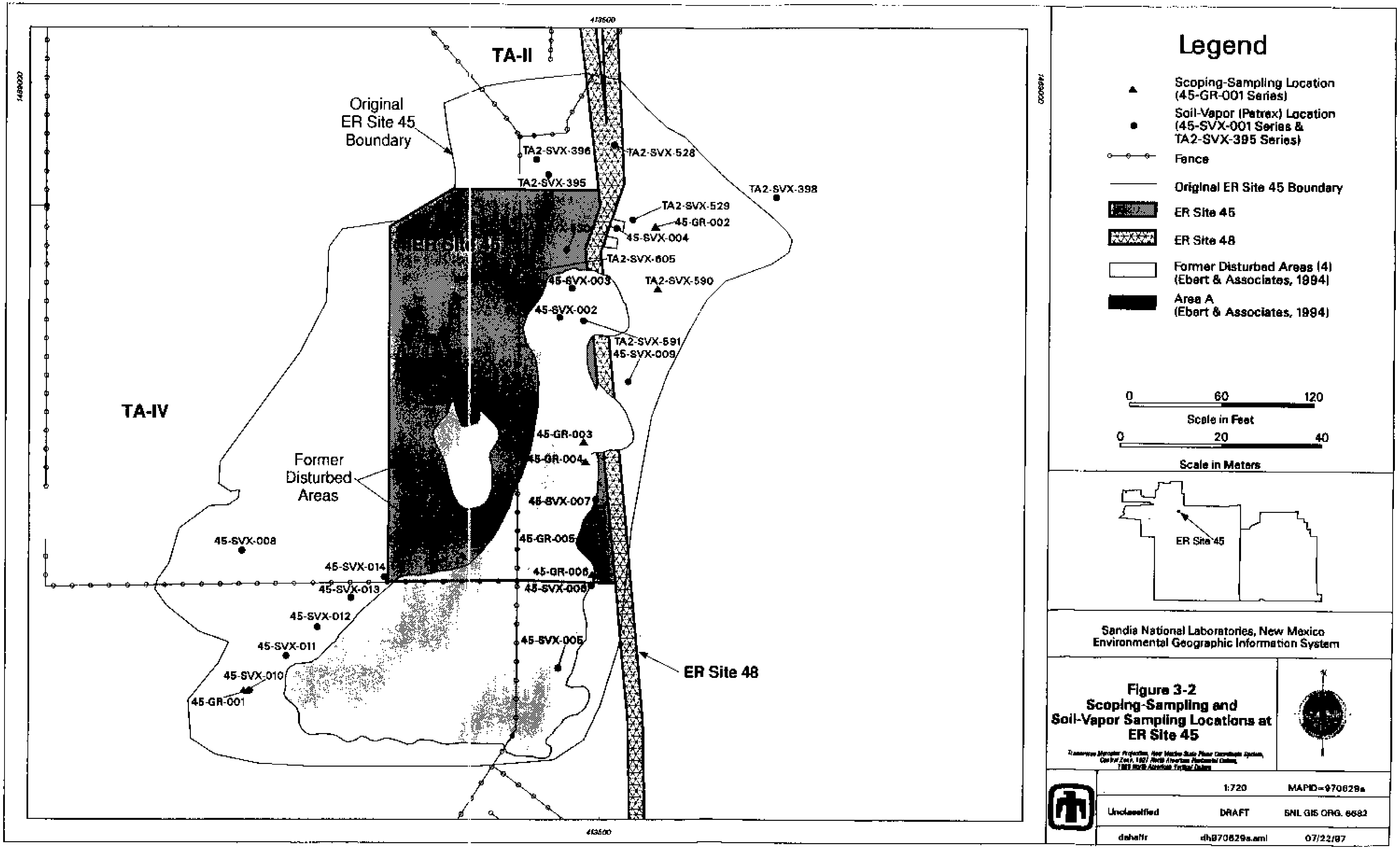


Figure 3-2
Scoping-Sampling and Soil-Vapor Sampling Locations at ER Site 45

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

Sample Number	Sample Date	Sample Depth (ft, BGL)	Concentration in Soil, mg/kg (ppm)							
			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	16 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).

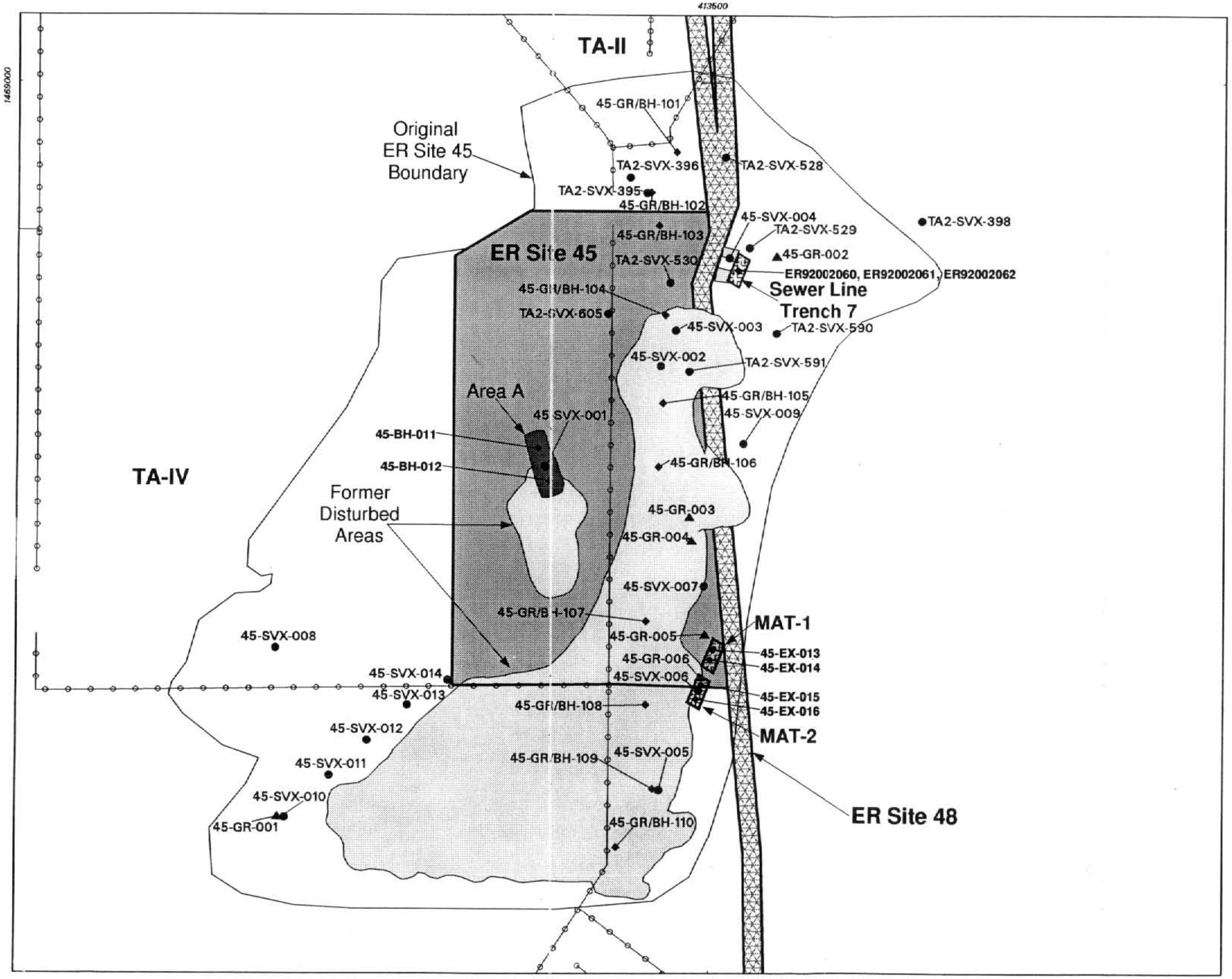
Both laboratory and field QA/QC samples were collected and analyzed to evaluate the validity of the analytical data. Section 6.2 presents a summary of the laboratory QA/QC procedures for each phase of the confirmatory sampling. The laboratory QA/QC procedures varied between the various analytical laboratories 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

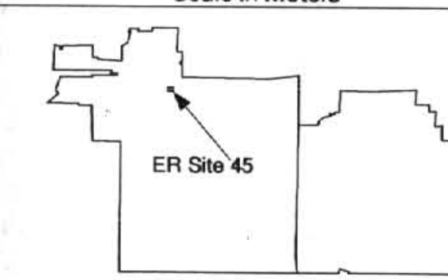


Legend

- ▲ Scoping-Sampling Location (45-GR-001 Series)
- ● Soil-Vapor (Petrex) Location (45-SVX-001 Series & TA2-SVX-395 Series)
- ◆ Confirmatory Soil Sample (ER92002060, 45-EX-013 & GR/BH-101, 45-BH-011 Series)
- Fence
- Original ER Site 45 Boundary
- Magnetic Anomaly Trench (MAT) or Sewer Line Trench
- 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 3-3
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

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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

Sample Number	ER Sample ID	Sample Date	Sample Depth (ft, BGL)	Concentration in Soil, mg/kg (ppm)							
				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

Sample Number	ER Sample ID	Sample Date	Soil Moisture (% weight)	Sample Depth (ft, BGL)	Activity in soil			
					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)	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
			Concentration in Soil, mg/kg (ppm)							
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.

			Concentration in Soil, mg/kg (ppm)							
Sample Number	Sample Date	Sample Depth (ft, BGL)	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

			Concentration in Soil, mg/kg (ppm)							
Sample Number	Sample Date	Sample Depth (ft, BGL)	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).

5.0 REFERENCES

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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^{-6} [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 <u>Toxicity Benchmarks</u>

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) for noncarcinogenic compounds (=ED x 365 d/y)	25550[a] 10950	25550[a] 10950	25550[a] 10950
Soil Ingestion Pathway			
Ingestion rate	100 mg/d[c]	6.24 g/y[d]	114 mg-y/kg-d[a]
Inhalation Pathway			
Inhalation rate (m^3/yr)	5000[a,b]	146[d]	5475[a,b,d]
Volatilization factor (m^3/kg)	chemical specific	chemical specific	chemical specific
Particulate emission factor (m^3/kg)	1.32E9[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).

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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 Duplicates: 45-BH-106-1-SD-01 45-BH-106-1-SD-02 Rinsates: 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.
Area A: 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 Soil from magnetic-anomaly trenches: 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 Area A Duplicate: 45-BH-012-4-SD02 Trench duplicates: 45-EX-013-3-SD01 45-EX-013-3-SD02 Rinsate: 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