Sandia National Laboratories/New Mexico

PROPOSAL FOR RISK-BASED NO FURTHER ACTION ENVIRONMENTAL RESTORATION SITE 70 EXPLOSIVE TEST PIT CENTRAL COYOTE TEST AREA OPERABLE UNIT 1334

September 1997

Environmental
Restoration
Project

United States Department of Energy
Albuquerque Operations Office

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ENVIRONMENTAL RESTORATION SITE 70
EXPLOSIVE TEST PIT
CENTRAL COYOTE TEST AREA
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Albuquerque, New Mexico

Prepared for
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ACRONYMS AND ABBREVIATIONS

CEARP	Comprehensive Environmental Assessment and Response Program
COC	constituents of concern
COPEC	constituents of potential ecological concern
cpm	counts per minute
DOE	U.S. Department of Energy
DOU	Document of Understanding
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
GM	Geiger-Mueller
HE	high explosives
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NaI	sodium iodide
NFA	No Further Action
NMED	New Mexico Environment Department
OB	Oversight Bureau
PETN	2,2-bis[(nitrooxyl)methyl]-1,3-propanodial
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-trazine
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SNL/NM	Sandia National Laboratories/New Mexico
SVOC	semivolatile organic compounds
TNT	2,4,6-trinitrotoluene
UXO	unexploded ordnance
VOC	volatile organic compounds

1.0 INTRODUCTION

1.1 Description of ER Site 70

ER Site 70 (Figure 1-1) is a former explosive metal-forming test facility enclosed by a 100-square-foot barbed-wire fence. The site also includes a steel and wood observation bunker located approximately 50 feet southeast of the fenced area. In the center of the fenced area, there is a 25-foot square concrete pad, a 2-foot inside diameter by 3.5-foot high cylindrical metal die resting on the concrete pad, and the explosives metal-forming test structure itself.

The explosives metal-forming test structure is an in-ground, open-top, cylindrical, concrete containment vessel measuring 10 feet in diameter and about 10 feet deep. The lower sides of the vessel were painted with asphalt water-proofing material. A steel reinforcing rod ladder rungs set into the side descends into the vessel.

The small bunker was used as a control and observation station during the explosive metal-forming tests. The top and front of the bunker are constructed of 1.5-inch thick steel armor plate, with a viewing port and camera shelf facing the fenced area. The sides of the bunker are constructed of wood.

No records have been located that indicate when this explosive metal-forming facility was constructed. ER Project interviews with current and former Sandia National Laboratories/New Mexico (SNL/NM) employees indicate the site may have been active in the 1950s (SNL/NM EORC, Refs. 70-26; 70-27), and it is estimated that between 20 and 30 firings took place at this facility until it was abandoned (Durand 1989). The site was not evident in an aerial photograph from 1951, but is present on an aerial photograph from 1971 (USGS 1951, USGS 1971). Aerial photographs indicate that the site was constructed after 1951 (USGS 1951) and was abandoned by 1971 (USGS 1971). In the early 1960s, SNL/NM personnel published a number of technical papers on the subject of explosive metal-forming (Jones [n.d.]; Butler et al. [n.d.]). A textbook description of the typical explosive metal-forming facility matches the configuration of this site (Ezra 1973).

ER Site 70 lies on land owned by the Kirtland Air Force Base (permitted to U.S. Department of Energy [DOE]). This site is located 1,000 feet east of Lovelace Road, just south of the twin water towers, near the intersection of Lovelace and Isleta Roads. The site covers 0.38 acre of land at mean elevation of 5,731 feet above sea level (SNL/NM 1994a). Current and projected land use for ER Site 70 is industrial (DOE and USAF 1996).

The geologic and hydrologic conditions at ER Site 70 are expected to be similar to those measured at the Lake Christian West well, located approximately 0.5 mile to the north. Geological information obtained from the lithologic log of the Lake Christian West well indicates that the local area is underlain by at least 72 feet of alluvial deposits, which itself overlies Precambrian or Paleozoic rocks. When the Lake Christian West well was completed, the depth to groundwater was measured at 55 feet (IT Corporation 1994a). Depth to groundwater at ER Site 70 is estimated to be 73 feet (SNL/NM 1994a).

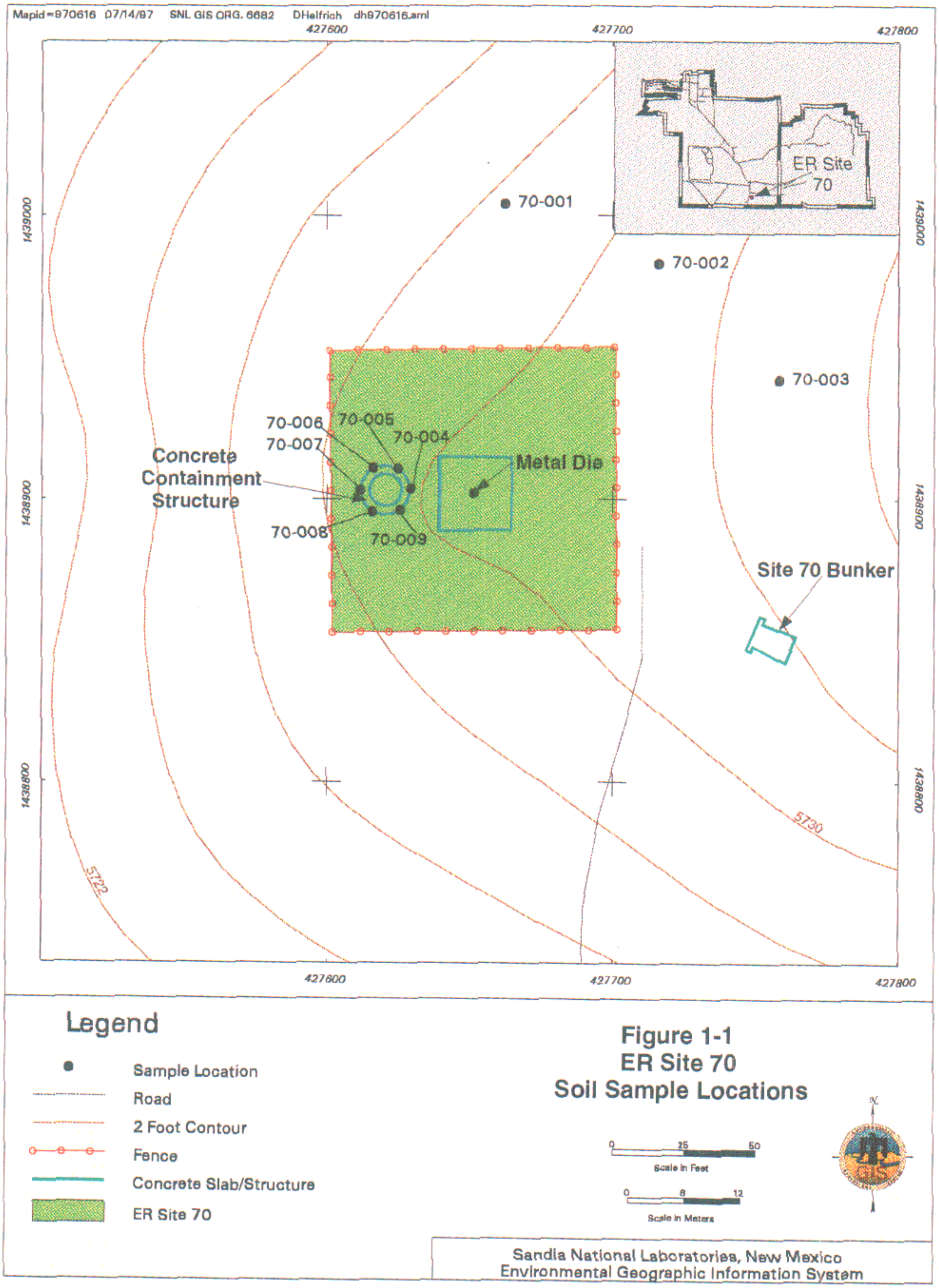

Figure 1-1
ER Site 70
Soil Sample Locations

For a detailed discussion regarding the local setting at ER Site 70, including locator maps and diagrams of the site layout, refer to the "RFI [Resource Conservation and Recovery Act (RCRA) Facility Investigation] Work Plan for OU [Operable Unit] 1334, Central Coyote Test Area" (SNL/NM 1994b).

1.2 No Further Action Basis

Review and analysis of all relevant data for ER Site 70 indicates that the concentrations of constituents of concern (COC) at this site are less than applicable risk assessment action levels. Thus, ER Site 70 is being proposed for a no further action decision (NFA) based on confirmatory sampling and residual rainwater data demonstrating that COCs that may have been released from this Solid Waste Management Unit (SWMU) into the environment pose an acceptable level of risk under current and projected future land use per Criterion 5 of the ER Document of Understanding (DOU) (NMED 1996).

2.0 HISTORY OF ER SITE 70

2.1 Historical Operations

The design of the ER Site 70 facility matches the description of a typical explosive metal-forming facility (SNL/NM 1990, Ezra 1973). A metal work piece was placed in a die assembly, a hold-down ring was put in place, a vacuum was pulled on the die cavity, and the explosive charge was placed over the center of the metal work piece. This assembly was lowered to the bottom of an in-ground, cylindrical concrete, water-filled vessel, and the explosive charge was detonated. The die and water-filled concrete structure were designed to contain the energy of the explosion during the metal-forming process, and most of the water was expelled by the explosion during the course of each test. The assembly was extracted from the containment vessel to remove the formed metal work piece (Ezra 1973).

Support facilities for this type of explosive metal-forming operation included a working area, an observation/instrument facility, and other support equipment, including air and vacuum pumps, cranes, and other heavy equipment. Air pumping equipment was used to create a bubble curtain to protect the vessel walls. A vacuum pump was used to remove air between the die and the metal work piece. The die and the metal work pieces were handled by cranes or other heavy equipment. Pumps were also used for filling and dewatering the vessel (Ezra 1973).

Typically less than 1 pound of high explosives (HE) was used per detonation (SNL/NM EORC, Ref. 70-27). Explosives used included 2,4,6-trinitrotoluene (TNT), octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), 2,2-bis[(nitrooxyl)methyl]-1,3-propanodial (PETN), and Composition 4 (SNL/NM EORC, Refs. 70-26; 70-27).

Potential COCs at the site include trace residual HE residue from the explosions; metals from the work pieces, die, and support equipment; and semivolatile organic compounds (SVOC) from lubricants and fluids used in support equipment such as pumps. Metals and HE could potentially remain in the test structure after testing, and SVOCs from pumps and equipment could potentially be present outside the test structure. Rainwater would have washed metals and HE residue to the bottom of the test structure, where it would accumulate in residual rainwater. Metals and HE may also have been ejected from the test structure to the surrounding surface soils during a test. Water containing COCs could have migrated into subsurface soils beneath the test facility.

There is no visual evidence at ER Site 70 indicating that the site released hazardous waste or constituents into the environment, although vermiculite is present on the ground around the facility. About 6 inches of residual rainwater was present in the containment structure when sampling took place in December 1994 and April 1995. The concrete containment structure is not cracked, and the residual rainwater has since evaporated.

2.2 Previous Audits, Inspections, and Findings

ER Site 70 was identified during investigations conducted under the Comprehensive Environmental Assessment and Response Program (CEARP) (DOE 1987) and the RCRA Facility Assessment (RFA) (EPA 1987). The CEARP determined that there was not enough information to calculate a hazard ranking score for the site.

3.0 EVALUATION OF RELEVANT EVIDENCE

The following are discussions of the evidence presented in support of a decision of NFA for ER Site 70.

3.1 Unit Characteristics and Operating Practices

The concrete containment structure was cleaned out and backfilled with engineered fill in May 1997. There have not been any other changes to the site.

3.2 Results of SNL/NM ER Project Sampling/Surveys

3.2.1 Summary of Prior Investigations

The following information, presented in chronological order, was used to evaluate ER Site 70:

- Reports of historical site operations and results of explosive metal forming tests performed at the site (Jones [n.d.], Butler et al. [n.d.])
- Textbooks on principles and practices of explosives and explosives metal-forming (Ezra 1973, Meier 1993)
- Interviews with current and retired SNL/NM facility personnel (SNL/NM EORC, Refs. 70-19; 70-20; 70-21; 70-22; 70-23; 70-24; 70-26; 70-27; 70-28; 70-29; 70-30; 70-34; 70-35)
- Historical test facility reports spanning 20 years (SNL/NM 1989)
- Photographs and field notes from several inspections conducted by SNL/NM ER staff (SNL/NM 1993; SNL/NM 1985)
- A surface gamma radiation survey and an unexploded ordnance (UXO)/HE survey of the area
- Confirmatory sampling of surface and subsurface soil and residual rainwater.

3.2.2 Cultural-Resources Survey

No cultural resources were identified at ER Site 70 (Hoagland and Dello-Russo 1995).

3.2.3 Sensitive-Species Survey

No sensitive species were identified at ER Site 70 (IT Corporation 1995).

3.2.4 UXO/HE Surveys

In December 1993, Kirtland Air Force Base Explosive Ordnance Disposal conducted a UXO and HE survey at the site. No live UXO/HE or significant UXO/HE debris was found (Young 1994).

3.2.5 Surface Gamma Radiation Survey

In January 1994, RUST Geotech Inc. conducted a surface gamma radiation survey at the site. The survey used crutch-mounted sodium iodide (NaI) scintillometers. The areas inside and outside the fence, including the observation bunker, were surveyed. No anomalies were detected above the background readings of 8 to 12 microroentgen per hour (RUST Geotech Inc. 1994).

3.2.6 Surface Soil Sampling

In December 1994, surface soil samples were collected at nine sample locations, including six on-site locations (sample numbers 004 through 009), and three site-specific background locations about 50 feet northeast of the ER Site 70 boundary (sample numbers 001 through 003) (Figure 1-1). At each location, samples were collected at two depth intervals, 0 to 0.5 foot and 1.5 to 2 feet. Field screening for volatile organic compounds (VOC) and radiation was performed at each sampling location.

Chemical analytical results for surface soil samples are summarized in Table 3-1. The New Mexico Environment Department (NMED) collected one split soil sample (SNL/NM ER Sample ID 70-S1-005-F), and the analytical result for this sample is included in Table 3-1. Quality assurance (QA)/quality control (QC) samples were also collected, including one duplicate sample and one equipment rinsate blank (Table 3-1). QA/ QC results on these data are discussed in Section 3.2.7.1.

Field screening for VOCs was performed using a photoionization detector with a 10.0 electron volt lamp. There were no detectable VOCs at any sample location or depth interval. Radiation field screening measurements were taken on all soil samples using a pancake Geiger-Mueller (GM) beta-gamma probe, as well as a 2- by 2-inch NaI gamma scintillometer. These radiation field measurements were compared to background radiation measurements. The action level for radiation field screening was set at two standard deviations above background for each instrument. No radiation above background levels (80 counts per minute [cpm] for the pancake GM, and 10,465 cpm for the NaI scintillometer) was identified in any soil sample. Soils were therefore not analyzed for isotopic uranium and thorium or by gamma spectroscopy.

Table 3-1
Summary of ER Site 70 RFI Surface Soil Sample Analytical Results, December 1994

Sample Attributes			Metals (EPA 6010/7000) (mg/kg)								
Sample Number	ER Sample ID (Figure 3-1)	Sample Depth (ft)	As	Ba	Be	Cd	Cr	Hg	Se	Pb	Ag
21107	70-S1-004-F	0-0.5	2.0	63.1	0.24	ND	6.9	ND	ND	3.9 J	ND
21108	70-S2-004-F	1.5-2	6.6	165	0.37 J	ND	5.4	ND	ND	ND	ND
21109	70-S1-005-F	0-0.5	1.8	94.8	0.21	ND	12.3	ND	ND	4.9 J	ND
70-3	70-S1-005-F	0-0.5	1.4	90	0.2	0.5	16	ND	NA	18	ND
21110	70-S2-005-F	1.5-2	4.9	123	0.35	ND	5.8	ND	ND	4.6 J	ND
21111	70-S1-006-F	0-0.5	2.4	131	0.18 J	ND	22.9	ND	ND	3.9 J	ND
21112	70-S1-006-DU	0-0.5	2.3	186	0.17 J	ND	40.9	ND	ND	9.2	ND
21113	70-S2-006-F	1.5-2	4.7	103	0.25 J	ND	5.7	ND	ND	ND	0.8 J
21114	70-S1-007-F	0-0.5	2.5	93.8	0.23	ND	17.2	ND	ND	9.9	ND
21115	70-S2-007-F	1.5-2	4.4	115	0.33	ND	4.8	ND	ND	6.1	ND
21116	70-S1-008-F	0-0.5	2.1	67.8	0.24	ND	5.1	ND	ND	6.2	ND
21117	70-S2-008-F	1.5-2	5.2	144	0.39	ND	5.5	ND	ND	4.6 J	ND
21118	70-S1-009-F	0-0.5	1.7	101	0.24	ND	13.9	ND	ND	8.3	ND
21119	70-S2-009-F	0-0.5	5.4	508	ND	ND	9.6	ND	ND	34.4	ND
Practical Quantitation Limit (mg/kg)			1.0	1.0	0.2	0.5	1.0	0.1	0.77	5.0	1.0
NMED Oversight Bureau Background Maximum Value			5.6	130	0.65	<1	17.3	<0.25	<1	21.4	<1
Site-Specific Background UTL/95th% (mg/kg)			8.9	NC	0.97	26	15.2	NA	NA	15.9	NA
Surface Sample Quality Assurance/Quality Control Samples (in mg/L)											
21120	70-LW-010-F	NA	ND	0.2	ND	ND	0.0085 J	ND	ND	0.13	ND
21121	70-FB-011	NA	ND	ND	ND	ND	ND	ND	ND	0.0028 J	ND
21122	70-LW-010-DU	NA	ND	0.31	ND	ND	0.0093 J	ND	ND	0.18	0.0043 J
Practical Quantitation Limit (mg/L)			0.01	0.01	0.002	0.005	0.01	0.0002	0.005	0.003	0.010

Notes: mg/kg - Milligrams per kilogram; mg/L - Milligrams per liter; ft = Foot/feet.

Metals: **As** - arsenic; **Ba** - barium; **Be** - beryllium; **Cd** - cadmium; **Cr** - chromium; **Hg** - mercury; **Se** - selenium; Pb - lead; **Ag** - silver.

J - Concentration below the practical quantitation limit (PQL); B - Analyte was detected in the laboratory method blank.

ND - Not detected at the PQL; UTL - Upper tolerance limit; NA - Not applicable; NC - Not calculated; NMED - New Mexico Environment Department.

Surface soils from six locations around the perimeter of the vessel were analyzed for RCRA metals and HE. The metals results were compared with NMED Oversight Bureau (OB) background concentrations of metals in soils. With the exception of arsenic (6.6 mg/kg, sample number 70-S2-004-F), barium (508 mg/kg, sample number 70-S2-009-F), chromium (22.9 and 40.0 mg/kg, sample numbers 70-S1-006-F and 70-S1-006-DU, respectively) and lead (34.4 mg/kg, sample number 70-S2-009-F), metals in soil were not elevated above NMED-OB maximum background concentrations (Table 3-1). No HE was identified in these soil samples.

3.2.6.1 QA/QC Results

A field blank and a rinsate blank plus duplicate rinsate blank (all aqueous) were sampled and analyzed for metals and HE. Very low concentrations of barium and lead were detected, and chromium, lead, and silver were detected in concentrations below their practical quantitation limits (i.e., "J" values). None of these concentrations of metals indicated potential problems with any of the soil data.

3.2.7 Subsurface-Soil Borehole Data

In August 1995, subsurface soils were collected (approximately 12 feet deep) from three locations around the perimeter of the vessel were analyzed for RCRA metals. The metals results were compared with NMED-OB background concentrations of metals in soils. With the exception of barium (range 38 to 54 mg/kg, sample numbers 70-BH1-10S, 70-BH2-10-S, and 70-BH3-10-S), metals were not detected in subsurface soil samples, nor was any metal detected above NMED-OB maximum background concentrations (Table 3-2).

3.2.7.1 QA/QC Results

An aqueous equipment blank was collected and analyzed for metals. Metals were not detected below their practical quantitation limits. None of these concentrations of metals indicated potential problems with any of the subsurface soil borehole data.

3.2.8 Residual Rainwater Sampling

Although it was intended to sample sediment in the bottom of the containment structure according to the sampling plan for ER Site 70, no sediment accumulation was found. Instead, about 3 inches of accumulated rainwater was present in the bottom of the vessel. At the request of NMED-OB, residual rainwater was sampled and analyzed for metals, SVOCs, and HE on two separate occasions (December 1994, Table 3-3, and April 1995, Table 3-4). This residual rainwater has since evaporated.

The metals results were compared with NMED-OB background concentrations of metals in groundwater, even though the water in the containment structure was residual rainwater and would not be considered to be a drinking water source. With the exception of barium (range 0.2

Table 3-2

Summary of ER Site 70 RFI Subsurface Soil Borehole Sample Analytical Results, August 1995

Sample Attributes			Metals (EPA 6010/7000) (mg/kg)								
Sample Number	ER Sample ID	Sample Depth (ft)	As	Ba	Be	Cd	Cr	Hg	Se	Pb	Ag
24868	70-BH1-10-S	12	ND	44	ND	ND	ND	ND	ND	ND	ND
24869	70-BH1-10-SD	12	ND	18 J	ND	ND	ND	ND	ND	ND	ND
24870	70-BH2-10-S	12	ND	54	ND	ND	ND	ND	ND	ND	ND
24871	70-BH3-10-S	12	ND	13 J	ND	ND	ND	ND	ND	ND	ND
Practical Quantitation Limit (mg/kg)			190	38	13	38	0.24	191	38	38	1.0
NMED Oversight Bureau Background Maximum Value			5.6	130	0.65	<1	17.3	<0.25	<1	21.4	<1
Subsurface Sample Quality Assurance/Quality Control Sample (in mg/L)											
24872	70-GR4-0-EB	NA	ND	ND	ND	ND	ND	NT	ND	2.0 U	ND
Practical Quantitation Limit (mg/L)			1.9	0.38	0.13	0.38	0.38	0.0024	1.9	0.38	0.38

Notes: mg/kg - Milligrams per kilogram; mg/L - Milligrams per liter; ft = Foot/feet.

Metals: **As** - arsenic; **Ba** - barium; **Be** - beryllium; **Cd** - cadmium; **Cr** - chromium; **Hg** - mercury; **Se** - selenium; **Pb** - lead; **Ag** - silver.

J - Concentration below the practical quantitation limit (PQL).

ND - Not detected at the PQL; NA - Not applicable; NT - Not tested; NMED - New Mexico Environment Department.

Table 3-3
Summary of ER Site 70 RFI Residual Rainwater Sample Metals Analytical Results, December 1994

Sample Attributes			Metals (EPA 6010/7000) (mg/L)								
Sample Number	**ER Sample ID**	**Sample Depth**	**As**	**Ba**	**Be**	**Cd**	**Cr**	**Hg**	**Se**	**Pb**	**Ag**
21120	70-LW-010-F	Tank bottom	ND	0.2	ND	ND	0.0085 J	ND	ND	0.13	ND
21122	70-LW-010-DU	Tank bottom	ND	0.31	ND	ND	0.0093 J	ND	ND	0.18	0.0043 J
NMED	70-1	Tank bottom	ND	0.50	ND	ND	0.03	ND	ND	0.45	ND
NMED	70-2	Tank bottom	ND	0.4	ND	ND	0.031	ND	ND	0.35	ND
Practical Quantitation Limit (mg/kg)			0.01	0.01	0.002	0.005	0.01	0.0002	0.0079	0.003	0.010
NMED Oversight Bureau Ground-water Background Maximum Value			0.014	0.12	0.004	0.00047	0.043	0.0002	0.0005	0.01	<0.01
Quality Assurance/Quality Control Samples (in mg/L)											
21121	70-FB-011	NA	ND	ND	ND	ND	ND	ND	ND	0.0028 J	ND
22745	70-GR-003-0-EB	NA	ND	ND	ND	ND	ND	ND	ND	0.0028	ND
22746	70-GR-003-0-EB	NA	ND	0.31	ND	ND	0.0093	ND	ND	0.18	0.0043
Practical Quantitation Limit (mg/L)			0.01	0.01	0.002	0.005	0.01	0.0002	0.0079	0.003	0.010

Notes: mg/L - Milligrams per liter; mg/kg - Milligrams per kilogram.

Metals: **As** - arsenic; **Ba** - barium; **Be** - beryllium; **Cd** - cadmium; **Cr** - chromium; **Hg** - mercury; **Se** - selenium; **Pb** - lead; **Ag** - silver.

J - Concentration below the practical quantitation limit (PQL)

ND - Not detected at the PQL; NA - Not applicable; NMED - New Mexico Environment Department.

Table 3-4
Summary of ER Site 70 RFI Residual Rainwater Sample Semivolatile Organics and Explosives Analytical Results, December 1994 and April 1995

Sample Attributes			Semivolatile Organics (ug/L)					Explosives (ug/L)			
Sample Number	ER Sample ID	Sample Date	Benzoic Acid	bis(2-Ethylhexyl) phthalate	Diethylphthalate	4-Methylphenol	Phenol	1,3-Dinitrobenzene	RDX	Tetryl	2,6-Dinitrotoluene
21120	70-LW-010-F	12/94	22 J	8.9 J	13	ND	12	ND	ND	ND	ND
21122	70-LW-010-DU	12/94	12 J	ND	3.3 J	ND	5.3 J	ND	ND	ND	ND
NMED	70-1	12/94	NA	NA	NA	NA	NA	ND	ND	ND	ND
NMED	70-2	12/94	NA	NA	NA	NA	NA	ND	ND	ND	ND
22743	70-GR-001-0-BW	04/95	53	ND	3.9 J	21	8.8	0.64	1.5	ND	ND
22744	70-GR-001-0-BW	04/95	60	ND	3.8 J	60	17	ND	1.1	ND	ND
Practical Quantitation Limit (ug/L)			50	10	10	10	10	.03	0.85	1.0	0.25
Quality Assurance/Quality Control Samples (in ug/L)											
21121	70-FB-011	12/94	ND	ND	ND	ND	ND	ND	ND	ND	ND
22745	70-GR-003-0-EB	04/95	ND	21	4.8 J	ND	ND	ND	0.28 J	0.16 J	ND
22746	70-GR-003-0-EB	04/95	ND	ND	ND	ND	ND	ND	ND	0.12	0.38
Practical Quantitation Limit (ug/L)			50	10	10	10	10	0.3	0.85	1.0	0.25

Notes: ug/L - Micrograms per liter

J - Concentration below the practical quantitation limit (PQL).

ND - Not detected at the PQL; NA - Not applicable.

to 0.5 milligrams per liter [mg/L], sample numbers 70-LW-010-F, 70-LW-010-DU, 70-1, and 70-2), chromium (0.03 and 0.031 mg/L, sample numbers 70-1, and 70-2, respectively) and lead (range 0.13 to 0.45 mg/L, sample numbers 70-LW-010-F, 70-LW-010-DU, 70-1, and 70-2), metals in residual rainwater were not elevated above NMED-OB maximum background concentrations (Table 3-3).

The SVOCs and HE results were reported if the values in residual rainwater samples were above the practical quantitation limits for the analyte or the QA/QC sample. With the exception of benzoic acid (range 50 to 60 micrograms per liter [µg/L], sample numbers 70-GR-001-0-BW, 70-GR-001-0-BW), diethylphthalate acid 13 µg/L, sample number 70-LW-010-F), 4-methylphenol (range 21 to 60 µg/L, sample numbers 70-GR-001-0-BW and 70-GR-001-0-BW), phenol (range 8.8 to 17 µg/L, sample numbers 70-LW-010-F70-GR-001-0-BW and 70-GR-001-0-BW), 1,3-dinitrobenzene (0.64 µg/L, sample number 70-GR-001-0-BW), and hexahydro-1,3,5-trinitro-1,3,5-trazine (RDX) (range 1.1 to 1.5 µg/L, sample numbers 70-GR-001-0-BW and 70-GR-001-0-BW), SVOCs and HE in residual rainwater were not elevated above practical quantitation limits (Table 3-4).

3.2.8.1 QA/QC Results

A field blank and two equipment blanks (all aqueous) were collected and analyzed for SVOCs and HE. With the exception of bis(2-ethylhexyl)phthalate (21 µg/L, sample number 70-GR-003-0-EB), tetryl (0.12 µg/L, sample number 70-GR-003-0-EB), and 2,6-dinitrotoluene (0.38 µg/L, sample number 70-GR-003-0-EB), SVOCs and HE in QA/QC samples were not detected (Table 3-4). None of these concentrations of constituents indicated potential problems with any of the residual rainwater data.

3.3 Gaps in Information

The original (i.e., pre-RFI) gaps in information for ER Site 70 included lack of reliable data on the actual uses of the site and the possible contaminants associated with them. The RFI focused on the distribution of contaminants adjacent to, and underneath the metal forming facility, as a result of historical operations. The nature and extent of metals and HE in soils, as well as metals, SVOCs, and HE, in the residual rainwater, were characterized for this site in order to develop human health and environmental risk scenarios, as well as to make an NFA determination.

3.4 Risk Evaluation

ER Site 70 had relatively minor contamination consisting of some inorganic constituents. Because of the location of the site on Kirtland Air Force Base, the designated industrial land-use scenario and the nature of the contamination, the potential exposure pathways identified for this site included soil ingestion, as well as dust and VOC inhalation. Plant uptake was included as an exposure pathway for the residential land-use scenario. This site is designated for industrial land-use for human health evaluation (DOE and USAF 1996); the residential land-use scenario is provided for perspective only. Risk from constituents in residual rainwater was not performed because this water has since evaporated and it is unlikely that any remaining constituents in the confines of the containment structure will migrate to the surrounding environment. A detailed summary of the findings is presented in Section 6.1.

3.4.1 Human Health Risk Assessment

ER Site 70 has been recommended for industrial land use (DOE and USAF 1996). A complete discussion of the risk assessment process, results, and uncertainties is provided in Section 6.1. Due to the presence of several metals in concentrations greater than background levels, it was necessary to perform a human health risk assessment analysis for the site. 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 an industrial and residential land-use setting.

In summary, the main contributor to the industrial land-use scenario human health risk assessment values is arsenic. However, arsenic (6.6 mg/kg) was reported within the range of background concentrations (0.015 to 9.7 mg/kg) (IT Corporation 1996), and therefore is not indicative of contamination. Using conservative assumptions, the calculations for the COCs show that for the industrial land-use scenario the Hazard Index (0.04) is significantly less than the accepted numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). The incremental Hazard Index is 0.02. Incremental risk calculations indicate insignificant risk to human health from the COCs considering an industrial land-use scenario. The estimated cancer risk (5×10^{-6}) is in the low end of the suggested acceptable risk range, and there is zero incremental cancer risk for the industrial land-use scenario.

The residential land-use scenarios for this site are provided only for comparison in the Risk Assessment report. The report concludes that ER Site 70 does not have significant potential to affect human health under a residential land-use scenario.

3.4.2 Ecological Risk Assessment

It was also necessary to perform an ecological risk assessment analysis for ER Site 70 (Section 6.1). The risk assessment process provides a quantitative evaluation of the potential adverse ecological effects to indicator species caused by constituents in the site's soil. The Risk Assessment report calculated the Hazard Quotient for representative plant, deer mouse, and burrowing owl species as ecological receptors.

Potential risks were indicated for all three ecological receptors at ER Site 70; however, the use of the maximum measured soil concentration or maximum detection limit to evaluate risk provides the most conservative exposure scenario for the risk assessment and may not reflect actual site conditions. An amount equal to half of the detection limit was used to evaluate risk for mercury and selenium. Maximum soil concentrations for barium and chromium exceeded their respective plant benchmark concentrations. Maximum measured soil concentrations for arsenic and barium exceeded their respective HQs for the deer mouse. No potential risk was predicted for the burrowing owl.

Based on these results, cadmium, lead, mercury, selenium, and silver can be justified for elimination as constituents of potential ecological concern (COPEC) at ER Site 70; however, it is very likely that the other risk results are driven by conservatisms in data analysis. Hazard Quotients based on 95 percent upper confidence limits of the mean will likely be lower and still be a conservative estimate of site conditions. If average concentrations are used in the evaluation of ecological risks associated with ER Site 70, average concentrations of arsenic, barium, and cadmium fall within the range of background concentrations, which would eliminate them as COPECs. Based on this additional information, ecological risks at ER Site 70 are expected to be low.

4.0 RATIONALE FOR NO FURTHER ACTION DECISION

Based on field investigation data and the human and environmental health assessments, an NFA is being recommended for ER Site 70 for the following reasons:

- No VOCs were detected during the field screening program
- Field screening beta-gamma results were within background levels
- The RFI defined the extent of metals to be limited to the shallow subsurface
- The levels of most metals, all SVOCs, and all HE in the surface soils and shallow subsurface were within either sitewide background levels or risk-based action levels
- The residual rainwater impacted by SVOCs and HE has since evaporated, and it is unlikely that any remaining constituents in the confines of the containment structure will migrate to the surrounding environment
- Risk assessments for human health do not show adverse effects under the industrial land-use scenario.
- Risk assessment for ecological receptors indicates some potential risk under a conservative scenario, but it is expected to be low.

Based on the evidence provided above, ER Site 70 is proposed for an NFA based on Criterion 5 of the ER DOU (NMED 1996).

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6.0 ANNEXES

6.1 ER Site 70: Risk Assessment Analysis

Section 6.1
ER Site 70: Risk Assessment Analysis

ER SITE 70: RISK ASSESSMENT ANALYSIS

I. Site Description and History

ER Site 70 is a former explosive metal-forming test facility in Central Coyote Test Area. The facility may have been in operation from 1952 until the end of that decade. The test structure itself is an in-ground, open-top, cylindrical, concrete containment vessel measuring 10 feet in diameter and about 10 feet deep. For a firing, a metal workpiece was placed in a die assembly with an explosive charge. This assembly was lowered to the bottom of the in-ground, cylindrical concrete, water-filled vessel, and the explosive charge was detonated. The die and water-filled concrete structure were designed to contain the energy of the explosion during the metal-forming process, and most of the water was expelled by the explosion during the course of each test. The assembly was extracted from the containment vessel to remove the formed metal workpiece.

Typically less than 1 pound of high explosives was used per detonation, including 2,4,6-trinitrotoluene (TNT), octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), 2,2-bis[(nitrooxyl)methyl]-1,3-propanodial (PETN), and Composition 4. Potential constituents of concern (COC) at the site include trace residual HE residue; metals from the workpieces, die, and support equipment; and semivolatile organic compounds (SVOC) from lubricants and fluids used in support equipment such as pumps. Metals and HE could potentially remain in the test structure after testing, and SVOCs from pumps and equipment could potentially be present outside the test structure. Rainwater would have washed metals and HE residue to the bottom of the test structure, where it would accumulate in residual rainwater. Metals and HE may also have been ejected from the test structure during a test to the surrounding surface soils. Water containing COCs could have migrated into subsurface soils beneath the test facility.

There is no visual evidence at ER Site 70 indicating that the site released hazardous waste or constituents into the environment, although vermiculite is present on the ground around the facility. About 6 inches of residual rainwater was present in the containment structure when sampling took place in December 1994 and April 1995. The concrete containment structure is not cracked, and the residual rainwater has since evaporated. Only metals in soil were identified during the investigation, and only metals and trace residues of HE were identified in residual rainwater during sampling.

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 present at the site. The steps to be discussed include:

Step 1.	Site data are described that provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site.
Step 2.	Potential pathways 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 COCs and background.
Step 6.	These values are compared with guidance established by the U.S. Environmental Protection Agency (EPA) to determine whether further evaluation, and potential site clean-up, is required. 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 70 No Further Action 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 surface samples were used to provide conservative risk calculations. Because all maximum values were from the surface samples, the surface upper tolerance limit (UTL) or 95th percentile, as appropriate, was selected to provide the background screen in Table 1 and to be used to calculate risk attributable to background in Table 5. Chemicals that are essential nutrients, such as iron, magnesium, calcium, potassium, and sodium, were not included in this risk assessment (EPA 1989). Since site history and surveys indicated that there were no radioactive COCs at this site, it was not necessary to perform a radiological risk assessment. The only COCs evaluated were metals.

II.2 Step 2. Pathway Identification

ER Site 70 has been designated with an industrial future land-use scenario (DOE and USAF 1996) (see Appendix 1 for default exposure pathways and parameters). Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion. The inhalation pathway is included because of the potential to inhale dust. No contamination at depth was detected, and therefore, no pathways to groundwater are considered. Depth to groundwater at ER Site 70 is approximately 73 feet. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered insignificant. 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.

Table 1
COCs at ER Site 70 and Comparison to the Background Concentration Values

COC name	Maximum concentration (mg/kg)	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	6.6	5.6	No
Barium	508	130	No
Beryllium	0.39	0.65	Yes
Cadmium	0.5	<1^	NA
Chromium, total*	40.9	NC	NA
Lead	34.4	21.4	No
Mercury	0.05**	<0.25^	NA
Selenium	0.39**	<1^	NA
Silver	0.8 J	<1^	NA

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

PATHWAY IDENTIFICATION

Chemical Constituents
Soil ingestion
Inhalation (dust)
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 70 were evaluated using a tiered approach. First, the maximum COC concentrations were compared to the SNL/NM background screening concentrations for this area (IT Corporation 1996), as modified during verbal discussions with representatives of New Mexico Environment Department (NMED).

The maximum concentration of each COC was used in order to provide a conservative estimate of the associated risk. If any COCs were above the SNL/NM background screening levels, all site COCs were considered in further risk assessment analyses.

Second, if any COC failed the initial screening step, the maximum concentration was compared with action levels calculated using methods and equations promulgated in the proposed

Resource Conservation and Recovery Act (RCRA) Subpart S (40 CFR Part 2641990) and Risk Assessment Guidance for Superfund (RAGS) (EPA 1989) documentation. 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 1989). The combined effects of all COCs in the soils were calculated. The combined effects of the COCs at their respective UTL or 95th-percentile background concentration in the soil were also calculated. For toxic compounds, the combined effects were calculated 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}.

II.3.1 Comparison to Background and Action Levels

ER Site 70 COCs are listed in Table 1. The table shows the associated 95th-percentile or UTL background levels (IT Corporation 1996), as modified during verbal discussion with representatives of 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 from the Kirtland Air Force Base (KAFB). The values shown in Table 1 supersede the background values described in an interim background study report (IT Corporation 1994).

Several compounds have maximum measured values greater than background screening levels. Therefore, all COCs were retained for further analysis with the exception of lead. The maximum concentration value for lead is 34.4 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); for a residential land-use scenario, the EPA screening guidance value is 400 mg/kg (EPA 1994). The maximum concentration value for lead at this site is less than both of those screening values, and therefore lead is eliminated from further consideration in this risk assessment.

Because several COCs had concentrations greater than their respective SNL/NM background 95th percentile or UTL, the site fails the background screening criteria, and all COCs proceed to the proposed Subpart S action level screening procedure. Table 2 shows the inorganic COCs and the proposed Subpart S action level for the contaminants. The table compares the maximum concentration values to 1/10 of the proposed Subpart S action level. This methodology was guidance given to SNL/NM from the EPA (EPA 1996b). This is the second screening process in the tiered risk assessment approach. Three COCs had concentrations greater than 1/10 of the proposed Subpart S action level. Because of these COCs, the site fails the proposed Subpart S screening criteria, and a Hazard Index value and cancer risk value must be calculated for all the COCs.

Table 2
Comparison of ER Site 70 COC Concentrations to Proposed Subpart S Action Levels

COC name	Maximum concentration (mg/kg)	Proposed Subpart S Action Level (mg/kg)	Is individual contaminant less than 1/10 the Action Level?
Arsenic	6.6	0.5	**No**
Barium	508	6000	Yes
Beryllium	0.39	0.2	**No**
Cadmium	0.5	80	Yes
Chromium, total*	40.9	400	**No**
Lead	34.4	2000	Yes
Mercury	0.05^	20	Yes
Selenium	0.39^	400	Yes
Silver	0.8 J	400	Yes

* total chromium assumed to be chromium VI (most conservative)
^ concentrations are assumed to be one-half of the detection limit

II.3.2 Identification of Toxicological Parameters

Table 3 shows the COCs that have been retained in the risk assessment and the values for the toxicological information available for those COCs.

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 COCs and associated background 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 1989). The parameters are based on information from RAGS, as well as other EPA guidance documents, and reflect the RME approach advocated by RAGS.

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

Table 3
Toxicological Parameter Values for ER Site 70 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
Beryllium	0.005	--	L	4.3	8.4	B2
Cadmium	0.0005	0.0000571	H	--	6.3	B1
Chromium, total*	0.005	--	L	--	42	A
Mercury	0.0003	0.0000857	M	--	--	D
Selenium	0.005	--	H	--	--	D
Silver	0.005	--	L	--	--	D

* total chromium assumed to be chromium VI (most conservative)
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
E - evidence of noncarcinogenicity for humans

-- information not available

II.3.3.2 Risk Characterization

Table 4 shows that for the ER Site 70 COCs, the Hazard Index value is 0.04, and the excess cancer risk is 5×10^{-6} for the designated industrial land-use scenario. The numbers presented included exposure from soil ingestion and dust inhalation for the COCs. Table 5 shows that assuming the maximum background concentrations of the ER Site 70 associated background constituents, the Hazard Index is 0.02, and the excess cancer risk is 5×10^{-6} for the designated industrial land-use scenario.

Table 4 also shows that for the ER Site 70 COCs, considering the residential land-use scenario, the Hazard Index value increases to 1, and the excess cancer risk is 7×10^{-5}. 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 5 also shows that for the ER Site 70 associated background constituents, the Hazard Index is to 0.3 and the excess cancer risk is 7×10^{-5}.

Table 4
Risk Assessment Values for ER Site 70 COCs

COC Name	Maximum concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	6.6	0.02	4E-6	0.38	7E-5
Barium	508	0.01	--	0.08	--
Beryllium	0.39	0.00	7E-7	0.00	3E-6
Cadmium	0.5	0.00	2E-10	0.41	3E-10
Chromium, total*	40.9	0.01	1E-7	0.03	2E-7
Mercury	0.05^	0.00	--	0.09	--
Selenium	0.39^	0.00	--	0.14	--
Silver	0.8 J	0.00	--	0.03	--
TOTAL		**0.04**	**5E-6**	**1**	**7E-5**

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

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

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.

For the industrial land-use scenario, the Hazard Index calculated for the COCs is 0.04; this is much less than the numerical guideline of 1 suggested in RAGS (EPA 1989). The excess cancer risk is estimated at 5×10^{-6}. 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 low end of the suggested acceptable risk range. This risk assessment also determined risks considering background concentrations of the potential COCs for both the industrial and residential land-use scenarios. For the industrial land-use scenario, the Hazard Index is 0.02. The excess cancer risk is estimated at 5×10^{-6}. Incremental risk is determined by subtracting risk associated with background from potential COC risk. These numbers are not rounded before the difference is determined and, therefore, may appear to be inconsistent with numbers presented in tables and discussed within the text. The incremental Hazard Index is 0.02, and there is zero incremental cancer risk 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.

Table 5
Risk Assessment Values for ER Site 70 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	5.6	0.02	4E-6	0.32	6E-5
Barium	130	0.00	--	0.02	--
Beryllium	0.65	0.00	1E-6	0.00	5E-6
Cadmium	<1	--	--	--	--
Chromium, total*	NC	--	--	--	--
Mercury	<0.25	--	--	--	--
Selenium	<1	--	--	--	--
Silver	<1	--	--	--	--
TOTAL		0.02	5E-6	0.3	7E-5

* total chromium assumed to be chromium VI (most conservative)
NC - not calculated
-- information not available

For the residential land-use scenario, the calculated Hazard Index for the COCs is 1, which is at the numerical guidance. The excess cancer risk is estimated at 7×10^{-5}; this value is in the upper end of 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 7×10^{-5}. For the residential land-use scenario, the incremental Hazard Index is 0.82, and the incremental cancer risk is 8×10^{-6}. These incremental risk calculations indicate insignificant contribution to human health risk from the COCs considering a residential land-use scenario.

II.5 Step 7 Uncertainty Discussion

The data used to characterize ER Site 70, Explosive Test Pit, were provided by 14 surface soil samples randomly located in the area around the containment vessel. Subsurface borehole sample data were not used in this risk assessment. The number of samples was increased from that proposed in the draft RCRA Facility Investigation Work Plan for Operable Unit 1334 to include the borehole soil samples as requested by NMED Oversight Bureau. These samples were deemed sufficient to establish whether residues from the testing were detectable. The constituents of concern for the site are primarily metals and HE residue. The soil samples were analyzed for the eight RCRA metals by EPA Method 6010 and mercury by EPA Method 7471. Quality assurance/quality control samples for the sampling event consisted of one surface soil split sample at one location, one subsurface soil split sample at one location, and four equipment rinsate field blanks for the site COCs. All the samples were sent off site to a

Contract Laboratory Program (CLP) laboratory for analysis. The data provided by the CLP laboratory are considered definitive data suitable for use in a risk analysis.

The conclusion from the risk assessment analysis is that for the industrial land-use scenario, the potential effects caused by potential COCs on human health are within the acceptable range. Calculated incremental risk between potential COCs and associated background indicate insignificant contribution to human health risk from the COCs.

The potential effects on human health for the COCs are greater when considering the residential land-use scenario. Incremental risk between potential COCs and associated background indicates an increased contribution of risk from the COCs. The increased effects are primarily the result of including the plant uptake exposure pathway. Constituents that pose 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 70 is designated as an industrial land-use area, the likelihood of significant plant uptake in this area is highly unlikely. The uncertainty in this conclusion is considered to be small.

Because of the location, history of the site, and the future land-use, 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 (less than 12 feet) soils and because of the location and physical characteristics of the site, there is little uncertainty in the exposure pathways.

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 background 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 toxicological parameter values. There is a mixture of estimated values and values from the Health Effects Assessment Summary Tables (HEAST) (EPA 1996c) and Integrated Risk Information System (IRIS) (EPA 1988, 1994, 1997b) 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 guidance. Though the residential land-use Hazard Index is at the numerical guideline, it has been determined that future land-use at this locality will not be residential (DOE and USAF 1996). The overall uncertainty in all of the steps in the risk assessment process is considered insignificant with respect to the conclusion reached.

II.6 Summary

ER Site 70, an explosives test pit, had relatively minor contamination consisting of some inorganic constituents. 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. Plant uptake was included as an exposure pathway for the residential land-use scenario. This site is designated for industrial land use (DOE and USAF 1996); the residential land-use scenario is provided for perspective only.

Using conservative assumptions and employing a RME approach to the risk assessment, the calculations for the COCs show that for the industrial land-use scenario the Hazard Index (0.04) is significantly less than the accepted numerical guidance from the EPA. The estimated cancer risk (5×10^{-6}) is in the low end of the suggested acceptable risk range. The incremental Hazard Index is 0.02, and there is no incremental cancer risk for the industrial land-use scenario. Incremental risk calculations indicate insignificant risk to human health from the COCs considering an industrial land-use scenario.

The main contributor to the industrial land-use scenario risk assessment values is arsenic. Arsenic (6.6 mg/kg) was reported within the range of background concentrations (0.015 to 9.7 mg/kg) (IT Corporation 1996) and therefore may not be indicative of contamination.

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 70. 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 on screening level guidance presented by the EPA (EPA, 1992; 1996d; 1997a) 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 (1996d) 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 Ecological Pathways

ER Site 70 is located on top of a low hill about 1 kilometer (0.6 mile) northeast of the Lovelace Inhalation Research Institute, which is located in the south-central part of KAFB. This site is fenced, and the interior of the fence (around the test pit) has been graveled. The surrounding vegetation is grassland. Complete ecological pathways may exist at this site through the exposure of plants and wildlife to COPECs in surface and subsurface soil. Both the inside and outside (30-meter [100-foot] buffer) areas of the site were surveyed for sensitive species on May 18, 1994. No sensitive species were found during these surveys (IT Corporation 1995).

III.3 Constituents of Potential Ecological Concern

The potential COCs at this site are RCRA metals. 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. Eight inorganic analytes were identified as COPECs at ER Site 70: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. Two of these (mercury and selenium) were not detected in either surface or subsurface samples; however, the detection limits exceeded the UTLs of the background soil concentrations, and therefore, these analytes could not be excluded from the list of COPECs. 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).

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 6 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.

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. An amount equal to half of the detection limit (established from the on-site laboratory) was used for mercury and selenium, which were not otherwise detected but were retained due to the high detection limit.

Table 7 presents the transfer factors used in modeling the concentrations of COPECs through the food chain. Table 8 presents the maximum concentrations of COPECs in soil, the derived concentrations in the various food-chain elements, and the modeled dietary exposures for each of wildlife receptor species.

Table 6
Exposure Factors for Ecological Receptors at Environmental Restoration Site 70, 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).

Table 7
Transfer Factors Used in Exposure Models for Constituents of Potential Ecological Concern at Environmental Restoration Site 70, 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]
Cadmium	5.50×10^{-1} [a]	6.00×10^{-1} [d]	5.50×10^{-4} [a]
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]

[a]From Baes et al. (1984).
[b]Default value.
[c]From NCRP (1989).
[d]From Stafford et al. (1991).
[e]From Ma (1982).

Table 8
Media Concentrations (mg/kg)[a] for Constituents of Potential Ecological Concern at Environmental Restoration Site 70, Sandia National Laboratories, New Mexico

Constituent of Potential Ecological Concern	Soil (maximum)	Plant Foliage[b]	Soil Invertebrate[b]	Deer Mouse Tissues[c]
Arsenic	6.60×10^{0}	2.64×10^{-1}	6.60×10^{0}	2.23×10^{-2}
Barium	5.08×10^{2}	7.62×10^{1}	5.08×10^{2}	1.89×10^{-1}
Cadmium	5.00×10^{-1}	2.75×10^{-1}	3.00×10^{-1}	5.11×10^{-4}
Chromium (Total)	4.09×10^{1}	1.64×10^{0}	5.32×10^{0}	4.03×10^{-1}
Lead	3.44×10^{1}	3.10×10^{0}	1.38×10^{0}	7.31×10^{-3}
Mercury	5.00×10^{-2}	5.00×10^{-2}	5.00×10^{-2}	3.98×10^{-2}
Selenium	3.90×10^{-1}	1.95×10^{-1}	3.90×10^{-1}	9.38×10^{-2}
Silver	8.00×10^{-1}	8.00×10^{-1}	2.00×10^{-1}	8.06×10^{-3}

[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).

III.4 Toxicity Benchmarks

Benchmark toxicity values for the plant and wildlife receptors are presented in Table 9. For plants, the benchmark soil concentrations are based on the lowest-observed-adverse-effect level (LOAEL). 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. Total chromium was assumed to be chromium VI. Insufficient toxicity information was found to estimate the NOAEL for silver in the burrowing owl.

III.5 Risk Characterization

The maximum soil concentrations and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. The results of these comparisons are presented in Table 10. Hazard quotients (HQ) are used to quantify the comparison with the benchmarks for plants and wildlife exposure. Maximum soil concentrations for barium and chromium exceeded their respective plant benchmark concentrations. For the deer mouse, HQs exceeded unity for arsenic (HQ = 4.16) and barium (HQ = 4.47). No potential risk was predicted for the burrowing owl.

III.6 Uncertainties

Many uncertainties are associated with the characterization of ecological risks at ER Site 70. 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.

III.7 Summary

Potential risks were indicated for all three ecological receptors at ER Site 70; however, the use of the maximum measured soil concentration or maximum detection limit to evaluate risk provided a conservative exposure scenario for the risk assessment and may not reflect actual site conditions. An amount equal to one-half of the detection limit was used to evaluate risk for mercury and selenium. Maximum soil concentrations for barium and chromium exceeded their respective plant benchmark concentrations. Maximum measured soil concentrations for arsenic and barium show potential risk to the deer mouse. No potential risk was predicted for the burrowing owl. Based on these results, cadmium, lead, mercury, selenium, and silver can be justified for elimination as COPECs at ER Site 70; however, it is very likely that the other risk results are driven by conservatisms in data analysis. HQs based on 95 percent upper confidence limits of the mean will likely be lower and still be a conservative estimate of site

Table 9
Toxicity Benchmarks for Ecological Receptors at Environmental Restoration Site 70, 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
Cadmium	3	Lab rat[h]	0.008	0.0156	Mallard	1.45	1.45
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[j]	17.8[j]	34.8	---	---	---

[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]Body weight of 0.303 kg was used for NOAEL conversion (Sample et al. 1996).
[i]--- designates insufficient toxicity data.
[j]From EPA (1997b).

conditions. If average concentrations are used in the evaluation of ecological risks associated with ER Site 70, average concentrations of arsenic, barium, and cadmium fall within the range of background concentrations, which would eliminate them as COPECs. Based on this additional information, ecological risks at ER Site 70 are expected to be low.

Table 10
Comparisons to Toxicity Benchmarks for Ecological Receptors at Environmental Restoration Site 70, Sandia National Laboratories, New Mexico

Constituent of Potential Ecological Concern	Plant Hazard Quotient[a]	Deer Mouse Hazard Quotient	Burrowing Owl Hazard Quotient
Arsenic	6.60×10^{-1}	**4.16×10^{0}**	3.35×10^{-3}
Barium	**1.02×10^{0}**	**4.47×10^{0}**	5.55×10^{-2}
Cadmium	1.67×10^{-1}	2.45×10^{-1}	8.08×10^{-4}
Chromium (Total)	**4.09×10^{1}**	1.25×10^{-4}	1.36×10^{-1}
Lead	6.88×10^{-1}	2.91×10^{-2}	2.01×10^{-2}
Mercury	1.67×10^{-1}	1.27×10^{-1}	7.11×10^{-1}
Selenium	3.90×10^{-1}	1.19×10^{-1}	2.58×10^{-2}
Silver	4.00×10^{-1}	2.31×10^{-3}	---[b]

[a]**Bold** text indicates hazard quotient exceeds unity.
[b]--- designates insufficient toxicity data available for risk estimation purposes.

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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.

Table 1. Exposure Pathways Considered for Various Land Use Scenarios

Industrial	Recreational	Residential
Ingestion of contaminated drinking water	Ingestion of contaminated drinking water	Ingestion of contaminated drinking water
Ingestion of contaminated soil	Ingestion of contaminated soil	Ingestion of contaminated soil

Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)
Dermal contact	Dermal contact	Dermal contact
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	Ingestion of fruits and vegetables
		External exposure to penetrating radiation from ground surfaces

EQUATIONS AND DEFAULT PARAMETER VALUES FOR IDENTIFIED EXPOSURE ROUTES

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

<u>Generic Equation for Calculation of Risk Parameter Values</u>

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).

References

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