Sandia National Laboratories/New Mexico

PROPOSAL FOR
RISK-BASED NO FURTHER ACTION
ENVIRONMENTAL RESTORATION SITE 145
BUILDING 9981/9982 SEPTIC SYSTEM
OPERABLE UNIT 1295

May 1997

Environmental
Restoration
Project

United States Department of Energy
Albuquerque Operations Office

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Prepared by
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Albuquerque, New Mexico

Prepared for
the U.S. Department of Energy

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ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
BA	butyl acetate
bgs	below ground surface
BTEX	benzene, toluene, ethylene, and xylene
COC	constituents of concern
DOE	Department of Energy
DOU	Document of Understanding
ER	Environmental Restoration
ES&H	Environmental Safety and Health
KAFB	Kirtland Air Force Base
MEK	methyl ethyl ketone
MIBK	methyl isobutyl ketone
ug/kg	micrograms per kilogram
mg/kg	milligrams per kilogram
NEPA	National Environmental Policy Act
NERI	Northeast Research Institute
NFA	No Further Action
NMED	New Mexico Environment Department
OU	Operable Unit
PCE	perchloroethene
pCi/L	picocuries per liter
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SNL/NM	Sandia National Laboratories/New Mexico
SPT	Solar Power Tower
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
UTL	upper tolerance limit
VOC	volatile organic compound

1.0 INTRODUCTION

1.1 Description of ER Site 145

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a No Further Action (NFA) decision based on confirmatory sampling for Environmental Restoration (ER) Site 145, Building 9981/9982 Septic Systems, Operable Unit (OU) 1295. ER Site 145 is listed in the Hazardous and Solid Waste Amendments Module IV (EPA August 1993) of the SNL/NM Resource Conservation and Recovery Act (RCRA) Hazardous Waste Management Facility Permit (NM5890110518-1) (EPA August 1992).

SNL/NM occupies 2,829 acres of land owned by the Department of Energy (DOE), with an additional 14,920 acres of land provided by land-use permits with Kirtland Air Force Base (KAFB), the United States Forest Service, the State of New Mexico, and the Isleta Pueblo. SNL/NM has been involved in nuclear weapons research, component development, assembly, testing, and other research and development activities since 1945 (DOE September 1987).

ER Site 145 is located on KAFB, and is approximately 1.3 miles north of the Isleta Pueblo boundary and 1 mile west of Lovelace Road. It is reached by traveling south on Lovelace Road, and then west on Magazine Road for a distance of 1 mile (Figure 1-1). The site is also about 1,500 feet northwest of the Solar Power Tower (SPT), a prominent landmark in the area, and is situated northeast and west of Building 9984 (Figure 1-2).

ER Site 145 consists of two contiguous areas that encompass two septic systems and the area immediately around a former grease trap outfall. The system northwest of Buildings 9981 and 9982, and northeast of Building 9984 (designated ER Site 145-A on Figure 1-2) will be referred to as the "east system" in this report. It consisted of an 8-foot by 15-foot concrete septic tank (SNL/NM August 1995b), and five 4-inch diameter by 50-foot-long parallel polyvinyl chloride (PVC) drainlines that were buried about 6 to 7 feet below the ground surface (bgs) (SNL/NM August 1994). The system west of Building 9984 (designated ER Site 145-B on Figure 1-2) will be referred to as the "west system" in this report. It consisted of a 4-foot wide by 8-foot long concrete septic tank (SNL/NM August 1995c) and three 4-inch diameter by 40-foot-long parallel PVC drainlines buried about 2 feet bgs (SNL/NM August 1994). The third portion of ER Site 145 is the area immediately around the former grease trap outfall, and is designated ER Site 145-C on Figure 1-2. The three portions of ER Site 145 encompass a total of approximately 0.4 acre of flat-lying land at an average mean elevation of 5,570 feet above mean sea level (amsl).

The surficial geology in the ER Site 145 area consists of middle to upper Pleistocene alluvial fan deposits. The alluvial fan materials originated from the Manzanita Mountains that are 3 to 4 miles east of ER Site 145, and typically have a moderate to high (sand + gravel)/(silt + clay) ratio, are poorly sorted, and exhibit moderately connected lenticular bedding. Individual beds range from 1 to 5 feet thick with a preferred east-west orientation, and have moderate to low hydraulic conductivities. The SNL/NM ER project installed monitoring well STW-1

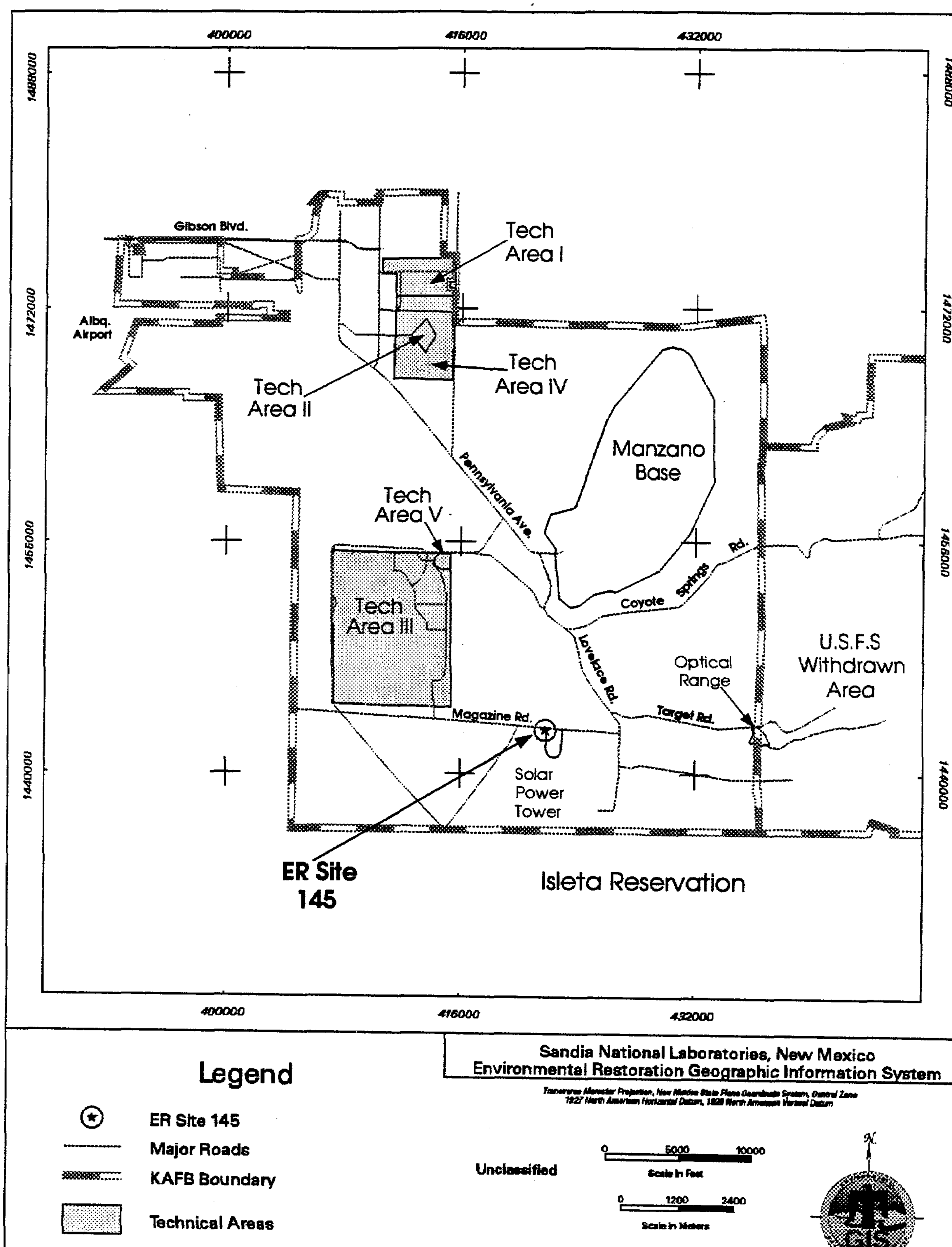

FIGURE 1-1
Location Map for ER Site 145
Sandia National Laboratories,
New Mexico

scmorri SNL GIS ORG. 7512 07/03/96 MAPID=960996

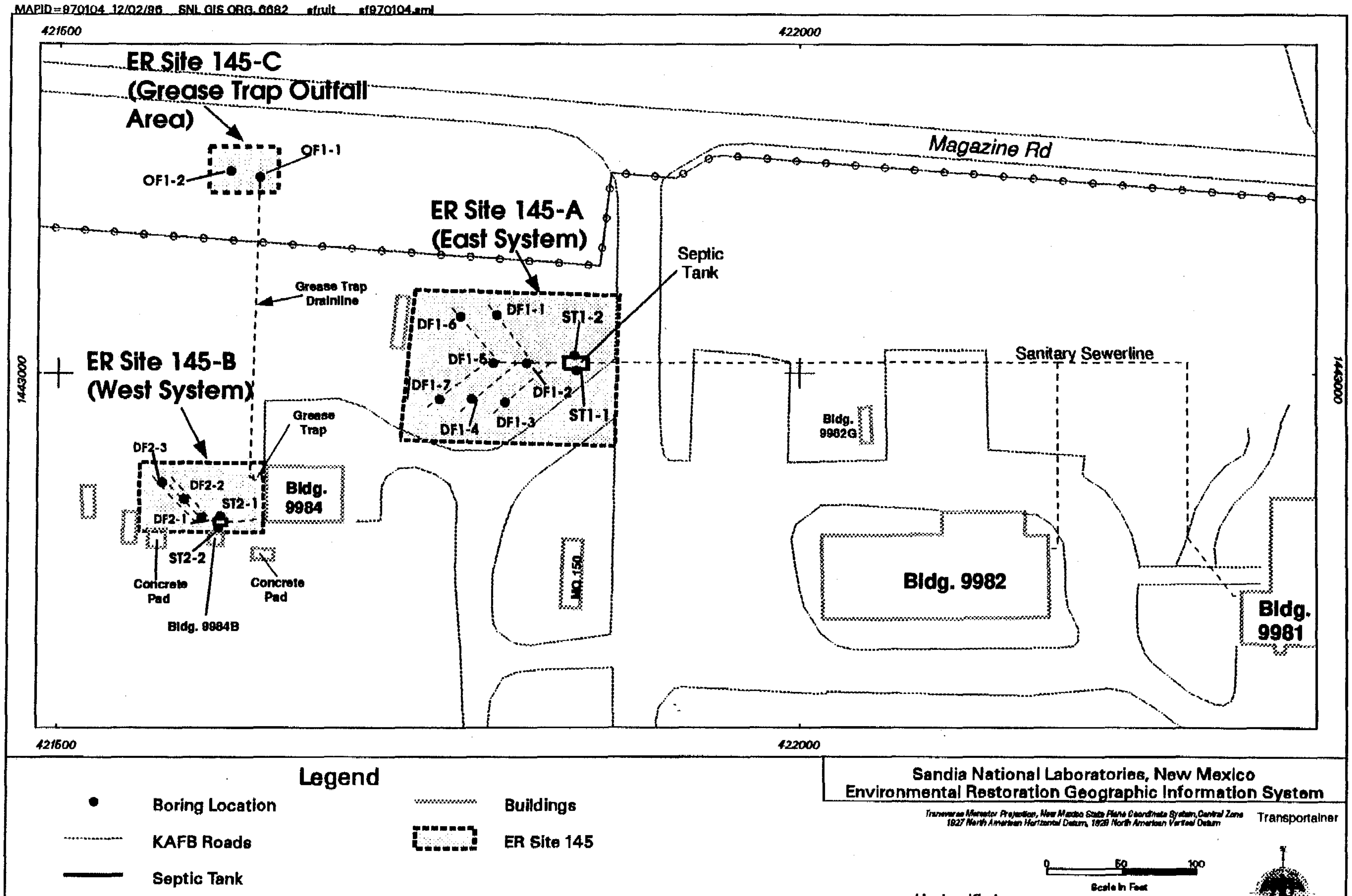

FIGURE 1-2
Site Map for ER Site 145
Sandia National Laboratories,
New Mexico

approximately 1,800 feet west of ER Site 145 in June 1995. During drilling at this location, several intervals of lost circulation were encountered in Tertiary conglomerate down to a total depth of 521 feet bgs. These intervals of lost circulation indicate that there are highly transmissive features in the alluvial materials that may be either poorly cemented conglomerate beds or fracture zones (SNL/NM March 1996).

The alluvial fan sediment package is approximately 1,900 feet thick beneath the site and rests on a bedrock surface presumed to be Permian Abo and Yeso formation sedimentary rocks. These rocks consist of massive to thinly bedded red sandstones, siltstones, and shales, with local interbedded gypsum (Plates XIII and XV of SNL/NM December 1995c). ER Site 145 is located in a structurally complex zone of faulted bedrock ramps that lie between the sediment-filled Albuquerque Basin to the west and the uplifted Manzanita Mountains to the east. The ramps are separated by generally west-dipping normal faults that trend northeast (and locally northwest), and exhibit down-to-the-west displacement. This extensive faulting has resulted in a detached and tilted block (the "Travertine Block" on Plate XV of SNL/NM December 1995c) capped by Abo and Yeso rock that dips in a southeasterly direction beneath the site. Vegetation consists predominantly of grasses including grama, muhly, dropseed, and galieta. Shrubs commonly associated with the grasslands include sand sage, winter fat, saltbrush, and rabbitbush. Cacti are common, and include cholla, pincushion, strawberry, and prickly pear (SNL/NM March 1993).

The water-table elevation is approximately 5,430 feet amsl at this location, so depth to groundwater beneath the site is approximately 140 feet. Local groundwater flow is believed to be in a generally westerly direction in the vicinity of this site (SNL/NM March 1996). The nearest groundwater monitoring well is STW-1 (located about 1,800 feet west of the site), which is screened from 149.8 to 169.8 feet bgs (SNL/NM August 1996b). The water level elevation in well STW-1 on August 7, 1996, was 5377.29 feet amsl or about 153 feet bgs (SNL/NM August 1996a). The nearest production wells are northwest of ER Site 145 and include KAFB-1, 2, 4, 7, and 14, which are approximately 5.3 to 7.7 miles away.

1.2 No Further Action Basis

Review and analysis of the ER Site 145 soil sample analytical data indicate that concentrations of constituents of concern (COC) at this site are less than (1) SNL/NM or other applicable background limits, (2) proposed Subpart S or other action levels, and (3) risk-based standards. Thus, ER Site 145 is being proposed for an NFA decision based on confirmatory sampling data and risk assessment analysis demonstrating that hazardous 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, NFA Criterion 5 of the Environmental Restoration Document of Understanding (DOU) (NMED April 1996).

2.0 HISTORY OF ER SITE 145

2.1 Historical Operations

The following historical information has been excerpted from several sources, including SNL/NM March 1993, IT March 1994, and SNL/NM November 1994e.

The Solar Facility was constructed in 1976 for the research and development of solar thermal technology. The Solar Control Building (9981) is a large office and control building containing a staff of 30 to 50 people. The Solar Assembly Building (9982) is used for repair and assembly of heliostats and other solar equipment. Building 9984, located west of Building 9982, is known as the Engine Test Facility. SNL/NM Facilities Engineering drawings (SNL/NM September 1985) and information from a long-time employee at the Solar Facility (SNL/NM October 1996) indicate that Building 9984 (and the associated west septic system and grease trap outfall) was constructed in late 1985.

Buildings 9981 and 9982 shared the now abandoned east septic system for lavatories and sinks. One sink in Building 9982 may have received small quantities of solvents (acetone, methanol, trichloroethene (TCE), 1,1,1-trichloroethane, and tetrachloroethene). Material Safety Data Sheets in Building 9981 listed other chemicals used in the facility, including methyl cyanide, methylene chloride, hexane, hydrofluoric acid, toluene, benzene, and xylene. It is not known if these chemicals were discharged into the septic system.

The sinks and toilets in Building 9984 drained to the west septic system on the west side of the building. According to September 1993 site interviews, the two drainfield lines in the southern half of the drainfield were removed during construction of a facility to the west. A SNL/NM Facilities Engineering drawing (SNL/NM February 1987) indicates that the drainfield modification occurred in approximately 1987. The former area of the southern half of the drainfield was not investigated as part of the ER Site 145 characterization work because of the hazard from abundant buried electrical utilities located in that area. Also, according to September 1993 site interviews, three floor drains in Building 9984 discharged to a grease trap outside the northwest corner of the building, and then via a 180-foot long drainline to a surface outfall in a roadside ditch on the south side of Magazine Road. An SNL/NM Facilities Engineering map (SNL/NM February 1987) also shows the approximate proposed bearing and length of the grease trap drainline. The surface outlet of the drain could not be located during the September 1993 site walkover (IT March 1994). It was probably removed when the excavation work for the new sanitary sewer line on the south side of Magazine Road took place in about 1991 (SNL/NM June 1991).

There are two other drain systems at the Solar Facility that were not included in the ER Site 145 investigation. A small drywell is located on the south side of Building 9981-A, a small structure that is about 300 feet southeast of Building 9981. Building 9981-A, which is not shown on Figure 1-2, houses a furnace and assorted equipment for monitoring solar receiver performance, and contains floor drains that are connected to the drywell. Available information presented in SNL/NM January 1995, and the nature of the use of Building 9981-A indicates that significant amounts of contaminants could not have been discharged to this drywell. Also, a SNL/NM Facilities Engineering drawing (SNL/NM May 1978) shows a drainline exiting the northwest corner of Building 9982 and daylighting in a small ditch about 100 feet west of the building. Discussions with a long-term employee at the site indicated that the floors of the building were never washed down and the floor drains were grouted in 1989 (SNL/NM November 1994e). The pipe is no longer exposed and the area is covered with asphalt. This drain was not included in the ER Site 145 investigations because process knowledge did not indicate any releases from the unit. These two units are listed with other SNL/NM non-ER septic and drain systems that will be investigated.

2.2 Previous Audits, Inspections, and Findings

There were no previous audits, inspections, or findings related to ER Site 145 except for some septic tank sampling results. Liquid and sludge samples were collected from the east system septic tank in July 1992 (SNL/NM June 1993). The liquid samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls, total metals, other miscellaneous constituents, gross alpha and beta activity, and three radionuclide constituents. Two VOCs, two SVOCs, a number of metals and other constituents, and very low radium-226 and radium-228 activities were detected in the liquid. The sludge samples (which consisted of 93% water) were analyzed for total metals, gross alpha and beta activity, tritium, and a number of radionuclides. Nine metals, gross alpha and beta activity, and low activity levels of a number of radionuclides were identified in the material. The analytical results of the July 1992 east tank samples are presented in Section 6.1.

3.0 EVALUATION OF RELEVANT EVIDENCE

3.1 Unit Characteristics and Operating Practices

There are no safeguards inherent in the drain systems from Buildings 9981/9982, 9984, or in facility operations, that could have prevented past releases to the environment. As discussed in Section 2.1, effluent was released to the Building 9981/9982 and 9984 septic systems and the Building 9984 grease trap drainline outfall when the septic and drain systems were active.

The two septic systems at the site are no longer in use. A memo dated June 21, 1991, from Joe Jones to David Dionne (SNL/NM June 1991) indicates that the Building 9981/9982 and 9984 septic tanks, and many others, had been removed from service with the construction of the Technical Area III sanitary sewer system. The Building 9984 grease trap was also connected to the sanitary sewer system at this time.

3.2 Results of Previous Sampling/Surveys

3.2.1 Summary of Prior Investigations

In preparing the confirmatory sampling NFA proposal for ER Site 145, available background information was reviewed to quantify potential releases and to select analytes for the soil sampling. The following sources of information were used to evaluate ER Site 145:

- Results of samples collected from the east and west septic tanks in April and November 1994 (SNL/NM April 1994a and November 1994a);
- Two survey reports, including a geophysical survey (Lamb 1994), and a passive soil gas survey (NERI June 1995);
- Confirmatory subsurface soil sampling conducted in November 1994 (SNL/NM November 1994c) and January 1995 (SNL/NM January 1995a);
- Approved RCRA Facilities Investigation (RFI) Work Plan for OU 1295, Septic Tanks and Drainfields (SNL/NM March 1993), and addenda (EPA September 1994, SNL/NM November 1994e and December 1994, EPA January 1995, SNL/NM January 1995c, March 1995a and March 1995b, EPA March 1995, and SNL/NM May 1995);
- Photographs and field notes collected at the site by SNL/NM ER staff;
- SNL/NM Facilities Engineering building drawings; and
- SNL/NM Geographic Information System data.

3.2.2 Septic Tank Sampling

East System Septic Tank Sampling

Additional sludge samples was collected for waste characterization from the east system tank in April 1994 (SNL/NM April 1994a). These samples were analyzed for VOCs, phenolic compounds, and the eight RCRA Toxicity Characteristic Leaching Procedure (TCLP) metals. Low concentrations of eight VOCs were identified; only one of the eight metals (barium) was detected in the TCLP-derived leachate from the sludge. The analytical results of the April 1994 east septic tank samples are presented in Section 6.2.

Another round of samples were collected from the east tank in November 1994 (SNL/NM November 1994a). The liquid samples were analyzed for isotopic uranium, tritium, and were screened for additional radionuclides using SNL/NM in-house gamma spectroscopy. Only very low activities of uranium-233/234 and uranium-238 were detected in the liquid. The sludge samples were analyzed for SVOCs, isotopic uranium, tritium, and were also screened for other radionuclides using SNL/NM in-house gamma spectroscopy. Low activity levels of three isotopic uranium constituents and a few additional radionuclides and a below-reporting-limit concentration of one SVOC (2-methylnapthalene) were identified in the material. The results of the third round of east tank septage samples are also presented in Section 6.2.

West System Septic Tank Samples

The first set of liquid and sludge waste characterization samples was collected from the west system tank in April 1994 (SNL/NM April 1994a). Both the liquid and sludge samples were analyzed for VOCs, phenolic compounds, cyanide, and total RCRA metals. The sludge was also analyzed for the eight RCRA TCLP metals. Trace levels of one VOC and cyanide were detected in the sludge, and neither was identified in the liquid samples. Very low concentrations of two of the eight RCRA metals were detected in the liquid. Six of the eight metals were identified in the sludge, but only one of the eight (barium) was detected in the TCLP metals analysis of the same material. The analytical results of the April 1994 west tank samples are presented in the Section 6.2 table.

A second and final set of liquid and sludge waste characterization samples was collected from the west system tank in November 1994 (SNL/NM November 1994a). The liquid and sludge samples were analyzed for SVOCs, isotopic uranium, tritium, and were also screened for radionuclides using SNL/NM in-house gamma spectroscopy. SVOCs and tritium were not identified in the liquid or sludge. Very low activity levels of two out of three of the isotopic uranium radionuclides were detected in both the liquid and sludge, and trace activities of a number of radionuclides were detected as a result of the gamma spectroscopy analysis. The analytical results of the November 1994 west tank samples are also presented in Section 6.2.

3.2.3 Geophysical Surveys

Three geophysical surveys using ground conductivity methods were completed in the east and west drainfield areas in February 1994. A Geonics™ model EM-38 was used for shallow investigations (less than 5 feet depth), and a model EM-31 was employed for deeper subsurface investigations (up to 18 feet bgs). Areas of either low conductivity (indicating possible areas of disturbed soils) or high conductivity (indicating possible areas of moist soils) were identified near the southeast corner of the east system drainfield. Geophysical techniques were not effective for precisely locating the drainlines in the two drainfields. The actual drainline locations (Figure 1-2) were later determined using a backhoe (SNL/NM August 1994).

3.2.4 Passive Soil-Gas Survey

A passive soil-gas survey conducted in the two drainfield areas in May and June 1994 used PETREX™ sampling tubes to identify any releases of VOCs and SVOCs to the drainfields that may have occurred (SNL/NM May 1994). A PETREX™ tube soil-gas survey is a semi-quantitative screening procedure that can be used to identify many VOCs and SVOCs. This technique may be used to guide VOC and SVOC site investigations. The advantages of this sampling methodology are that large areas can be surveyed at relatively low cost, the technique is highly sensitive to organic vapors, and the result produces a measure of soil vapor chemistry over a two- to three-week period rather than at one point in time.

Each PETREX™ soil-gas sampler consists of two activated charcoal-coated wires housed in a reusable glass test tube container. At each sampling location, sample tubes are buried in an inverted position so that the mouth of the sampler is about 1 foot below grade. Samplers are left in place for a two- to three-week period, and are then removed from the ground and sent to the manufacturer, Northeast Research Institute (NERI), for analysis using thermal desorption-gas chromatography/mass spectrometry. The analytical laboratory reports all sample results in terms of "ion counts" instead of concentrations, and identifies those samples that contain compounds above the PETREX™ technique detection limits. In NERI's experience, levels below 100,000 ion counts for a single compound (such as perchloroethene [PCE] or TCE), and 200,000 ion counts for mixtures (such as benzene, toluene, ethylene, and xylene [BTEX] or aliphatic compounds [C4-C11 cycloalkanes]), under normal site conditions, would not represent detectable levels by standard quantitative methods for soils and/or groundwater (NERI June 1995).

Ten PETREX™ samplers (numbers 50 through 59) were placed in a grid pattern that covered the west drainfield area, and 11 samplers (numbers 60 through 70) were placed in a grid pattern that covered the east drainfield area at this site (SNL/NM May 1994). Two samplers (numbers 71 and 72) were also installed around the grease trap outfall location even though soils in this area were extensively disturbed when the sanitary sewer line was extended to the Solar Facility by June 1991 (SNL/NM June 1991). Two maps showing the ER Site 145 PETREX™ sampling locations, and the analytical results of the ER Site 145 passive soil gas survey are included in Section 6.3. All of the PETREX™ samplers placed at this site were analyzed for two individual constituents (PCE and TCE) and two compounds groups (BTEX and aliphatic compounds). Potentially significant concentrations of VOCs in soil gas were identified at only 1 of the 23 PETREX™ samplers placed at this site. Both wires in the sampler placed at the east drainfield location 64 were analyzed for quality assurance/quality control (QA/QC) purposes. TCE ion counts of 210,756 were detected from one of the wires (denoted as "D-1064" in the Section 6.3 table), whereas the second wire (designated "64" in the table) contained only 92,338 TCE ion counts, which is below the single compound level of significance. As described in Section 3.6 below, confirmatory soil samples were collected within 27 feet of PETREX™ sampler 64 location. However, aside from laboratory-introduced contaminants, VOCs were not detected in any of the confirmatory soil samples collected from ER Site 145.

3.2.5 Confirmatory Soil Sampling

A backhoe was used in August 1994 to determine the precise location, dimensions, and depths of the drainlines in the two ER Site 145 drainfields, which had no surface expression. No visible evidence of soil discoloration, staining, or odors indicating residual contamination was observed (SNL/NM August 1994). Evidence of contamination also was not observed when soil samples were collected in the east and west system drainfields and around the septic tanks with the Geoprobe™ in November 1994 (SNL/NM November 1994c), and from two borings near the former grease trap outfall in January 1995 (SNL/NM January 1995a).

The east drainfield excavation operation is shown in the upper photograph of Figure 3-1. Once the drainlines were located, soil sampling at ER Site 145 was conducted in 1994 and 1995 to determine whether COCs above background or action levels were released at this site. The confirmatory soil sampling program was performed in accordance with the rationale and procedures described in the approved Septic Tanks and Drainfields (ADS-1295) RFI Work Plan (SNL/NM March 1993), and ER Site 145-pertinent addenda to the Work Plan (referenced in bullet item #4 in Section 2.1 above). A summary of the types of samples, number of sample locations, sample depths, and analytical requirements for the confirmatory soil samples collected at this site is presented in Table 3-1.

As shown on Figure 1-2, soil samples were collected from one boring on either side of and within 2 feet of the sides of the east system septic tank to determine if COCs had been released from a possible leaking or failed unit. The east septic tank soil samples were collected from one interval in each borehole starting at the bottom of the tank, which was determined to be 11 feet bgs based on field measurements (SNL/NM November 1994c). East drainfield samples were collected from five borings located 10 feet from the ends of each of the five drainfield lateral lines, and from two boreholes located at two of the lateral line junction points. Samples were collected from two intervals in each of the seven east drainfield boreholes. The top of the shallow intervals started at the bottom of the drainline trenches (average of 9 feet bgs), and the lower (deep) interval started at 10 feet below the top of the upper interval, or 19 feet bgs.

Trench excavated with a backhoe to partially expose and locate the east drainfield drainlines. August 30, 1994. View looking west.

East septic tank septage removal and decontamination operation. December 7, 1995. View looking southwest.

Figure 3-1. ER Site 145 Photographs

Table 3-1
Confirmatory Soil Sampling Summary Table

Sampling Location	Analytical Parameters	Number of Sample or Borehole Locations	Top of Sampling Intervals at Each Boring Location	Total Number of Investigative Samples	Total Number of Duplicate Samples	Date(s)Samples Collected
East System Drainfield Soil Samples	VOCs	7	9' and 19'	14	1	11/22 & 28/94
	SVOCs	7	9' and 19'	14	1	"
	RCRA metals + Cr^{6+}	7	9' and 19'	14	1	"
	Cyanide	7	9' and 19'	14	1	"
	Soil pH	7	9' and 19'	14		"
	Isotopic uranium comp.	7	9' and 19'	2		"
	Tritium composite	7	9' and 19'	2		"
	Gamma spec. composite	7	9' and 19'	2		"
Soil Samples Next to the East System Septic Tank	VOCs	2	11'	2		11/28/94
	SVOCs	2	11'	2		"
	RCRA metals + Cr^{6+}	2	11'	2		"
	Cyanide	2	11'	2		"
	Soil pH	2	11'	2		"
West System Drainfield Soil Samples	VOCs	3	4' and 14'	6		11/28/94
	SVOCs	3	4' and 14'	6		"
	RCRA metals + Cr^{6+}	3	4' and 14'	6		"
	Soil pH	3	4' and 14'	6		"
	Tritium composite	3	4' and 14'	2		"
	Gamma spec. composite	3	4' and 14'	2		"
Soil Samples Next to the West System Septic Tank	VOCs	2	6'	2	1	11/28/94
	SVOCs	2	6'	2	1	"
	RCRA metals + Cr^{6+}	2	6'	2	1	"
	Cyanide	2	6'	2	1	"
	Soil pH	2	6'	2		"
Soil Samples Near the Building 9984 Grease Trap Drainline Outfall	VOCs	2	1' and 11'	4		1/26/95
	SVOCs	2	1' and 11'	4		"
	RCRA metals + Cr^{6+}	2	1' and 11'	4		"
	Cyanide	2	1' and 11'	4		"
	Soil pH	2	1' and 11'	4		"
	Tritium composite	2	1' and 11'	2		"
	Gamma spec. composite	2	1' and 11'	2		"

Notes
Comp. = Composite
Cr^{6+} = Hexavalent chromium
RCRA = Resource Conservation and Recovery Act
Spec. = Spectroscopy
SVOCs = Semivolatile organic compounds
VOCs = Volatile organic compounds

Soil samples were also collected from one boring on either side of and within 2 feet of the sides of the west system septic tank. The west septic tank soil samples were collected from one interval in each borehole starting at the bottom of the tank, which was determined to be 6 feet bgs based on field measurements (SNL/NM November 1994c). West drainfield samples were collected from three borings located near the beginning, middle, and ends of the three remaining drainfield lateral lines (Figure 1-2). Samples were collected from two intervals in each of the three west drainfield boreholes. The top of the shallow intervals started at the bottom of the drain line trenches (average of 4 feet bgs), and the lower (deep) interval started at 10 feet below the top of the upper interval, or 14 feet bgs. No attempt was made to drill and collect samples in the area of the former south side of this drainfield because of the safety hazards associated with abundant buried electrical utilities in that area, and because of the soil disturbance that occurred during their installation.

Finally, subsurface soil samples were collected from two boreholes located near the estimated end of the grease trap drainline (Figure 1-2). Samples were collected from two depth intervals starting at 1 foot and 11 feet bgs in each borehole. As discussed in Section 2.3 above, the surface outlet of the drain could not be located during the September 1993 site walkover, and was probably removed when the drainline was connected to the new sanitary sewer line by 1991 (SNL/NM June 1991). Therefore, for purposes of selecting borehole locations the former location of the outfall was estimated based on the February 1987 drawing (SNL/NM February 1987), and information provided by Solar Facility personnel.

The Geoprobe™ sampling system was used to collect subsurface soil samples at this site. The Geoprobe™ sampling tool was fitted with a butyl acetate (BA) sampling sleeve and was then hydraulically driven to the top of the designated sampling depth. The sampling tool was opened, and driven an additional 2 feet in order to fill the 2-foot long by 1.25-inch diameter BA sleeve. The sampling tool and soil-filled sleeve were then retrieved from the borehole. In order to minimize the potential for loss of volatile compounds (if present), the soil to be analyzed for VOCs was not emptied from the BA sleeve into another sample container. The filled BA sleeve was removed from the sampling tool, and the top 7 inches were cut off. Both ends of the 7-inch section of filled sleeve were immediately capped with a Teflon membrane and rubber end cap, sealed with tape, and placed in an ice-filled cooler at the site. The soil in this section of sleeve was submitted for a VOC analysis.

Soil from the remainder of the sleeve was then emptied into a decontaminated mixing bowl. Following this, one or two more 2-foot sampling runs were then completed at each interval in order to recover enough soil to satisfy sample volume requirements for other analyses from the interval. Soil recovered from these additional runs was also emptied into the mixing bowl and blended with soil from the first sampling run. The blended soil was then transferred from the bowl into sample containers using a decontaminated plastic spatula.

Soil samples collected next to the septic tanks, in the drainfields, and from the grease trap outfall location were analyzed for VOCs, SVOCs, RCRA metals, hexavalent chromium, and cyanide by an off-site commercial laboratory, and soil pH for each sample was determined by an SNL/NM laboratory. Shallow and deep interval composite samples collected from the two drainfields and the grease trap outfall area were analyzed by an off-site commercial laboratory for tritium, and were screened for other radionuclides using SNL/NM in-house gamma spectroscopy. Shallow and deep interval composite soil samples from the east drainfield also were analyzed for isotopic uranium by an off-site laboratory because slightly anomalous uranium-233/234 and uranium-238 activities were detected in the tank sludge. No isotopic uranium soil samples were collected from the west drainfield or the grease trap outfall area because no anomalous uranium activities were detected in the west tank septage, and because there is no history or evidence of radionuclide usage at Buildings 9981/9982 or 9984. Samples were shipped to the offsite commercial laboratories by an overnight delivery service. Routine SNL/NM chain-of-custody and sample documentation procedures were employed for all samples collected at this site.

3.2.6 Quality Assurance/Quality Control Summary

QA/QC samples collected during the 1994 sampling effort included one set of duplicate soil samples from the shallow sampling interval in the east system drainfield borehole DF1-4, and a second set of duplicate soil samples from borehole ST2-2 next to the west septic tank (Figure 1-2). One set of aqueous equipment rinsate blanks was also collected during this sampling effort. The duplicate samples and equipment rinsate samples were analyzed for most of the same constituents (including VOCs, SVOCs, cyanide, RCRA metals, and cyanide) as the equivalent field samples from the same sampling intervals. Concentrations of the organic and inorganic constituents detected in the duplicate soil samples were for the most part in good agreement with those detected in the equivalent field samples from the same intervals, except for barium. Barium concentrations detected in both of the field samples were three to four times lower than, and in relatively poor agreement with, the barium concentrations detected in the equivalent duplicate samples from the same intervals. Except for two laboratory-introduced VOCs and one SVOC, no COCs were detected in the equipment rinsate samples.

Two soil trip blank samples were included with shipments of the November 1994 VOC soil samples to the off-site laboratory, and a third soil trip blank was included with the grease trap outfall samples shipped to the off-site laboratory in January 1995. Up to seven VOCs (acetone, 2-hexanone, methyl ethyl ketone [MEK], methyl isobutyl ketone [MIBK], methylene chloride, toluene, and total xylenes) were detected in the three trip blanks. These common laboratory contaminants were either not detected, or were for the most part found in lower concentrations in the site samples compared to the trip blanks. Soil used for the trip blanks was prepared by heating the material, and then transferring it immediately to the sample container. This heating process drives off any residual organic compounds (if present) and soil moisture that may be contained in the material. It is thought that when the soil trip blank container was opened at the laboratory, it immediately adsorbed both moisture and VOCs present in the laboratory atmosphere, and therefore became contaminated.

Analytical data summary tables of organic and inorganic constituents analyzed for and detected by commercial laboratory analyses in the 1994 and 1995 confirmatory soil and associated QA samples, and the soil pH measurements completed by an SNL/NM in-house laboratory, are contained in Section 6.4. Results of the SNL/NM in-house gamma spectroscopy screening for other radionuclides in soil samples from the two drainfields and in the grease trap outfall area are presented in Sections 6.5 through 6.10. Complete soil and septic tank septage sample analytical data packages for samples collected in 1994 and 1995 are archived in the SNL/NM

Environmental Safety and Health (ES&H) Records Center and are readily available for review and verification (SNL/NM April 1994b, November 1994b, November 1994d, January 1995b, and August 1995a).

3.3 Gaps in Information

The most recent material in the septic tanks was not necessarily representative of all discharges to the units that have occurred since the east and west systems were put into service starting in 1976 and 1985, respectively. The analytical results of the various rounds of septic tank sampling were used, along with process knowledge and other available information, to help identify the most likely COCs that might be found in soils surrounding the septic tanks, beneath the drainfields, and near the grease trap outfall, and to help select the types of analyses required. While the history of past releases at the site is incomplete, analytical data from soil samples collected at the site in November 1994 and January 1995 (Section 3.2.5) and subsequent risk assessment (Section 3.4) are sufficient to determine whether significant releases of COCs occurred at the site.

3.4 Risk Evaluation

The following subsections summarize the results of the risk assessment process for both human and ecological risk related factors. A complete discussion of the risk assessment process, assumptions, results, and uncertainties is provided in Section 6.11.

3.4.1 Human Risk Analysis

ER Site 145 has been recommended for industrial land-use (DOE 1996). Due to the presence of several metal COCs in a few samples at concentrations slightly greater than the SNL/NM 95th percentile or upper tolerance limit (UTL) background levels, it was necessary to perform a human health risk assessment analysis for the site. The risk assessment process results in 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 land-use and residential land-use setting.

In summary, the total hazard index calculated for chemical compounds is 0.02 for an industrial land-use setting, which is less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). The total excess cancer risk for chemical compounds is estimated to be 3×10^{-6} in an industrial land-use setting, which is at the low end of the suggested range of acceptable risk of 10^{-6} and 10^{-4} (EPA 1989).

The residential land-use scenarios for this site are provided only for comparison in the risk assessment analysis in Section 6.11. The analysis concludes that ER Site 145 does not have significant potential to affect human health under an industrial land-use scenario.

3.4.2 Ecological Risk Analysis

It is unlikely that the COCs at ER Site 145 will have much impact on ecological risk. Much of the relevant ecological information for ER Site 145 can be found in the National Environmental Policy Act (NEPA) compliance document (SNL/NM 1992). Ecological risk has not been addressed in this NFA proposal because the ecological risk analysis for ER Site 145 has not been estimated at this time. Ecological risk analyses are being conducted for SNL/NM ER Sites and the relevant analysis for this site will be presented when available.

4.0 RATIONALE FOR NO FURTHER ACTION DECISION

ER Site 145 is being proposed for an NFA determination for the following reasons:

- As discussed in Section 3.2.4, the passive soil-gas survey did not indicate any anomalies or areas of VOC or SVOC contamination in the two drainfield areas of this site.

- As shown in Section 6.4, only low concentrations of four VOC compounds (acetone, MEK, methylene chloride, and toluene), which are common laboratory contaminants, were detected in soil samples collected from ER Site 145. These four VOCs were also detected in associated soil trip blanks shipped with the samples, and are believed to be artifacts of laboratory contamination. One SVOC (di-n-butyl phthalate) was detected at a below-reporting limit concentration of 50 micrograms per kilogram (ug/kg) in the duplicate soil sample from the shallow sampling interval at the east drainfield location DF1-4 (Figure 1-2). It was not detected in the equivalent field sample from that interval. In addition, all detected concentrations of VOCs and SVOCs were much less than the proposed Subpart S action levels for the respective compounds. Cyanide was detected at near-reporting-limit concentrations of 640 and 820 ug/kg in two of the deep interval samples from the east drainfield. These concentrations are much lower than the proposed Subpart S soil action level of 2,000,000 ug/kg for cyanide in soil (EPA July 1990).

- As shown on Section 6.4, ER Site 145 soil sample analytical results indicate that the nine metals that were targeted in the Site 145 investigation were either (1) not detected, or (2) were detected in concentrations below the background UTL or 95th percentile concentrations presented in the SNL/NM study of naturally-occurring constituents (IT March 1996), or (3) were less than the proposed Subpart S action levels for these metals. An anomalous concentration of lead (115 milligrams per kilogram [mg/kg]) was originally detected by a commercial laboratory in the deep interval soil sample from the grease trap outfall boring OF-2 (Figure 1-2). This concentration is higher than corresponding 95th percentile concentration of lead in subsurface background samples from the southwest and off-site areas (IT March 1996), but is well below the EPA-proposed residential action level for lead in soil of 400 mg/kg (EPA July 1994). Also, the sample was submitted to an internal SNL/NM laboratory for a follow-up verification analysis and only 3.9 mg/kg of lead was detected in the material this time (SNL/NM November 1996). The difference between the two samples is most likely the result of non-homogenous nature of the sampled material.

- As shown in Section 6.4, isotopic uranium activity levels detected in the east drainfield shallow and deep interval composite soil samples were less than the corresponding 95th percentile background activity levels presented in the IT March 1996 report for the three radionuclides. Tritium was not detected in soil moisture from either of the east drainfield composite soil samples. Very low tritium activity levels (240 picocuries per liter [pCi/L]) were detected in soil moisture from the two west drainfield composite soil samples, and 260 pCi/L was identified in the shallow interval composite soil sample from the grease trap outfall area. Background tritium activity levels have not been determined for SNL/NM soils. The soil moisture contained in soil samples such as these represents either infiltrated precipitation, or water discharged from the Solar Facility buildings to the drainfields. It is therefore appropriate to compare the tritium activity level detected in the sample soil moisture to naturally occurring tritium levels found in precipitation or drinking water samples. The tritium activity levels of 240 and 260 pCi/L detected in these samples was therefore compared to and was found to be within the range of naturally occurring tritium activity range of 100 to 300 pCi/L found in precipitation samples collected from locations throughout the U.S., and 100 to 400 pCi/L in drinking water samples collected from locations around the country (EPA October 1993). This comparison indicates that tritium is not present above natural background levels in soil moisture beneath the west drainfield, or in the grease trap outfall area at this site.

- The gamma spectroscopy semi-qualitative screening of the composite soil samples from the shallow and deep sampling intervals in the two drainfields and the grease trap outfall area did not indicate the presence of contamination from other radionuclides in soils at this site (Sections 6.4 through 6.9).

- Finally, the west septic tank contents were determined to be non-regulated based on sample analytical results, and the tank was pumped out by a septic tank pumping company on August 31, 1995 (SNL/NM August 1995a). The west tank was backfilled with clean soil on November 14, 1995 (SNL/NM November 1995). The east septic tank septage was removed, and the tank was thoroughly cleaned and decontaminated on December 7, 1995 (SNL/NM December 1995a). The removal and cleaning operation is shown in the bottom photograph of Figure 3-1. The empty tank was then inspected by a representative of the New Mexico Environment Department (NMED) to verify that the tank contents had been removed and the tank closed in accordance with applicable State of New Mexico regulations (SNL/NM December 1995b).

Sample analytical results generated from this confirmatory sampling investigation and subsequent risk analysis have shown that detectable or significant concentrations of COCs are not present in soils at ER Site 145, and that additional investigations are unwarranted and unnecessary. Based on archival information and chemical and radiological analytical results of soil samples collected next to the two septic tanks, beneath the two drainfields, and in the grease trap outfall area at this site, SNL/NM has demonstrated that COCs that may have been released from this SWMU into the environment pose an acceptable level of risk under current and projected future land use (DOU Criterion 5), and the site does not pose a threat to human health or the environment. ER Site 145 is therefore recommended for an NFA determination.

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6.11 Risk Assessment Analysis

6.11.1 Site Description and History

ER Site 145 is located on Kirtland Air Force Base (KAFB), approximately 1.3 miles north of the Isleta Pueblo boundary and 1 mile west of Lovelace Road. The site is also about 1,500 feet northwest of the Solar Power Tower (SPT), a prominent landmark in the area, and is situated northeast and west of Building 9984.

ER Site 145 consists of two contiguous areas that encompass two septic systems and the area immediately around a former grease trap outfall. The system northwest of Buildings 9981 and 9982, and northeast of Building 9984 consisted of an 8-foot by 15-foot concrete septic tank, and five 4-inch diameter by 50-foot-long parallel PVC drainlines that were buried about 6 to 7 feet below the ground surface (bgs). The system west of Building 9984 consisted of a 4-foot wide by 8-foot long concrete septic tank and three 4-inch diameter by 40 feet long parallel PVC drainlines buried about 2 feet bgs. The third portion of ER Site 145 is the area immediately around the former grease trap outfall. The three portions of ER Site 145 encompass a total of approximately 0.4 acres of flat-lying land at an average mean elevation of 5,570 feet above mean sea level (amsl).

The Solar Facility was constructed in 1976 for the research and development of solar thermal technology. The Solar Control Building 9981 is a large office and control building containing a staff of 30 to 50 people. The Solar Assembly Building 9982 is used for repair and assembly of heliostats and other solar equipment. Building 9984, located west of Building 9982, is known as the Engine Test Facility. SNL/NM Facilities Engineering drawings and information from an employee at the Solar Facility indicate that Building 9984 (and the associated west septic system and grease trap outfall) was constructed in late 1985.

Buildings 9981 and 9982 shared the now abandoned east septic system for lavatories and sinks. One sink in Building 9982 may have received small quantities of solvents (acetone, methanol, TCE, 1,1,1-trichloroethane, and tetrachloroethene). Material Safety Data Sheets in Building 9981 listed other chemicals used in the facility, including methyl cyanide, methylene chloride, hexane, hydrofluoric acid, toluene, benzene, and xylene. It is not known if these chemicals were discharged into the septic system.

The sinks and toilets in Building 9984 drained to the west septic system on the west side of the building. According to September 1993 site interviews, the two drainfield lines in the southern half of the drainfield were removed during construction of a facility to the west. A SNL/NM Facilities Engineering drawing indicates that the drainfield modification occurred in approximately 1987. The former area of the southern half of the drainfield was not investigated as part of the ER Site 145 characterization work because of the hazard from abundant buried electrical utilities located in that area. Also, according to September 1993 site interviews, three floor drains in Building 9984 discharged to a grease trap outside the northwest corner of the building, and then via a 180-foot long drainline to a surface outfall in a roadside ditch on the south side of Magazine road. An SNL/NM Facilities Engineering map also shows the approximate proposed bearing and length of the grease trap drainline. The surface outlet of the drain could not be located during the September 1993 site walkover. It was probably removed when the excavation work for the new sanitary sewer line on the south side of Magazine Road took place in about 1991.

6.11.2 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 include:

Step 1.	Site data are described which 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 standards established by the United States (U.S.) Environmental Protection Agency (USEPA) and U.S. Department of Energy (USDOE) to determine if 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.	Discussion of uncertainties in the previous steps.

6.11.2.1 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 145 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. Both radioactive and nonradioactive COCs are evaluated. The only nonradioactive COCs evaluated are metals because VOCs were either non-detect or were determined to be laboratory contamination.

6.11.2.2 Step 2. Pathway Identification

ER Site 145 has been designated with a future land-use scenario of industrial (see Attachment 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 for metals is included because of the potential to inhale dust. It is included for radionuclides because of the potential to inhale dust and volatiles. Direct gamma exposure is also included in the radioactive contamination risk assessment. No contamination at depth was determined and therefore no water pathways to the groundwater are considered. Depth to groundwater at Site 145 is approximately 140 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)	Inhalation (Dust and Volatiles)
Plant uptake (Residential only)	Plant uptake (Residential only)
	Direct Gamma

6.11.2.3 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 145 were evaluated using a tiered approach. The maximum concentrations of COCs were compared to the SNL/NM background screening level for this area (IT, 1996). 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 (NURE) program (USGS, 1994). For the purpose of this investigation the background for tritium in soil moisture was assumed to be represented by samples taken by the EPA of rainwater throughout the United States (USEPA, 1993). Assuming that the atmospheric tritium concentration in this rainwater is in equilibrium with tritium in soil moisture this background range used is 100 - 400 pCi/liter (pCi/l) of soil moisture.

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

For radiological COCs that exceeded both the SNL/NM background screening levels and, as applicable, were above the EPA background tritium range, 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 USDOE orders. Radioactive COCs that did not have a background value and were detected above the analytical minimum detectable activity (MDA) 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 far enough below the assigned background level. When this "masking" occurs, the final incremental TEDE and estimated cancer risk are reduced and, therefore, provide a non-conservative 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.

Next, the remaining maximum concentration for each remaining nonradiological COC 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 264, 1990) and Risk Assessment Guidance for Superfund (RAGS) (USEPA, 1989) documentation. Accordingly, all calculations were based on the assumption that receptor doses from both toxic and potentially carcinogenic compounds result most significantly from ingestion of contaminated soil. Because the samples were collected below ground surface, this assumption is conservative. If there are 10 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 10 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 (USEPA, 1989). The combined effects of all nonradiological COCs in the soils were calculated. The combined effects of all associated nonradiological background constituents in the soils were also calculated. For toxic compounds, this was accomplished by summing the individual hazard quotients for each compound into a total Hazard Index. This Hazard Index is compared to the recommended standard 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 excess cancer risk estimated using USDOE's RESRAD computer code.

6.11.2.3.1 Comparison to Background and Action Levels

Nonradioactive ER Site 145 COCs are listed in Table 6-1; radioactive COCs are listed in Table 6-2. Both tables show the associated 95th percentile or UTL background levels (IT, 1996). The SNL/NM background levels have not yet been approved by the USEPA 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 report was submitted for regulatory review in early 1996. The values shown in Table 6-1 supersede the background values described in an interim background study report (IT, 1994). 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 is 9.8 mg/kg. The USEPA 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 2000 mg/kg (EPA, 1996a); for a residential land-use scenario, the EPA screening guidance value is 400 mg/kg (EPA, 1994a). 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.

Table 6-1
Nonradioactive COCs at ER Site 145 and Comparison to the Background Screening 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	5.2	7	Yes
Barium	248	214	**No**
Cadmium	<0.5	0.9	Yes
Chromium, total*	6.8	15.9	Yes
Chromium VI	<0.1	<2.5	**No^**
Cyanide	0.82	NC	**No**
Lead	9.8	11.8	Yes
Mercury	<0.1	<0.1	**No^**
Selenium	<0.5	<1.0	**No^**
Silver	<1	<1.0	**No^**

* total chromium assumed to be chromium III because chromium VI is calculated separately
^ uncertainty due to detection limits
NC - not calculated

Table 6-2
Radioactive COCs at ER Site 145 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	260 pCi/l	100-400 pCi/l	Yes
U-238	0.802	1.4	Yes
U-235	0.043 (J)	0.16	Yes
U-233/234	0.831	1.4*	Yes

* Background value provided as "<5.02", therefore background U-234 is assumed to be equal to that of it's parent radionuclide, U-238, as they would exist in secular equilibrium in their naturally-occurring state.
J - estimated value

Because several nonradiological COCs had concentrations greater than their respective 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. Since all radionuclide levels are indicative of background concentrations the radionuclides are not carried any further in the risk assessment. Table 6-3 shows the inorganic COCs. The table also shows 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 USEPA (USEPA, 1996b). This is the second screening process in the tiered risk assessment approach. One nonradioactive compound (arsenic) had a concentration value greater than 1/10 of the proposed Subpart S action level. Because of arsenic, the site fails the proposed Subpart S screening criteria and a Hazard Index value and cancer risk value must be calculated for the nine nonradioactive contaminants.

6.11.2.3.2 Identification of Toxicological Parameters

Table 6-4 shows the COCs that have been retained in the risk assessment and the values for the toxicological information available for those COCs.

6.11.2.3.3 Exposure Assessment and Risk Characterization

Section 6.11.3.3.1 describes the exposure assessment for this risk assessment.
Section 6.11.3.3.2 provides the risk characterization including the Hazard Index value and the excess cancer risk for both the potential COCs and associated background; industrial and residential land-uses.

Table 6-3
Comparison of ER Site 145 Nonradioactive 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	5.2	0.5	**No**
Barium	248	6000	Yes
Cadmium	<0.5	80	Yes
Chromium, total*	6.8	80,000	Yes
Chromium VI	<0.1	400	Yes
Cyanide	0.82	2000	Yes
Mercury	<0.1	20	Yes
Selenium	<0.5	400	Yes
Silver	<1	400	Yes

* total chromium assumed to be chromium III because chromium VI is calculated separately

Table 6-4
Nonradioactive Toxicological Parameter Values for ER Site 145 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*	1	0.000000571	L	--	--	**D**
Chromium VI	0.005	--	L	--	42	**A**
Cyanide	0.02	--	M	--	--	**D**
Mercury	0.0003	0.0000857	--	--	--	**D**
Selenium	0.005	--	H	--	--	**D**
Silver	0.005	--	--	--	--	**D**

* total chromium assumed to be chromium III because chromium VI is calculated separately
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

Exposure Assessment

Attachment 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 on RAGS (USEPA, 1989). The parameters are based on information from RAGS (USEPA, 1989) as well as other USEPA guidance documents and reflect the RME approach advocated by RAGS (USEPA, 1989).

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 to only provide perspective of the potential for risk to human health under the more restrictive land-use scenario.

Risk Characterization

Table 6-5 shows that for the ER Site 145 nonradioactive COCs, the Hazard Index value is 0.02 and the excess cancer risk is 3×10^{-6} for the designated industrial land-use scenario. The numbers presented included exposure from soil ingestion and dust inhalation for the nonradioactive COCs. Table 6-6 shows that for the ER Site 145 associated background constituents, the Hazard Index is 0.02 and the excess cancer risk is 4×10^{-6} for the designated industrial land-use scenario.

For the residential land-use scenario, the calculated Hazard Index is 1, which is at the numerical guidance. The excess cancer risk is estimated at 6×10^{-5}; this value is in the middle of the suggested acceptable risk range. The Hazard Index for associated background for the residential land-use scenario is also 1. The excess cancer risk is estimated at 8×10^{-5}. For the residential land-use scenario, there is no incremental Hazard Index or incremental cancer risk. All radiological COCs are indicative of background

6.11.2.4 Step 7 Uncertainty Discussion

The conclusion from the risk assessment analysis is that the potential effects caused by potential COCs on human health are within the acceptable range compared to established numerical standards for the industrial land-use scenario. Calculated incremental risk between potential nonradiological COCs and associated nonradiological background indicate no contribution of risk from COCs when considering the industrial land-use scenario.

The main contributor to the adverse effects on human health is arsenic (5.2 mg/kg). Arsenic was below the respective background screening level. Therefore, this risk assessment is considered conservative as arsenic is probably not indicative of contamination. All radiological COCs are indicative of background.

The potential effects on human health are greater when considering the residential land-use scenario. However there is no incremental risk between potential COCs and associated

Table 6-5
Nonradioactive Risk Assessment Values for ER Site 145 COCs

COC Name	Maximum concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	5.2	0.02	3E-6	0.30	6E-5
Barium	248	0.00	--	0.04	--
Cadmium	<0.5	0.00	2E-10	0.41	3E-10
Chromium, total*	6.8	0.00	--	0.00	--
Chromium VI	<0.1	0.00	3E-10	0.00	4E-10
Cyanide	0.82	0.00	--	0.01	--
Mercury	<0.1	0.00	--	0.17	--
Selenium	<0.5	0.00	--	0.18	--
Silver	<1	0.00	--	0.04	--
TOTAL		**0.02**	**3E-6**	**1**	**6E-5**

* total chromium assumed to be chromium III because chromium VI is calculated separately
-- information not available

Table 6-6
Nonradioactive Risk Assessment Values for ER Site 145 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	7	0.02	4E-6	0.4	8E-5
Barium	214	0.00	--	0.03	--
Cadmium	0.9	0.00	4E-10	0.74	5E-10
Chromium, total*	15.9	0.00	--	0.01	--
Chromium VI	<2.5	--	--	--	--
Cyanide	NC	--	--	--	--
Mercury	<0.1	--	--	--	--
Selenium	<1.0	--	--	--	--
Silver	<1.0	--	--	--	--
TOTAL		**0.02**	**4E-6**	**1**	**8E-5**

* total chromium assumed to be chromium III because chromium VI is calculated separately
-- information not available
NC - not calculated due to absence in SNL/NM background report (IT, 1996)

background. The increased effects on human health are primarily the result of including the plant uptake exposure pathway. 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 145 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 (USDOE, 1996). The uncertainty in this conclusion is considered to be small.

Because of the location, history of the site and the future land-use (USDOE, 1996), there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in making the risk assessment analysis. Because the COCs are found in subsurface soils and because of the location and physical characteristics of the site, the exposure pathways relevant to the analysis are conservative. For example, in the case of the industrial land-use scenario, the soil ingestion pathway results are very conservative as a worker contacting the soil at depth would likely be involved in construction and would contact the soil for only a short time instead of 30 years.

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 6-4 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) (USEPA, 1996c) and Integrated Risk Information System (IRIS) (USEPA, 1988, 1994b) databases. 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 standards. Though the residential land-use Hazard Index is at the numerical standard, it has been determined that future land-use at this locality will not be residential (USDOE, 1996). The overall uncertainty in all of the steps in the risk assessment process is considered not significant with respect to the conclusion reached.

6.11.3 Summary

ER Site 145 had relatively minor contamination consisting of some inorganic compounds. All radiological COCs are indicative of background. 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 inhalation for chemical constituents and soil ingestion, dust and volatile inhalation, and direct gamma exposure for radionuclides. These exposure pathways are very conservative as a worker contacting the soil at depth would likely be involved in construction and would contact the soil for only a short time instead of 30 years.

The residential land-use scenario includes the soil ingestion, inhalation, and plant uptake exposure pathways. Because the small amount of contamination present is below ground surface, the potential for exposure from soil ingestion and inhalation of surface dust is not significant. Likewise, plant uptake will generally occur near surface. Because the site is designated as industrial and the residential land-use scenario is provided to only provide perspective, the stated exposure pathways were included but provide a conservative risk assessment.

The main contributors to the industrial land-use scenario risk assessment values is arsenic (5.2 mg/kg). Arsenic was below the respective background screening level. Therefore, this risk assessment is considered conservative as arsenic is probably not indicative of contamination.

Using conservative assumptions and employing a RME approach to the risk assessment, the calculations for the nonradiological COCs show that for the industrial land-use scenario the Hazard Index (0.02) is significantly less than the accepted numerical guidance from the USEPA. The estimated cancer risk (3×10^{-6}) is in the low end of the suggested acceptable risk range. There is no incremental Hazard Index or incremental cancer risk for the industrial land-use scenario.

The calculations show that for the residential land-use scenario the Hazard Index (1) is at the accepted numerical guidance from the USEPA. The estimated cancer risk (6×10^{-5}) is in the middle the suggested acceptable risk range. The increased effects on human health are primarily the result of the inclusion of the plant uptake exposure pathway. 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 145 is an industrial site (USDOE, 1996), the likelihood of significant plant uptake in this area is highly unlikely. Also, the contamination occurs at depth, below typical plant root zones. There is no incremental Hazard Index or incremental cancer risk for the residential land-use scenario. Increased risk from the COCs was evident considering residential land-use, due to plant uptake, but future use will be restricted to industrial land-use (USDOE, 1996).

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

Ecological Risk Assessment

The ecological risk for this site has not been estimated at this time. SNL/NM ecological risk analyses are being conducted and the relevant analysis for this site will be presented when available.

6.11.4 References

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40 CFR Part 196, 1994, Code of Federal Register, Radiation Site Cleanup Regulation, rough draft, U.S. Government, 1994.

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ATTACHMENT 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).

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 x (CR x EFD/BW/AT) x Toxicity Effect
(1)

where

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

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, 1989) 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

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, 1992.

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.

References

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