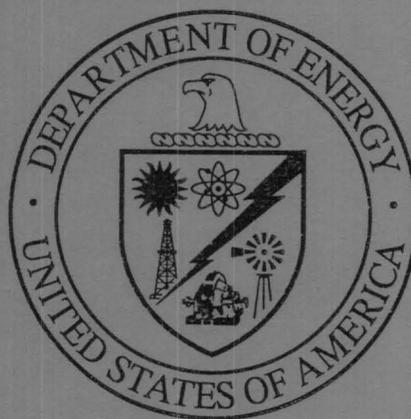


Sandia National Laboratories/New Mexico

**PROPOSAL FOR
RISK-BASED NO FURTHER ACTION
ENVIRONMENTAL RESTORATION SITE 96
STORM DRAIN SYSTEM
OPERABLE UNIT 1302**

May 1997

Environmental
Restoration
Project



United States Department of Energy
Albuquerque Operations Office

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Prepared by
Sandia National Laboratories/New Mexico
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Albuquerque, New Mexico

Prepared for
U.S. Department of Energy

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APPENDICIES

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Appendix C: ER Site 96 Tables

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ACRONYMS

ARCOC	Analysis Request and Chain of Custody
CAB	cellulose acetate butyrate
CEARP Program	Comprehensive Environmental Assessment and Response
COC	constituents of concern
DOE	Department of Energy
DV	data verification/validation
EPA	Environmental Protection Agency
ER	Environmental Restoration
ERDMS	ER data management system
FID	flame ionization detector
GPS	global positioning system
LAL	Lockheed Analytical Laboratory
MDA	minimum detectable activity
ml	milliliter
mrem	millirem
MS	matrix spike
MSD	matrix spike duplicate
NEPA	National Environmental Policy Act
NFA	No Further Action
NMED	New Mexico Environmental Department
NPDES	National Pollutants Discharge Elimination System
PCB	polychlorinated biiphenyl
pCi/g	picocuries per gram
PID	photoionization detector
PIP	Program Implementation Plan
ppb	parts per billion
ppm	parts per million
PRS	potential release site
Pu	plutonium
QC	quality control
RCRA	Resource Conservation and Recovery Act

RFI	RCRA Facility Investigation
RL	reporting limit
SMO	SNL/NM Sample Management Office
SNL/NM	Sandia National Laboratories/New Mexico
SVOC	semi-volatile organic compound
SWMU	solid waste management unit
TA	technical area
TAL	target analyte list
U	uranium
UTL	upper tolerance limit
VCM	Voluntary Corrective Measure
VOC	volatile organic compound
yr	year

1.0 INTRODUCTION

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a No Further Action (NFA) decision for Environmental Restoration (ER) Site 96 determined by risk based analysis with confirmatory sampling (NFA Criterion 5; NMED et al. 1995).

1.1 ER Site Identification Number and Name

ER Site 96 (herein referred to as the site) is the Storm Drain System, and is included in Operable Unit 1302. The Storm Drain System was listed as Site 96 based on information obtained during the Comprehensive Environmental Assessment and Response Program (CEARP) Phase I interviews. (DOE, 1987). The original ER site name was the Storm Drain System (Active). The ER site name was changed to the Storm Drain System during the development of the TA-I RFI Work Plan (SNL/NM, 1995).

1.2 SNL/NM NFA Process

The basis for proposing an NFA is thoroughly described in Section 4.5.3 of the Draft *Program Implementation Plan (PIP) for Albuquerque Potential Release Sites* (SNL/NM, 1994a), and in Annex B of the *Environmental Restoration Document of Understanding* (NMED et al., 1995). ER Site 96 is being proposed for a risk based, confirmatory sampling NFA decision based on NFA Criterion 5. The potential release site (PRS) has been characterized in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use.

1.3 Local Setting

The original storm drain system was constructed between 1948 and 1950. The system collects storm water runoff from TA-I, -II, and -IV. The majority of the storm water flows from east to west with the terrain across SNL/NM. For TA-I, the water is conveyed through a series of open channels and underground lines from north to south to the Tijeras Arroyo. The system was developed in three watersheds and is described in a drainage system analysis (Bohannon-Huston, Inc., 1993). ER Site 96 only covers the storm drain system in and around TA-I (Appendix A, Plate 1-1). The site boundaries are assumed to be the limits of areas where potential constituents of concern (COCs) have been detected near breaks in the lines or at the outfall locations. Any storm water flowing within the system will not be addressed in this NFA. Storm water flow within the storm drain system is

regulated under the National Pollutant Discharge Elimination System (NPDES) amendments to the Clean Water Act (SNL/NM, 1993). The NPDES Permit application was submitted to the EPA on October 1, 1992.

2.0 HISTORY OF THE SWMU

This section provides a summary of the historical information that has been obtained at the site.

2.1 Sources of Supporting Information

Detailed information regarding the site is provided in the following documents.

- *Comprehensive Environmental Assessment and Response Program (CEARP), Phase I: Installation Assessment, Sandia National Laboratories, Albuquerque, New Mexico [DRAFT] (DOE, 1987).*
- *Final RCRA Facilities Assessment Report of Solid Waste Management Units at Sandia National Laboratories, Albuquerque, New Mexico (EPA, 1987).*
- *Program Implementation Plan for Albuquerque Potential Release Sites [Draft] (SNL/NM, 1994a).*
- *Technical Area I (ADS 1302) RCRA Facility Investigation Work Plan (SNL/NM, 1995).*

2.2 Previous Audits, Inspections, and Findings

The site was first listed as a potential SWMU by the *Comprehensive Environmental Assessment and Response Program (CEARP), Phase I: Installation Assessment, Sandia National Laboratories, Albuquerque, New Mexico [DRAFT] (DOE, 1987)*. The listing resulted from information collected during the Phase I interviews in which the system was reported to have received contaminants from various activities. System discharges were reported to include nonpoint source surface runoff from TA-I, blowdown from an incinerator scrubbing system, and cooling tower blowdown water (possibly containing chromates and other antifoulants). There were several specific releases to the storm drains recorded in the CEARP report (DOE, 1987).

- An estimated 200 gal of 20 percent sodium hydroxide spilled from an aboveground tank at ER Site 42, Wastewater Treatment Facility for discharges from Building 870, in 1984.

- An estimated 1000 gal of 30 percent hydrochloric acid was released from an aboveground tank at the Wastewater Treatment Facility near Building 870, ER Site 42, in 1983.
- A cooling tower on the roof of Building 806 caught fire in 1983 and wood slats that were believed to have been contaminated with chromium burned. Much of the debris was reported to have been washed down the drain.
- An estimated 500 gal of Number 2 fuel oil from a tank overflow was released to the storm drain system; the location of the tank was not reported.

2.3 Historical Operations

The storm drain system has been in continuous operation since its construction in 1950.

3.0 EVALUATION OF RELEVANT EVIDENCE

The section summarizes the data collected and evaluated from operational practices, previous investigations, and the RFI investigation.

3.1 Unit Characteristics

The storm drain system is an operational unit within TA-I. All operational safeguards are overseen by TA-I facility personnel.

3.2 Operating Practices

Hazardous wastes were not managed or contained at the site. However, hazardous wastes have entered through the lines and may have been released to the surrounding soils from breaks in the lines.

3.3 Presence or Absence of Visual Evidence

No visual evidence of hazardous waste constituents was seen on the surface or in soil samples collected for chemical and radionuclide analyses during the ER Site 96 RFI field investigation.

3.4 Results of Previous Sampling Surveys

Several previous investigations have been conducted in and around the storm drain system. These investigations have included a soil sampling program associated with cross-connections between the storm drain system and sanitary sewer system (IT Corp., 1993); sediment and soil sampling in discharge and channel areas west of TA-II (IT Corp., 1992); and soil sampling during the removal (and relocation) of the storm drain system at Building 870 (PCR, 1993).

All sample results and documentation associated with the investigations that had previously been conducted were documented in the TA-I RFI Work Plan (SNL/NM, 1995). In summary, the data gathered prior to the TA-I RFI indicated no contamination associated with the cross-connections investigation; radionuclides were detected, but the values were consistent with SNL/NM background levels at the discharge and channel areas investigation; and several metals were detected, but below SNL/NM background levels at Building 870.

3.5 Assessment of Gaps in Information

The RFI field investigation was designed to fully characterize each area of potential concern within the site. The RFI Sampling and Analysis Plan for this site is provided in Appendix B.

3.6 Confirmatory Sampling

The following subsection provides a summary of the RFI field investigation and the evaluation of the data collected/analyzed during the investigation.

3.6.1 Project Summary

The objectives of the field investigation were to determine the potential vertical and horizontal extent of soil contamination at breaks in the underground lines and at the system's inlet and outfall locations. The potential constituents of concern are acids, bases, petroleum hydrocarbons, metals, chlorinated solvents, alcohols, PCB's, and radionuclides. These COCs were determined by past spills, tank overflows, operational discharges, sanitary sewer system cross-connections, and nonpoint source runoff.

The ER Site 96 field investigation began June 13, 1995 and was completed July 11, 1995. The field activities included an in-line camera survey of the sewer lines, drilling soil boreholes, collecting sediment samples from storm drain inlets and outfalls for chemical and radionuclide analysis, collecting subsurface soil samples for chemical and radionuclide analysis, collecting waste samples for chemical and radionuclide analysis, handling the waste generated during drilling, and surveying borehole locations.

3.6.1.1 Health and Safety Monitoring

A photoionization detector (PID) and/or flame ionization detector (FID) was used to monitor the breathing zone around the drilling operations and the general background area for organic vapors during soil borehole activities. In addition, a pancake probe was used to monitor the alpha and beta/gamma radiation. The PID and FID readings for the breathing zone and the general area were no greater than background readings for all soil boreholes. The pancake probe readings ranged from 25 to 75 counts per minute and were within normal background levels.

3.6.1.2 In-Line Camera Survey

During the spring of 1993, an in-line camera survey was conducted in the storm drain system. These data were used to identify pipe deficiencies along

the storm drain system. This was a major tool for the placement of soil boreholes as discussed in the Work Plan (SNL/NM, 1995). For this field investigation, an in-line camera survey was conducted to confirm the exact location of the pipe deficiency for soil borehole placement. The camera crew located the in-line problem and then marked aboveground the location/depth of the pipe deficiency. This survey placement ensured that the location to be sampled was accurately identified.

3.6.1.3 Drilling Program

The drilling program was conducted using a truck mounted Geoprobe® drill rig. A portable auger drill rig was used at two locations where the Geoprobe® could not gain access. A total of 55 soil borings (T1096-GP-001 through T1096-GP-055) were placed along the storm drain system (Appendix A, Plate 1-1).

- Boreholes T1096-GP-001 through T1096-GP-043 and T1096-GP-046 through T1096-GP-055 were drilled with the Geoprobe® rig.
- Boreholes T1096-GP-044 and T1096-GP-045 were drilled with the portable auger drill rig.
- Soil borehole numbers T1096-GP-012, T1096-GP-032, and T1096-GP -049 were used to identify duplicate soil samples collected during the project and are not shown on Plate 1-1 (Appendix A).

3.6.1.4 Soil Collection

Soil samples were collected approximately 18 inches below the storm drain at each borehole using the Geoprobe® rig and/or portable auger rig equipped with a 2.5 inch outside diameter by 24 inches long core sampler which was lined with a cellulose acetate butyrate (CAB) sleeve. Samples were collected at a depth ranging from 3 to 10 feet bgs. Upon removal of the CAB liner from the sampler, one 6-inch section was cut from the liner. This section was sealed with tape and prepared for shipment to the off-site laboratory for VOC analyses. The remaining sample was composited, placed into appropriate containers, and also prepared for shipment to the off-site for SVOC, PCB, Target Analyte List (TAL) metals, isotopic uranium, plutonium, and tritium. A container was sent to the on-site laboratory for gamma spectroscopy analyses. Usually two sampling runs with the Geoprobe® were required to collect enough soil sample for these analyses.

The samples collected and the analyses performed on these samples are provided in Appendix C, Table 1. Fifty-five soil samples were collected and

sent to the off-site laboratory for VOC, SVOC, PCB, TAL metal, isotopic uranium, isotopic plutonium, and tritium analyses. Fifty-three samples were sent to the on-site laboratory for gamma spectroscopy.

An additional 29 sediment samples (TI096-SD-001 to TI096-SD-029) were collected at two storm drain inlets and five storm drain outfall areas (Appendix A, Plate 1-1). One sediment sample was collected from each inlet area and five sediment samples were collected at each of the outfall areas. Sediment sample numbers TI096-SD-008 and TI096-SD-024 were used to identify duplicate sediment samples collected during the project. These samples were sent to the same laboratories and analyzed for the same parameters as the subsurface soil samples.

3.6.1.5 Sample Packaging and Shipping

Soil samples sent to the off-site laboratory for VOC analysis were collected in CAB liners or glass bottles containing 125 ml of soil; for SVOCs, PCBs, TAL metals analysis, soils were collected into 500 ml glass bottles; and for isotopic uranium and isotopic plutonium analysis, soils were collected into 500 ml plastic bottles. Soil samples sent to the off-site laboratory for tritium analysis were collected in one liter amber glass bottles. Soil samples sent to the on-site laboratory for gamma spectroscopy analysis were collected in 500 ml Marenelli beakers. All liner and bottle sets were labeled, sealed with custody tape, and placed in a protective bubble-wrap Ziplock bag. The soil samples were placed on ice in the field and cooled to 4°C.

Samples were delivered to the SNL/NM Sample Management Office (SMO) on a daily basis. SMO personnel performed cross-checking of the information on the sample labels against the data on the ARCOCs, and prepared samples for shipment. Samples were shipped by overnight delivery to the off-site laboratories for chemical and radionuclide analyses. The gamma spectroscopy samples were delivered to the on-site laboratory the same day as delivery to SMO.

3.6.1.6 Survey Soil Borehole Locations

Soil borehole and sediment locations were surveyed with global positioning system (GPS) equipment. The GPS data included northing and easting coordinates for each borehole. The soil boring elevations were determined by topographic maps.

3.6.1.7 Field Quality Control Samples

Four types of field QC samples were shipped for analysis during the field investigation: field duplicate subsurface soil and sediment samples, equipment rinsate blank samples, soil and water trip blank samples, and field soil blank samples. Additional soils were collected for matrix spike/matrix spike duplicate (MS/MSD) analysis. Sample number, date/time of sample event, location, and analysis performed are presented in Appendix C, Table 1.

Five (three subsurface soil and two sediment) field duplicate samples were collected and analyzed for the same parameters as their corresponding samples. The subsurface soil samples were collected by splitting the CAB sleeve crosswise in two pieces for VOC analysis. For the remaining analysis, soils were removed from the CAB sleeves into a stainless steel bowl and composited, then transferred into appropriate containers. The sediment samples were collected by scooping up the dirt, compositing, and placing it in the appropriate containers.

Five equipment rinsate blank samples were collected from deionized water poured over the equipment after decontamination of the sampling equipment. The samples were analyzed for all parameters for which soil samples were analyzed.

Five field blank soil samples were exposed (open jar) to atmospheric conditions around the drilling/sampling operation and analyzed for VOCs only. The field blanks, which consisted of glass bottles filled with clean soils were supplied by the SMO field office.

Trip blank samples were submitted with each shipment which contained samples for VOC analysis. Twenty trip blanks (14 soil and 6 water) accompanied the sample containers to the field and back to the laboratory.

3.6.2 Data Management

Upon sample shipment to the off-site laboratories, sample information was entered into a database to track the status of each sample. Upon completion of the laboratory analyses, SMO received analytical results in a summary data report and laboratory QC report.

The data summary (Certificate of Analysis) reports were reviewed by the SMO for completeness and accuracy as required by SNL/NM TOP 94-03 (SNL/NM, 1994b). Data validation was performed using SNL/NM Data Verification/Validation (DV) Level 1 (DV1) and Level 2 (DV2) checklists.

SMO submitted the original ARCOCs, the Certificate of Analysis Reports, and the DV1/DV2 review reports to the Environmental Operations Record Center. In addition, the laboratories submitted analytical data in an electronic format for loading into the ER data management system (ERDMS). All chemical analytical data tables generated for this report were downloaded through the ERDMS except gamma spectroscopy data.

3.6.3 Analytical Data Summary

This section discusses the analytical methods and the analytical results of the subsurface soil and sediment samples.

3.6.3.1 Analytical Methods

Subsurface soil and sediment samples sent to the off-site laboratory were analyzed by the following approved EPA methods: Method 8240/8260 for VOCs, Method 8270 for SVOCs, Method 8080 for PCBs, Method 6010 for TAL metals, and Methods 7471/7470 for mercury. For the radionuclide samples, the off-site laboratory used EPIA-011/-011B for isotopic uranium, EPIA-012/-012B for isotopic plutonium, and isotopic thorium (waste sample only). The tritium samples were analyzed by the off-site laboratory using method LAL-91-SOP-0067. In addition, the gamma spectroscopy were analyzed by SNL/NM approved analytical procedures by the on-site laboratory.

Analytical results for organic compounds listed "J" values for some compounds. A "J" indicates an estimated value for a compound detected at a level less than the reporting limit but greater than the method detection limit. Data results flagged as "J" values are included in the data summary tables used in this report; however, because "J" values may represent false-positive concentrations, care should be used when evaluating these analytical results.

3.6.1.2 Subsurface Soil Sample Results

A total of 55 subsurface soil samples (includes three field duplicates) were sent to the off-site laboratories for analysis. Table 2 (Appendix C) summarizes the VOC analytical results. Table 3 (Appendix C) summarizes the SVOC analytical results. Table 4 (Appendix C) summarizes the PCB analytical results. Metal analytical results are provided in Table 5 (Appendix C). Table 6 (Appendix C) summarizes the radionuclide analytical results. Gamma spectroscopy analytical results are located in the SNL/NM Environmental Operations Record Center.

- All samples were either non-detect or J values for VOCs except acetone, which had two elevated values at 47.6 and 26.4 ppb. The J value compounds were acetone, methylene chloride, and chloromethane.
- All samples were either non-detect or J values for SVOCs except for 13 compounds with elevated values at three sample locations. The majority of these elevated values are associated with the sample collected at TI096-GP-011.
- All samples were non-detect except for one J value (only one sample) for PCBs.
- A complete discussion of the metal results is provided in Section 3.6.2.1.
- Plutonium (Pu)-238, Pu-233/234, Uranium (U)-233/234, U-238, and tritium were detected with elevated values above reporting limits. Four samples had elevated values of Pu-238 with the highest value at 0.934 ± 0.121 pCi/g. One value of Pu-239/240 was detected at 0.0434 ± 0.0191 pCi/g. Thirty-six samples had elevated values of U-233/234 with the highest value at 1.53 ± 0.184 pCi/g. Thirty-three samples had elevated values of U-238 with the highest value at 1.41 ± 0.139 pCi/g. Seven samples had elevated values of tritium with the highest at $16,200 \pm 1,000$ pCi/L. U-235 was not detected above its reporting limit.
- Gamma spectroscopy results were within background levels.

3.6.1.3 Sediment Sample Results

A total of 29 sediment samples (includes two field duplicates) were sent to the off-site laboratories for analysis. Table 2 (Appendix C) summarizes the VOC analytical results. Table 3 (Appendix C) summarizes the SVOC analytical results. Table 4 (Appendix C) summarizes the PCB analytical results. Metal analytical results are provided in Table 7 (Appendix C). Table 6 (Appendix C) summarizes the radionuclide analytical results. Gamma spectroscopy analytical results are located in the SNL/NM Environmental Operations Record Center.

- All samples were either non-detect and/or J values for VOCs except for acetone and toluene. Toluene had three detects ranging from 12.4 to 39.3 ppb and acetone had five detects ranging from 22.4 to 43.7 ppb.
- All samples were either non-detect and/or J values for SVOCs except for 10 compounds with elevated values at nine sample locations. The

majority of these elevated values are associated with the samples (T1096-SD-001 through T1096-SD-005) collected at the 9th and Hardin Streets outfall.

- Three PCB compounds (Aroclors 1254, 1260, and 1262) were detected with elevated values at four of the five outfall sample locations. At the 9th and Hardin Streets outfall (sample numbers, T1096-SD-001 to -005), Aroclor 1254 was detected once at 164 ppb, Aroclor 1260 had two elevated values at 94.1 and 196 ppb, and Aroclor 1262 was detected twice at 91.7 and 97.6 ppb. At the M Street curve outfall (sample numbers, T1096-SD-006 to -011), Aroclor 1262 had five elevated values ranging from 64.7 to 197 ppb. At the M Street outfall near Building 897 (sample numbers; T1096-SD-012 to -016); Aroclor 1260 had one elevated value at 66.3 ppb and Aroclor 1262 had two elevated values at 62.8 and 70 ppb. At the ditch location east of Buildings T-4, T-24, and T-25 (sample numbers, T1096-SD-017 to -021), Aroclor 1260 had five detections ranging from 47.4 to 163 ppb and Aroclor 1254 was detected once at 45.8 ppb. One outfall (at the corner of 20th and Hardin Streets) and two inlet locations were non-detect for PCBs. All remaining samples were non-detects and J values.
- Only two metals, antimony and selenium, were non-detect for all samples. A complete discussion of the metal results is provided in Section 3.6.2.2.
- Pu-238, (U)-233/234, and U-238 were detected with elevated values above the reporting limit. One elevated value of Pu-238 was detected at 0.0697 ± 0.0641 pCi/g. One elevated value of U-233/234 was detected at 0.903 ± 0.128 pCi/g, and one elevated value of U-238 at 0.905 ± 0.128 pCi/g. U-235 was not detected above its reporting limit (0.09 pCi/g).

Gamma spectroscopy results were within background levels.

3.6.1.4 Quality Control Samples

All trip blanks either yielded non-detect or J values for all VOC analyses except for acetone (eight samples) with values ranging from 21 to 177 ppb (Appendix C, Table 2). Soil sample and associated trip blank results indicate no significant sample contamination by VOCs field and shipment sources.

All equipment rinsate blanks were non-detect for all VOC and PCB analyses. SVOCs were non-detect for all samples except one elevated value (44.5 ppb) of bis(2-ethylhexyl)phthalate (Appendix C, Table 3). Radionuclide compounds were either detected at/or below laboratory reporting limits.

Metals were either non-detect or J values except for low elevated hits for calcium, iron, sodium, magnesium, mercury, nickel, and zinc.

All field blanks either yielded non-detect or J values for all VOC analyses except acetone ranging from 24.1 to 116 ppb (Appendix C, Table 2). In addition, 2-butanone was detected in one sample at 26.2 ppb. The sample results indicate no sample contamination by VOCs during field activities and daily TA-I facility operations.

The subsurface soil and sediment field duplicate sample results were consistent with their corresponding confirmation sample results.

3.6.2 Statistical Analysis/Evaluation of Concentrations

Statistical analysis of the VOC, SVOC, PCB, isotopic plutonium, and tritium results could not be completed, due to the small number of elevated values from Site 96 data and the lack of positive concentrations for the above mentioned compounds from the TA-I background soil investigation (SNL/NM, 1996a).

The chemical and radionuclide data evaluation discussion is provided using the following guidelines: comparing the VOC, SVOC, and PCB analytical results to EPA proposed Subpart S action level for soils (EPA, 1990) and comparing the metal and isotopic uranium analytical results to the background soil data collected during the TA-I field investigation, the site-wide background study for SNL/NM (IT Corp., 1996), and EPA Subpart S action levels for soils (metals only). For updated soil action levels, some values (example, zinc) were taken from "Report of Generic Action Level Assistance for the Sandia National Laboratories/New Mexico Environmental Restoration Program" (IT Corp., 1994). The generic values from this report were made current for guidance through June, 1994 according to RCRA proposed Subpart S methods. Any soil action level used from that report will be referred to as "generic action level for soils". For TA-I background metal and radionuclide analytical results, the UTL/95th values were developed from software package Statgraphics (SNL/NM, 1996a). In addition, the isotopic plutonium results will be compared to the off-site laboratory reporting limit (RL) and the tritium results will be compared to the off-site laboratory minimum detectable activity (MDA).

Based on the soil evaluation (Sections 3.6.2.1 and 3.6.2.2), a risk assessment analysis was completed on certain chemical and radionuclide data that were detected above background levels. Summary of that analysis is provided in Section 3.7.

3.6.2.1 Subsurface Soil Evaluation

VOC results were either non-detect or J values except for acetone for all samples. The two elevated values of acetone (26.4 and 47.6 ppb) were within the range (21 to 177 ppb) of acetone identified in the laboratory trip blank samples. In addition, these levels of acetone are well below the EPA proposed Subpart S action level of 8,000,000 ppb. Based on this data evaluation, VOCs should not be considered COCs for subsurface soils at this site.

SVOC results were either non-detect or J values except in the following 3 categories: compounds detected above the RL, but with no corresponding EPA proposed Subpart S action levels for soils, compounds detected above the RL, but below known proposed Subpart S values, and compounds detected above known proposed Subpart S values (Appendix C, Table 8).

- Seven SVOC compounds were detected above the RL, but with no corresponding proposed Subpart S values: phenanthrene, benzo(k)fluoranthene, chrysene, benzo(a)anthracene, indeno(1,2,3,-cd)pyrene, benzo(ghi)perylene, and benzo(b)fluoranthene.
- Five compounds were detected above the RL, but below the proposed Subpart S values: fluorene, fluoranthene, anthracene, pyrene, and bis(2-ethylhexyl)phthalate.
- Only benzo(a)pyrene at 1010 ppb was detected above its proposed Subpart S value of 100 ppb.

These SVOC compounds are commonly associated with asphalt and/or road tars. Due to the heavy construction (i.e.; installing new underground gas lines) associated with the roads inside/around TA-I, pieces of road could have been backfilled around new and/or existing underground utilities. The detected SVOCs could be considered a product of asphalt and/or road tars rather than contamination with leaking pipes. Although these SVOC compounds could be considered products of asphalt and road tars, to better characterize the soil, the SVOCs listed in the three bullets above will be evaluated in the risk assessment analysis.

All PCB results were non-detect (except for one J value result) and should not be considered COCs for subsurface soils at this site.

TAL metals were compared: first, to TA-I background levels; second, to SNL/NM site-wide background levels; and third, to EPA proposed Subpart S action levels and/or the generic action level for soils (Appendix C, Table 9). The metals are within TA-I background levels, SNL/NM background levels,

and/or Subpart S action levels except for common cations: calcium, iron, magnesium, and potassium; and beryllium and cobalt. Although some calcium, iron, magnesium, and potassium values were above background levels, these chemicals are considered essential nutrients and should not be considered COCs for this site. In addition, beryllium was detected below background levels, but above the proposed Subpart S action level for soils. However, beryllium occurs naturally at higher concentrations in the soils within this geologic region and should not be considered a COC for Site 96 (SNL/NM, 1996a). Cobalt will be evaluated in the risk assessment analysis.

Isotopic uranium (U-233/234 and U-238) results were compared first, to TA-I background levels, and second to SNL/NM site-wide background levels (Appendix C, Table 10). These isotopic uranium compounds were within TA-I and SNL/NM background levels except for U-238 at one sample location, TI096-GP-040 with an elevated value of $1.38 \pm .169$ pCi/g. Based on this data evaluation, U233/234 and U-235 should not be considered COCs for soils at this site and U-238 will be evaluated in the risk assessment analysis.

Isotopic plutonium (Pu-238 and Pu-239/240) results were compared to the off-site laboratory RL (Appendix C, Table 6).

- All Pu-238 results were below the RL (0.03 pCi/g) except for 4 samples: TI096-GP-006 ($.136 \pm .0321$ pCi/g), TI096-GP-015 ($.0331 \pm .0198$ pCi/g), TI096-GP-019 ($.0337 \pm .022$ pCi/g), and TI096-GP-52 ($.094 \pm .121$ pCi/g).
- All Pu-239/240 results were below the RL (0.03 pCi/g) except for one sample, TI096-GP-052, with an elevated value of $0.0434 \pm .0191$ pCi/g.

Based on the data (above the RL), isotopic plutonium will be evaluated in the risk assessment analysis.

Tritium results (Appendix C, Table 6) were compared to the off-site laboratory MDA (ranging from 250 to 820 pCi/L). All tritium results were below the MDA except for 7 samples: TI096-GP-006 ($16,200 \pm 1,000$ pCi/L), TI096-GP-007 ($7,240 \pm 640$ pCi/L), TI096-GP-008 ($11,700 \pm 1,500$ pCi/L), TI096-GP-009 ($6,040 \pm 590$ pCi/L), TI096-GP-010 ($1,300 \pm 320$ pCi/L), TI096-GP-018 (270 ± 230 pCi/L), and TI096-GP-044 (350 ± 230 pCi/L). These tritium sample locations are located in the north to northwest section of TA-I (Appendix A, Plate 1-1). Based on the data (above the MDA), tritium will be evaluated in the risk assessment analysis.

3.6.2.2 Sediment Evaluation

VOC results were either non-detect or J values except for toluene and acetone for all samples. Toluene had three values detected above the RL (10 ppb). The values ranged from 12.4 to 39.4 ppb, but are well below the EPA proposed Subpart S action level of 20,000,000 ppb. The elevated values of acetone, which ranged from 22.4 to 43.7 ppb, were within the range (21 to 177 ppb) of acetone identified in the laboratory trip blank samples.

Therefore, the acetone identified in the sediments were representative of laboratory contamination. In addition, these levels of acetone are well below the EPA proposed Subpart S action level of 8,000,000 ppb. Based on this data (above RL), toluene will be evaluated in the risk assessment analysis.

SVOC results were either non-detect or J values except in the following two categories: compounds detected above the RL, but with no corresponding EPA proposed Subpart S action levels for soils and compounds detected above the RL, but below known proposed Subpart S values (Appendix C, Table 8).

- Seven SVOC compounds were detected above the RL, but with no corresponding proposed Subpart S values: phenanthrene, benzo(k)fluoranthene, chrysene, benzo(a)anthracene, indeno(1,2,3-cd)pyrene, benzo(ghi)perylene, and benzo(b)fluoranthene.
- Three SVOC compounds were detected above the RL, but below known proposed Subpart S values: fluoranthene, pyrene, and bis(2-ethylhexyl)phthalate.

These SVOC compounds are commonly associated with asphalt and road tars. Due to the heavy construction (i.e.; installing new underground gas lines) associated with the roads inside/around TA-I, pieces of road could have been washed down through the storm drain system and deposited at the outfall locations. The detected SVOCs could be considered a product of asphalt and/or road tars rather than contamination with TA-I building operations. To better characterize the soil, the SVOCs listed in the two bullets above will be evaluated in the risk assessment analysis.

PCB compounds (Aroclor 1254, 1260, and 1262) were detected above RL at four of the five outfall locations. The highest Aroclor 1254 value was 164 ppb, the highest Aroclor 1260 value was 196 ppb, and the highest Aroclor 1262 value was 122 ppb. All these elevated values are above the proposed Subpart S action level for soil of 90 ppb. The SNL/NM ER Project has proposed a cleanup action level of 10,000 ppb for PCB in soils (SNL/NM, 1996b). The regulatory agencies in their review of this plan did not comment on or request a lower action level; however, the agencies have

provided guidance of a numerical cleanup criteria of 10 ppm (10,000 ppb) in a commercial scenario and 1 ppm (10 ppb) in a residential scenario (Klavetter and Knowlton, 1996). Because the levels of PCBs identified in the sediments of the storm drain system fall between these values (with the greatest concentration being 1.9 ppm), PCB's were included in the risk assessment analysis.

TAL metals were compared: first, to TA-I background levels; second, to SNL/NM site-wide background levels; and third, to EPA proposed Subpart S action levels and/or the generic action level for soils (Appendix C, Table 11). The metals are within TA-I background levels, SNL/NM background levels, and/or Subpart S action levels except for beryllium, chromium, and potassium. Although some potassium values were above background levels, this chemical is considered an essential nutrient and should not be considered a COC for this site. In addition, beryllium was detected below background levels, but above the proposed Subpart S action level for soils. However, beryllium occurs naturally at higher concentrations in the soils within this geologic region and should not be considered a COC for Site 96 (SNL/NM, 1996b). Chromium will be evaluated in the risk assessment analysis.

Isotopic uranium (U-234/234, and U-238) results were compared: first, to TA-I background levels; and second, to SNL/NM site-wide background levels (Appendix C, Table 10). These isotopic uranium results were within TA-I background levels and SNL/NM background levels and should not be considered COCs for this site. Isotopic plutonium (Pu-238 and Pu-239/240) results were compared to the off-site laboratory RL. All Pu-238 results were below the RL (0.03 pCi/g) except for one sample: T1096-SD-017 at $.0439 \pm .235$ pCi/g (Appendix C, Table 6). All Pu-239/240 results were below the RL (0.03 pCi/g). Tritium results were compared to the off-site laboratory MDA (ranging from 250 to 820 pCi/L) and all values were below the MDA and should not be considered a COC for this site. Based on the data (above RL), Pu-238 will be evaluated in the risk assessment analysis.

3.7 Risk Analysis

The following subsections summarize the results of the risk assessment process for both human and ecological risk related factors.

3.7.1 Human Risk Analysis

Site 96 has been recommended for industrial land-use (DOE, 1996). A complete discussion of the risk assessment process, results, and uncertainties is provided in Appendix D. Due to the presence of several metals, PCBs, and radionuclides in concentrations greater than background

levels, it was necessary to perform a human health risk assessment analysis for the site. Besides metals, any organics detected above their reporting limits and any radionuclide compounds either detected above background levels and/or MDAs were included in this assessment. 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. The excess cancer risk from nonradioactive COCs and the radioactive COCs is not additive (EPA, 1989).

In summary, the Hazard Index calculated for chemical compounds is 0.1 and the incremental Hazard Index is 0.06 for an industrial land-use setting, which is less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA, 1989). The excess cancer risk for chemical compounds is estimated to be 2.0×10^{-5} and the incremental excess cancer risk is 1.8×10^{-5} in an industrial land-use setting, which is in the middle of the suggested range of acceptable risk of 10^{-6} and 10^{-4} (EPA, 1989). The excess cancer risk for radionuclides is 7×10^{-7} for industrial land-use scenario, which is much less than risk values calculated due to naturally occurring radiation and from intakes considered background concentration values. In addition, the estimated effective dose equivalent for an industrial land-use setting is 0.06 mrem/yr; this value is well below the standard dose limit of 15 mrem/yr (40CFR196, 1994).

The residential land-use scenarios for this site are provided only for comparison in the risk assessment report (Appendix D). The report concludes that Site 96 does not have significant potential to affect human health under an industrial land-use scenario.

3.7.2 Ecological Risk Analysis

It is unlikely that activities or COCs at Site 96 will have much impact on ecological risk. TA-I is an industrial complex and has been heavily disturbed by humans for over 50 years. Given the amount of known and potential human intrusion, a great diversity or abundance of nonhuman species is unlikely. Much of the relevant ecological information for TA-I can be found in the National Environmental Policy Act (NEPA) compliance document (SNL/NM, 1992).

3.8 Rationale for Pursuing a Risk-Based NFA Decision

Fifty-five soil borehole locations were drilled around the TA-I storm drain system. The data evaluation for the subsurface soil samples shows no VOC

or PCB contamination, but some SVOC, TAL metals, and radionuclide compounds were detected either above background levels, proposed Subpart S values and/or the laboratory RL and MDA.

Twenty-nine sediment samples were collected at two inlet and five outfall locations around the TA-I area. The data evaluation for the sediment samples shows no VOC contamination above background action levels, but some SVOCs, PCBs, TAL metals, and one radionuclide compound were detected either above background levels and/or the laboratory RL and MDA.

Based on the field investigation data and the human health risk assessment analysis, a NFA is being recommended for Site 96 for the following reasons:

- No VOCs and radionuclides were detected during the field screening program.
- Gamma spectroscopy results were within background levels.
- No significant VOCs were detected by the off-site laboratory.
- PCBs were either non-detect and/or J values except at four of the five outfall locations.
- U-235 results were not detected above its reporting limits and SNL/NM background levels.
- No COCs (particularly SVOCs, PCBs, TAL metals, and radionuclides) were present in concentrations considered hazardous to human health for an industrial and/or a residential land-use scenario.

Based on site history and the data evaluated from the field investigation, further investigation and/or a VCM are not required for Site 96.

4.0 CONCLUSION

Based upon the evidence cited above, no potential remains for a release of hazardous and radionuclide waste that pose a threat to human health or the environment. Therefore, ER Site 96 is recommended for an NFA determination based on NFA Criterion 5. The potential release site has been characterized in accordance with current applicable state or federal regulations, and the available data indicated that contaminants pose an acceptable level of risk under current and projected future land use.

5.0 REFERENCES

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Appendix A

ER Site 96 Figure

Appendix B

Section 5.10 of the TA-I RFI Work Plan (SNL/NM, 1995)

5.10 ER Site 96, Storm Drain System

5.10.1 Site Description and History

The original storm drain system was constructed between 1948 and 1950. The system (Plates 5-1 to 5-6) collects storm water runoff from TA-I, -II, and -IV. The majority of the storm water flows from east to west with the terrain across SNL/NM. The water is conveyed through a series of open channels and underground lines from north to south to the Tijeras Arroyo. The system was developed in three watersheds and is described in a drainage system analysis (Bohannon-Huston, Inc. 1993), summarized below.

Watershed A is located north of H Street and west of 12th Street in the northwest corner of TA-I. Storm water flows from east to west across watershed A into KAFB, collecting in underground storm drains along F and G Streets. Flow from KAFB from the north enters the system at F Street west of 14th Street to Wyoming Boulevard. The line running parallel with G Street intercepts flow along G Street and a portion of H Street.

Watershed B is located south of H Street and west of 9th Street in TA-I. Storm water flows from east to west into KAFB west of TA-I; underground storm drain lines convey the flow south of K Street.

Watershed C covers portions of TA-I, -II, and -IV. The storm water flows from east to west with the terrain, as described above, and is conveyed in underground lines and open channels from north to south. Four drainage systems, the 9th, 14th, 17th, and 20th Street systems, described below, comprise the network for Watershed C, all discharging directly or indirectly into the 9th Street channel. The 9th Street channel from O Street south to the outfall at Tijeras Arroyo is earthen with culverts at the cross streets.

The 9th Street system conveys the majority of storm water collected in TA-I, -II, and -IV. The system collects all storm water falling outside watersheds A and B in TA-I, the western half of TA-II, and three-fourths of TA-IV. The system is comprised of the 11th Street and 9th Street storm drains. The 11th Street storm drain is split at L Street with one section extending from H Street to L Street and the other section extending from L Street to just north of O Street. At the southern end of each section, storm water flow joins the 9th Street storm drain. The 9th Street storm drain runs from K Street to O Street where it discharges into the upstream end of the 9th Street channel.

The 14th Street system extends north to the bypass and includes the area north of H Street between 20th and 14th Streets and from H Street to O Street between 17th Street and 14th Street. Flows from KAFB to the north enter the 14th Street at the bypass and are conveyed in an open channel south to H Street. At H Street, flow is collected in the storm drain where it flows south to K Street to the confluence with

a K Street storm drain carrying flow from the area north of K Street between 20th and 14th Streets. At the intersection of 14th and M Streets, the 14th Street storm drain discharges into the 14th Street channel. The channel continues south to O Street where it combines with the 17th/20th Street channel. The 14th Street channel then continues south to southwest through TA-II to approximately 100 ft south of East Ordnance Road, then west to the 9th Street Channel.

The 17th Street system is a combination of open channels and underground lines located in TA-I and -II. The 17th Street system drains runoff primarily from the area between H and O, and 17th Streets. A small storm drain at the intersection of K and 17th Streets diverts flow from north of K Street into the 17th Street channel which runs from K Street to L Street. At L Street the channel discharges into an underground storm drain which runs approximately 270 ft south of M Street where it discharges into the 17th Street Channel. The 17th Street channel joins the 20th Street channel at Q Street.

The 20th Street system occupies the eastern half of TA-I. Flow enters TA-I from KAFB to the north and the City of Albuquerque to the east. The 20th Street channel consists of a large open channel which runs from G Street near the KAFB Eubank Boulevard gate, along the east side of 20th Street, and down to O Street where it combines with the 17th Street Channel.

The storm drain system was listed as ER Site 96 in the CEARP Phase I Report (DOE 1987). The listing resulted from information collected during the Phase I interviews in which the system was reported to have received contaminants from various activities. System discharges were reported to include nonpoint source surface runoff from TA-I, blowdown from an incinerator scrubbing system, and cooling tower blowdown water (possibly containing chromates and other antifoulants) (EPA 1987a). There were several specific releases to the storm drains recorded in the CEARP report (DOE 1987).

- An estimated 200 gal of 20 percent sodium hydroxide spilled from an aboveground tank at ER Site 42, Wastewater Treatment Facility for discharges from Building 870 in 1984.
- An estimated 1000 gal of 30 percent hydrochloric acid was released from an aboveground tank at the Wastewater Treatment Facility near Building 870, ER Site 42, in 1983.
- A cooling tower on the roof of Building 806 caught fire in 1983 and wood slats that were believed to have been contaminated with chromium burned. Much of the debris was reported to have been washed down the drain.
- An estimated 500 gal of Number 2 fuel oil from a tank overflow was released to the storm drain system; the location of the tank was not reported.

Other discharges to the storm drain have also been identified. These include the following:

- In 1965 a 10 ft x 20 ft wash/steam clean area was constructed on the south side of Building 876 at the Motor Pool (ER Site 33, Section 5.3). The wash/steam clean area is comprised of a grated pit with four evenly spaced floor drains which were originally connected to the storm drain system via an oil interceptor east of the wash area. In the early 1990s the interceptor lines were rerouted from the storm drain to the sanitary sewer system. Interview information with current and past Motor Pool employees indicates that various materials may have drained into the wash/steam clean area.
- During dye testing and an in-line camera survey conducted in the spring of 1993 for the SNL/NM National Pollutant Discharge Elimination System (NPDES) Permit, several connections between the storm drain and the sanitary sewer systems, termed cross-connections, were identified (SNL/NM 1993e). At system cross-connections, the constituents in the sanitary sewage and light industrial discharges conveyed in the sanitary sewage system could have entered the storm drain system. (A more detailed description of cross-connections can be found in Section 5.10.2.2.)

The ER Site 96 boundaries are assumed to be the limits of areas where potential COCs have been detected near breaks in the lines. Any stormwater flowing within the line will not be addressed in this ER site investigation. Storm water flow within the storm drain system is regulated under the NPDES amendments to the Clean Water Act which included SIC codes 21 through 39 (SNL/NM 1993f). The NPDES Permit application was submitted to the EPA on October 1, 1992. Construction activities are currently covered by a Notice of Intent to Discharge (NOI) which was also submitted October 1, 1992.

5.10.2 Previous Investigations

5.10.2.1 *Environmental Surveillance Monitoring*

Environmental monitoring at SNL/NM is described in annual reports. The information described in this section is described in the 1992 report (SNL/NM 1993f). The 1993 report had not been released by the DOE at the time this plan was prepared.

5.10.2.1.1. Stormwater Sampling

In 1992 stormwater was sampled during three storm events from six outfalls in or near TA-I and at the 14th and O Street and 9th and O Street outfalls (SNL/NM 1993f). Samples were analyzed for the

parameters listed in Table 5-23. The analytical results for all storm water and nonstorm water samples collected from the outfalls were well below the COA NPDES limits for sanitary sewer discharges (SNL/NM 1993f).

5.10.2.1.2. Sediment and Soil Sampling

To determine whether SNL/NM activities impact soil and sediment quality, soil and sediment samples have been collected under the routine environmental surveillance program since 1992. They are analyzed for uranium, tritium, and cesium-137 (SNL/NM 1993f). Beginning in 1994, samples will be analyzed for metals in addition to the radionuclides (Culp 1994). Sediment samples are collected from three locations (Figure 5-31) (1) a community station (Location No. 68) northeast of the SNL/NM boundary near Placitas serves as a background location; (2) a perimeter station (Location No. 72) in Coyote Arroyo near the confluence of Tijeras and Coyote Arroyos; and (3) an on-site station (Location No. 73) in Tijeras Arroyo where the arroyo enters KAFB. Soil samples are collected from perimeter locations north of SNL/NM in KAFB housing (Location No. 58) and at Tijeras Arroyo (Location No. 60) near the old City Prison Farm (SNL/NM 1993f).

The 1992 analytical results for sediments (Location Nos. 73, 72, and 68) are believed to be consistent with each other. The SNL/NM Environmental Monitoring Report (SNL/NM 1993f) concludes, "Differences in radionuclide concentrations are believed to represent normal sample variation and do not indicate any contaminant loading of the arroyo system due to activities at SNL/NM." Since 1992 the analytical results for soils have been generally consistent with values for community locations and have been lower than community locations in some instances. (SNL/NM 1993f).

5.10.2.2 Cross-Connects Investigation

In compliance with the requirements identified in the SNL/NM NPDES permit application, dye testing and an in-line camera survey of lines from buildings to manholes were conducted in the spring of 1993. Several points where cross-connections between the storm drain and sanitary sewer systems were identified (SNL/NM 1993e). These system "cross-connects" are inadvertent tie-ins to the storm drain system from the sanitary system (*e.g.*, sink and floor drains routed to the storm drain rather than to the sanitary sewer lines). At these system cross-connects, the constituents in the sanitary sewage and light industrial discharges usually conveyed in the sanitary sewage system could have

Table 5-23. Stormwater Sampling Parameters for 1992

Parameter	Sample Type	
	Grab	Composite
Oil and grease	X	
Cyanide	X	
Phenolics	X	X
Residual chlorine	X	
VOCs	X	
pH	X	X
Temperature	X	
Total coliform	X	
Fecal coliform	X	
Biological oxygen demand		x
Chemical oxygen demand		X
Total suspended solids		X
Total Kjeldahl nitrogen		X
Nitrate plus nitrite		X
Total phosphorus		X
Fluoride		X
Arsenic		X
Barium		X
Cadmium		X
Chromium		X
Copper		X
Lead		X
Manganese		X
Mercury		X
Nickel		X
Selenium		X
Silver		X
Zinc		X
SVOCs		X
Pesticides		X
Explosives		X
Gross alpha and beta		X
Orthophosphate		X
Total dissolved solids		X

J:\dgn\sandia\sn080.dgn 12/1994

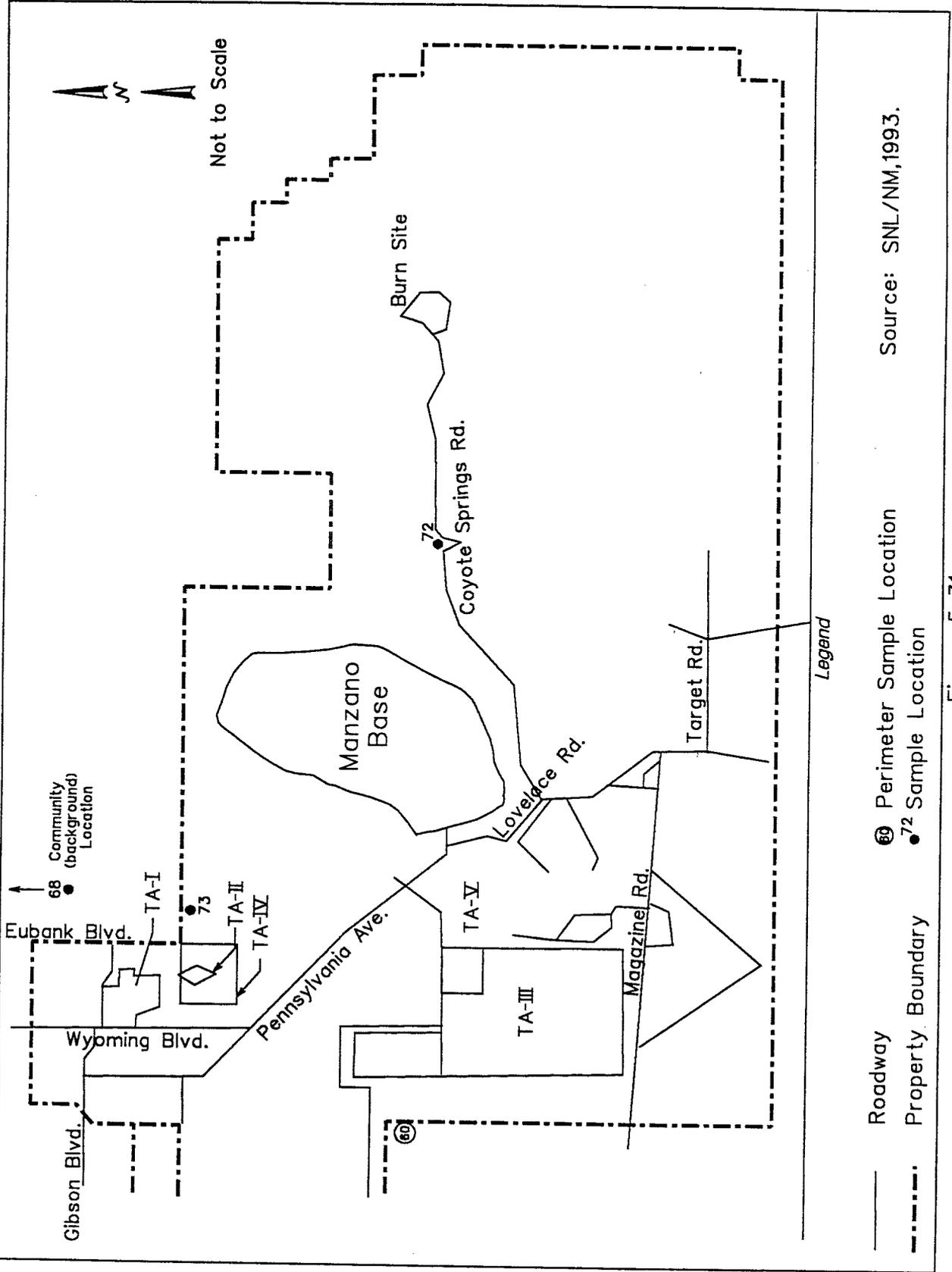
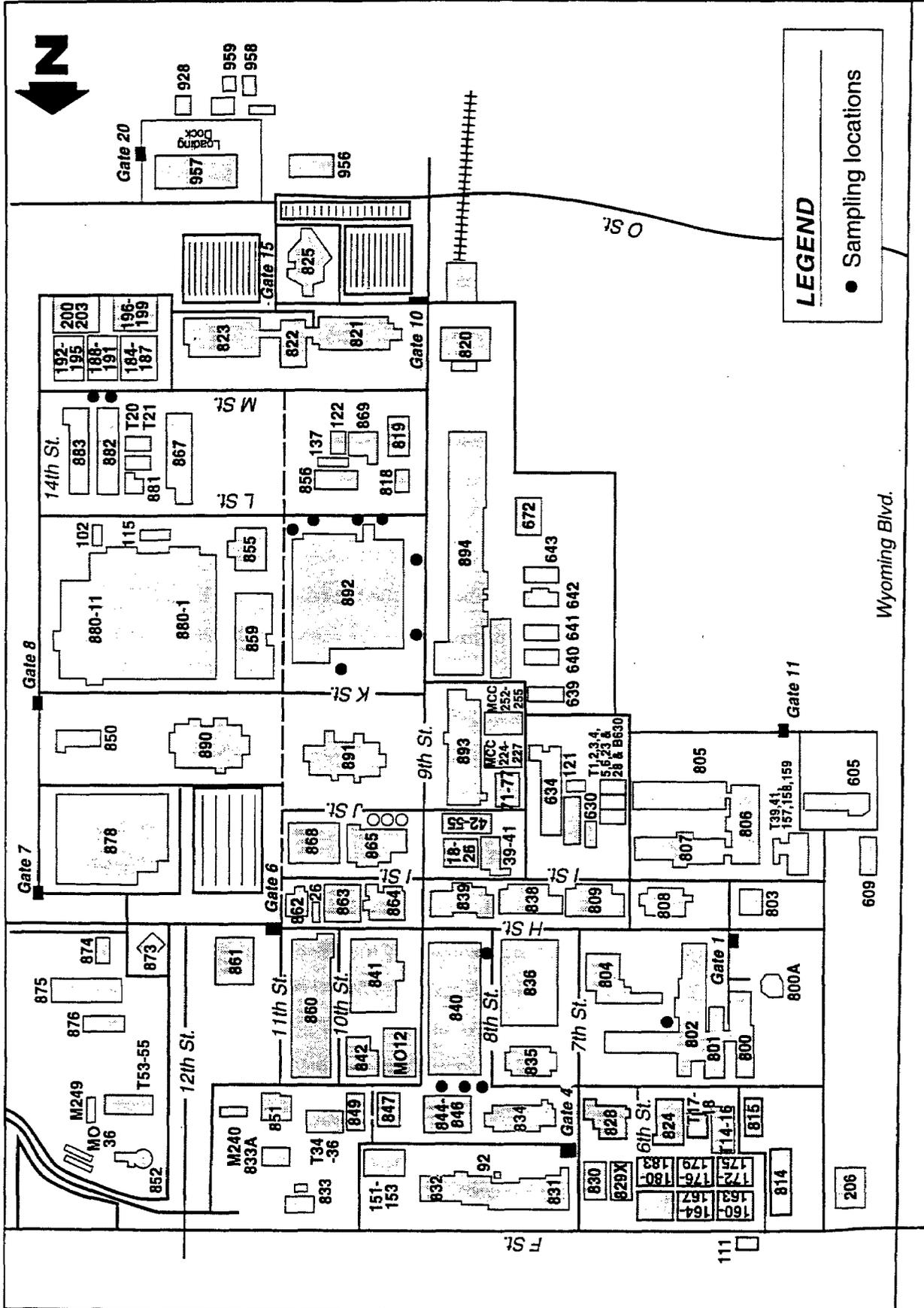


Figure 5-31
ER Site 96: Arroyo and Background Sediment Monitoring Locations

entered the storm drain system. The cross-connections have been corrected to comply with NPDES permit application requirements.

Before undertaking construction activities to eliminate the cross-connects, the cross-connects were evaluated against dye testing and camera survey data, available information on upgradient building(s) functions, and process knowledge to determine if there was a potential release of COCs to the storm drain system. Where there was a potential for release to the storm drain system, the cross-connect was considered to have the potential to be within ER Site 96 boundaries (IT Corp. 1993a). Cross-connects to the storm drain system requiring sampling were identified at the locations shown in Figure 5-32. Soils surrounding system cross-connects that were considered to have the potential to lie within ER Site 96 boundaries — Buildings 892, 840, 867, and 802 — were sampled and analyzed in March 1993 (IT Corp. 1993b). Based on the in-line camera survey and subsequent soil sampling, several cross-connects could be eliminated from ER Site 96 boundaries. The results of this investigation are provided below.

Fourteen soil samples were collected using the Geoprobe from the locations shown in Figure 5-32. Samples were collected within 18 in. of, and from approximately the same horizon as, the system cross-connections, at depths ranging from 4 to 6 in. to 5 to 8 ft bgs. Selected samples were field screened for VOCs, for alpha radiation, and for beta/gamma radiation. Samples were analyzed on site by the SNL/NM Radiation Protection Operations Department for gross alpha/beta, tritium, and gamma-emitting radionuclides. Samples were shipped to an off-site analytical laboratory for total RCRA metals, total cyanide, soil pH, PCB analyses, and, for samples in which VOCs were detected by the field screening, for VOCs and SVOCs (*i.e.*, one sample). Ten percent of the soil samples were shipped to an off-site radiological laboratory for isotopic uranium, plutonium, thorium, and tritium analyses. No compounds were detected in any soil sample at levels greater than proposed Subpart S action levels and DOE guidelines (EPA 1990b). Since no constituents were detected above action levels, a baseline risk assessment was considered unnecessary at the time. Soil pH ranged from 7.0 to 8.4. No cyanide was detected in soil samples above laboratory reporting limits (IT June 1993b). Therefore, based upon the analytical data collected at the cross-connect locations, no COCs were identified and the sewer lines were repaired to ensure effluents were discharged to the appropriate system. Based upon these data, the areas assessed during the cross-connect investigation were eliminated as areas of concern to the ER Project, and no additional site characterization is required at these locations.



SNL/JA/RFI-09/12-20-94

Figure 5-32

ER Site 96: Previous Sampling Locations Related to Storm Drain and Sanitary Sewer Cross-Connections

5.10.2.3 *Discharge Area and Channel Surface Soil Sampling*

As part of a site investigation at a potential construction site west of TA-II, current and historic discharge areas were sampled in May 1992 (IT Corp. 1992c). The current discharge area is comprised of an eroded, man-made channel that runs in an east-west direction southwest of the main entry gate for TA-II, north of TA-IV, south of East Ordnance Road and east of 9th Street (Figure 5-33). The former channel originally connected with the existing storm channel and discharged into a flat, broad runoff area. Historic photographs indicate that the storm drain system discharged to this location until 1982 when the system was expanded to the south and began discharging to Tijeras Arroyo. Soil within 1 ft of the surface was sampled at 21 locations in the current and historic storm drain discharge areas (Figure 5-33). Five test pits were dug and two samples were collected from each pit at depths of 3 and 6 ft bgs. Samples were analyzed at an off-site analytical laboratory for total RCRA metals, TCLP metals, VOCs, and SVOCs. All samples were analyzed for tritium, gross alpha, gross beta, and gamma spectroscopy with five reported isotopes (cesium-137, potassium-40, radium-224, radium-226, and radium-228) at an off-site radiological laboratory. Additional isotopic results were reported on nine samples for the isotopes americium-241, cobalt-60, ruthenium-106, and thorium-234 (IT Corp. 1992c).

No VOCs, SVOCs, or metals were detected at levels that exceeded risk-based action levels derived using the methodology in the proposed 40 CFR Subpart S and SNL/NM background soil levels (IT Corp. 1994b). Since no constituents were detected above action levels, a baseline risk assessment was considered unnecessary at the time. No TCLP leachate concentrations exceeded the RCRA land disposal restriction levels (40 CFR 268) or the RCRA toxicity characteristic hazardous waste threshold levels (40 CFR 262) (IT Corp. 1992c).

Radiological results for the detected radionuclides are summarized in Table 5-24. Tritium, americium-241, cobalt-60, and ruthenium-106 were not detected in any samples; potassium-40, radium-224, radium-226, and radium-228 were detected in all samples; cesium-137 was detected in 18 samples; and thorium-234 was detected in all nine samples analyzed for that isotope. Comparison of the gamma spectrum results with soil values obtained from the sitewide soil background study indicates that the values are consistent with other soil at SNL/NM (IT Corp. 1994b); the background ranges are shown for comparison purposes in Table 5-25. Based on these results, no additional site investigation is proposed for this portion of the TA-I storm drain system.

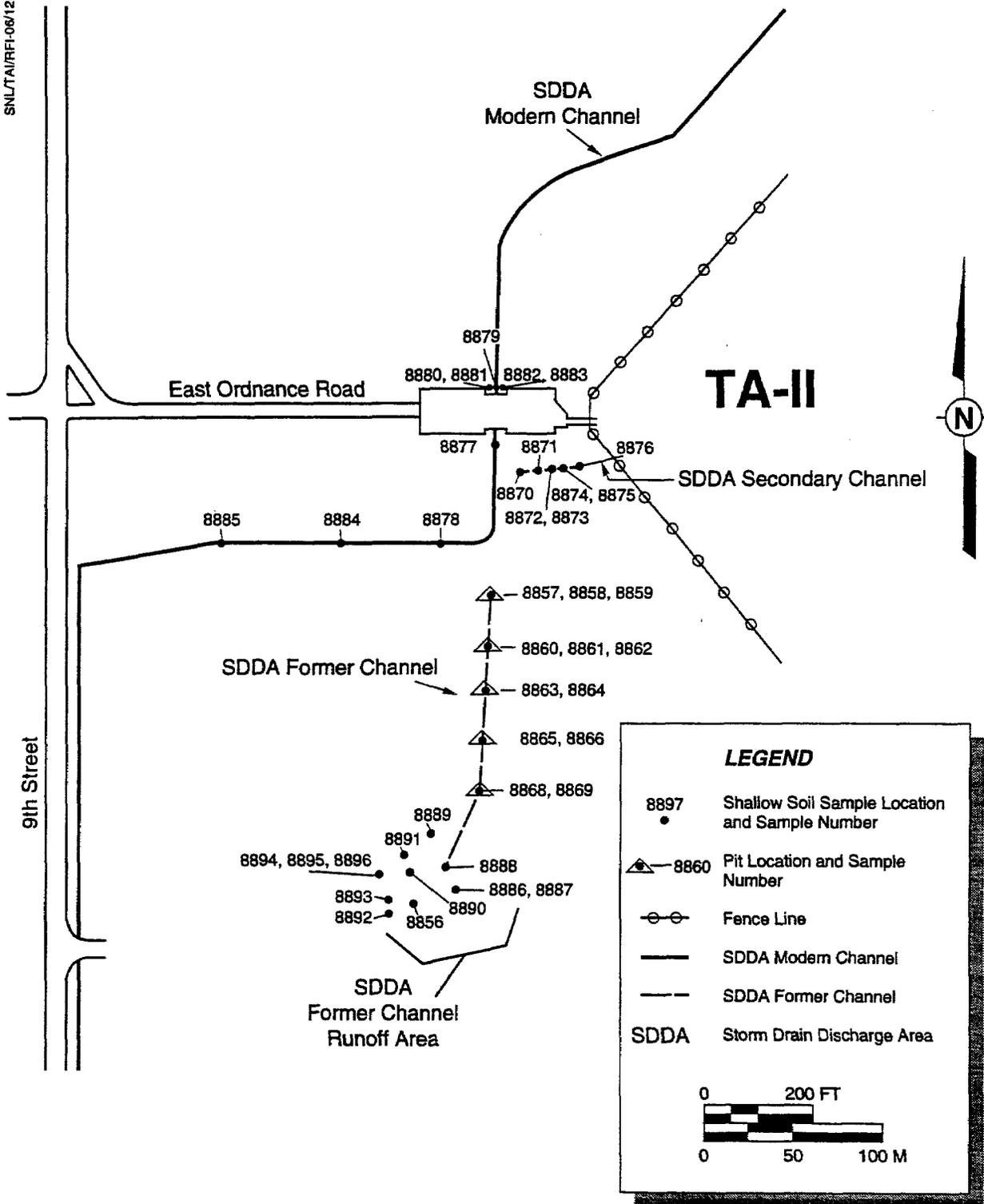


Figure 5-33
ER Site 96: Storm Drain Channels and Discharge Area,
Previous Sample Locations

Table 5-24. Results of 1992 Sampling of Storm Drain Discharge Area and Channel Surface Soil

Analyte	Range of Results	SNL/NM Background
Gross alpha	ND to 26.6 pCi/g	None available
Gross beta	ND to 29.8 pCi/g	None available
Cesium-137	ND to 0.253 ± 0.044 pCi/g	0.92 pCi/g
Potassium-40	16.3 ± 1.8 to 34.9 ± 26 pCi/g	25.34 pCi/g
Radium-224	0.510 ± 0.076 to 0.99 ± 0.14 pCi/g	0.968 pCi/g
Radium-226	0.536 ± 0.053 to 0.973 ± 0.091 pCi/g	1.94 pCi/g;
Radium-228	0.538 ± 0.065 to 1.20 ± 0.12 pCi/g	1.05 pCi/g
Thorium-234	0.569 ± 0.178 to 1.39 ± 0.31 pCi/g	2.89 pCi/g

ND = Not detected

5.10.2.4 Building 870 Investigation

Prior to a major renovation of Building 870 that involves the removal, disposal, or relocation of existing storm drain (and sanitary sewer) lines, soil sampling was carried out to characterized potential release sites near breaks and deficiencies in the storm drain and sanitary sewer lines. The stormwater discharge lines in the vicinity of Building 870 originate locally and receive surface runoff from areas adjacent to Building 870, 870B, 870C, and 884. The stormwater discharge lines in the area of Building 870 may have received rainwater runoff potentially containing a variety of organic and inorganic constituents from the buildings and grounds near Building 870. The storm drain system has also received effluents (NaOH and HCl) during two reported releases from the adjacent ER Site 42 (PRC 1993a). (See Section 5.4).

In October 1993, soil was sampled near storm drain lines at two locations on the east side of Building 870 at 1 to 2 ft below the level of the piping. The two samples were analyzed for ethylene glycol, VOCs, SVOCs, and total RCRA metals by an off-site analytical laboratory. Ethylene glycol, VOCs, and SVOCs were not detected in the soil samples collected adjacent to the storm drain lines. Several metals (arsenic, barium, total chromium, and lead) were detected, but all were below risk-based action levels derived in accordance with the methodology in proposed Subpart S (EPA 1990b) and SNL/NM background metals concentrations (PRC 1993c). Since no constituents were detected above action levels, a baseline risk assessment was considered unnecessary at the time.

Soil samples were also collected in May 1994 at one location near the southwest corner of Building 870, just southeast of Building 884, where a Building 870 lateral extends to the main storm drain line. Samples were collected below the most severe line break in the lateral at two depths: 4 ft bgs (the storm drain line depth) and 9 ft bgs (5 ft below the drain line depth). A duplicate sample was collected at 9 ft bgs. Samples were shipped to an off-site analytical laboratory for VOC, SVOC, and total RCRA metal analyses. No VOCs, SVOCs, or metals were detected above the risk-based action level derived in accordance with the methodology in the proposed 40 CFR Subpart S and SNL/NM background metals concentrations (IT Corp. 1994b; Heimer 1994). Since no constituents were detected above action levels, a baseline risk assessment was considered unnecessary at the time.

5.10.2.5 *In-Line Camera Survey*

The storm drain system was surveyed by an in-line camera in the spring of 1993 to detect breaks in the lines and cross-connections to the sanitary sewer system (Section 5.10.2.2) (SNL/NM 1993e). Abandoned storm drain lines that served the former Hazardous Waste Repackaging/Storage Facility, ER Site 73, were surveyed in the fall of 1993 and those that served Building 870 were surveyed in March of 1993.

When the field work was completed, a quality control review of the video cassette tapes was performed to note pipe deficiencies. Specific pipe deficiencies, exposed gaskets, cracks, and offset joints were noted during the in-line camera survey. In some cases modifiers, such as minor or slight, moderate, or severe were added. For offset joints, the designation was based on deflection, which was estimated based on the light reflection at the joint, typically indicated by a crescent moon shape. The following criteria were used to define pipe deficiencies (Jones 1994):

- A minor crack is a hairline crack which shows no sign of an open void in the pipe material.
- A moderate crack has a visible void in the pipe wall and may have an offset of pipe material at the crack.
- A severe crack was noted in cases where soil was visible through the opening in the pipe.
- A slight offset joint has a deflection of approximately 1/4 in. or less.
- A moderate offset joint has an exposed gasket or a joint deflection greater than 1/4 in.
- A severe offset joint has soil visible through the offset joint.

At locations where a line was plugged with dirt or concrete, it was assumed the line was inactive because of facility requirements. A plugged line is not considered a break in the system. Any crack noted in the system, however, is considered a break.

Once all deficiencies were interpreted, deficiencies which were not previously assigned a slight, moderate, or severe designation were evaluated and assigned a designation. The assumptions noted below form the bases for the slight, moderate, and severe designations.

- Where there are roots in the lines, particularly in clay pipe, there is the potential for a moderate crack.
- Where not specified, offset joints are slight breaks.
- Where an offset joint is noted to be cracked, the break is moderate.
- Where there is either a joint with offset, a joint with roots, a possible old repair, or a cracked joint, the break is moderate.
- Where there is a broken pipe, a bad joint, an old repair, or a hole in the pipe, the break is severe.

The results of the in-line camera survey, shown in Plates 5-1 to 5-6, were used to develop the sampling strategy outlined in detail in Section 5.10.5. All keyed notes are shown in the plate legends; pipe deficiencies or breaks in the line which may have been the source of a release to surrounding soil are shown on the plates. The pipe deficiencies or breaks are shown as slight, moderate, or severe by the thickness of the line around and shading within the keyed note symbol.

5.10.3 Nature and Extent of Contamination

As noted above, there have been at least five documented releases to the storm drain lines during the course of TA-I operations (Section 5.10.1). Where there are pipe deficiencies and at system outfalls, hazardous constituents that entered the storm drain system via releases, building drainage, or cross-connections with the sanitary sewer may have been released to surrounding soil.

Data on the potential extent of any release from the storm drain system are limited. Since 1992, data are collected annually to measure radionuclides in arroyo sediment and soils under the SNL/NM routine environmental surveillance program (SNL/NM 1993f). Also under the SNL/NM routine environmental surveillance program, stormwater has been sampled and analyzed annually since 1992. Other investigations include soils adjacent to selected cross-connects (IT Corp. 1993b), sampling of surface soils in portions of the historic and current discharge channels (IT Corp. 1992c), and sampling of soils adjacent to the Building 870 storm drain lines (PRC 1993c; Heimer 1994).

Available data indicate that releases to the storm drain system have not impacted the soils adjacent to the storm drain system. The results of routine environmental monitoring of sediment and soil indicate that activities have not released radionuclides (SNL/NM 1993f). No COCs were detected above

action levels in soil samples collected adjacent to cross-connections (IT Corp. 1993b) and the current and historic discharge areas in TA-II (IT Corp. 1992c), or near the Building 870 storm drain lines (PRC 1993c).

5.10.4 Conceptual Model

The conceptual model for the storm drain system is based on available information on the historic releases to the system, the sanitary sewer/storm drain cross-connect data, pipe deficiencies identified during dye testing and the in-line camera survey. During the 40-year period of storm drain system operation, chemical and radiological constituents may have been released to the system via the cross-connections to the sanitary sewer, discharges associated with operations, and releases associated with unusual occurrences. These materials may have been released to the soil from pipe deficiencies and at system outfalls. Potential COCs include HCl and NaOH from spills; petroleum hydrocarbons from tank overflows; and chromium, chlorinated solvents, alcohols, metals, PCBs, and radionuclides from operational discharges, sanitary sewer system cross-connections, and nonpoint source runoff.

Based on available data and knowledge of system use, the potential COCs would be expected neither to migrate substantially from the release site nor to be present in concentrations which pose a risk to human health or the environment. There is little potential for lateral contaminant migration. In most cases the lines are buried 4 to 8 ft bgs. There is no grade or local topography, nor surface runoff or overland flow which would contribute to lateral contaminant migration. There is the potential for vertical migration through the vadose zone. During storm events, water flowing through the system provides a constant hydraulic head to transport COCs vertically through the vadose zone at pipe deficiencies, at system outfalls, and in earthen channels. The COCs present in the soil could also migrate vertically through the vadose zone with infiltrating precipitation; however, that migration mechanism is limited because of the extensive paving in TA-I. The recorded releases to the system during unusual occurrences (DOE 1987) and COCs entering the system via building discharges, nonpoint sources, and cross-connections are diluted by the water carried in the system. Thus, only dilute COCs have potentially been released to soil.

In order to develop a strategy for investigating releases from the storm drain system, a model of migration of contaminants through the vadose zone has been assumed. The storm drain system is designed to flow full during a storm event; any crack in the system has the potential to be a release pathway. Cracks or other deficiencies in the line are considered a point source of a release. Because

of the low potential for lateral migration, any release is assumed to migrate downward in a conical configuration. The release is assumed to spread at approximately a 45-degree angle from the vertical as it migrates vertically.

The potential for vertical migration of most metals and radionuclides is limited by their low solubilities and tendency to adsorb to the clay fraction of the soil. Chromium may have been released to the sewer in the hexavalent oxidation state (*i.e.*, as chromate), which is the form of chromium with the highest concern because of its toxicity and high mobility at a near neutral pH (Bartlett and Kimble 1976). However, chromate is quickly reduced to the trivalent form in the presence of soil or sediment organic matter so that chromate released to the soil through a break in the line can potentially be reduced to trivalent chromium. The subsoil of TA-I contains very little organic matter. However, the alkaline nature of the subsoil and its large buffering capacity would drive the chromium to the reduced trivalent state. The mobility of trivalent and hexavalent chromium differ significantly due to their differing solubilities. The solubility of trivalent chromium decreases as the pH is raised, whereas the solubility of the hexavalent form increases. Any hexavalent chromium that is not reduced remains highly mobile in the soil and will continue to migrate downward with infiltrating water from either the sewer or precipitation (Bartlett and Kimble 1976).

Acids released from a deficiency in a pipe would be quickly neutralized by the alkalinity of the native soil. Unlike the situation with an acid release, there is no buffer in the native soil available to neutralize bases that might be released. It is not known how far any bases released might have migrated. Because of the lack of natural neutralizing capabilities, it is possible that bases might have migrated farther than acids released in equal volume and molarity, but these bases would not be considered a COC unless the soil pH exceeds 12.5 (action level based on 40 CFR 261.22 criteria for corrosive hazardous waste).

The mobility and persistence of chlorinated solvents in the environment is well documented (ATSDR 1988; Kloefer *et al.* 1985; Wilson and Wilson 1985; Cline and Viste 1985; Barrio-Lage *et al.* 1986). The mobility of common solvents through the vadose zone is greater than that of metals. Most chlorinated solvents are considered to have a medium mobility through soil and tend to move in an aqueous phase. However, information gathered at other sites at SNL/NM indicate that these solvents may show significant migration in the gaseous phase in the arid soils at SNL/NM (SNL/NM 1992e). In the absence of biodegradation or volatilization, chlorinated solvents may be

relatively persistent in the environment. Likewise, the mobility and persistence of PCBs is well understood (Erickson 1986; EPA 1979). Because PCBs are relatively inert compounds, dispersion and accumulation in the environment are important factors in the fate of PCB contamination. PCBs released from the lines are not expected to migrate to a great extent. With a low water solubility and a high viscosity in the oil state, the adsorbed phase of PCBs is the most important mechanism affecting migration. PCBs are strongly adsorbed to organic matter, but much less readily to minerals (Schwartz, Cherry, and Roberts 1982).

The potential COCs released from the storm drain system at pipe deficiencies pose no direct human exposure risk. In most cases, the area affected by a break in the line is a minimum of 5 ft bgs. Unless the line is accessed for construction purposes, there should be no direct contact with the affected soil via inhalation, ingestion, or dermal exposure. If construction is required, proper precautions will be taken to protect site workers. Potential COCs released to system outfalls and earthen channels are not suspected to pose a risk to human health or the environment nor are the channels and discharge areas suspected to have received volatile organics in concentrations which would pose an inhalation exposure risk. Five hundred feet separate the potential release source and the local aquifer, therefore COCs are not expected to have migrated to a depth where risk to potable water exists.

Potential corrective measures at the storm drain system are primarily limited to excavation and offsite treatment or disposal. Because of the wide range of contaminants that may be present and the distribution of COCs at break locations, *in situ* and on-site treatment technologies do not appear to be technically or economically feasible during this preliminary review. However, on-site treatment may be feasible if a large soil volume is affected. If data collected indicate that the areal and vertical extent of COCs in a discharge area or earthen channel or the volume of soil to be generated from releases along the lines warrant it, on-site treatment technologies will be evaluated.

5.10.5 Sampling Plan

The sampling strategy selected for the storm drain system is designed to characterize potential releases from the system at the break locations identified by the in-line camera survey and system outfalls.

General DQOs for TA-I RFI are specified in Section 4.3. Specific DQOs for the storm drain system investigation are listed below.

- Determining if any VOCs, SVOCs, metals, PCBs, and/or radionuclides have been released to the soil within 18 in. of identified line breaks in the storm drain system and at system outfalls.
- Producing data of adequate quality (Level III) for all shallow subsurface samples at each break location under investigation so that risk calculations may be performed for an individual break location.
- Characterizing the vertical extent of any COCs detected above action levels near the storm drain lines and outfalls by collecting samples from deep soil borings for analysis (Level II and Level III).
- Producing data of adequate quality (Level III) for 20 percent of deep borehole samples so that risk calculations may be performed and corrective measures may be evaluated.

DOQs will be achieved through implementation of the sampling strategy outlined below. If contaminants are detected in the soil samples at concentrations above the action levels, additional samples (*i.e.*, boreholes) will be collected. Analytical Levels II and III will be required for analytical procedures identified under this plan. Data will be collected during surface and shallow subsurface soil sampling and deep soil boring investigations.

5.10.5.1 Surface and Shallow Subsurface Soil Sampling

5.10.5.1.1. Data Collection

Surface and shallow subsurface soil samples will be collected during the storm drain investigation:

- Shallow subsurface samples within 18 in. at or below a crack in a storm drain line.
- Surface samples from 12 to 18 in. bgs at system outfalls and in earthen channels.

Line Break Locations

Soil samples will be collected adjacent to the breaks identified by the in-line camera survey. In many cases, the breaks are clustered along a segment of the line. Where samples are clustered, a

streamlined sampling approach will be taken. Soil will be sampled at one location, selected to be representative of the potential worst case release to surrounding soil. This streamlined approach has been adopted based on the homogeneous nature of the storm water. Since the system flows west and/or south, the storm water and any COCs which may have entered the system would be the same along a given line or section of line that received discharge from the same source. COCs present would be diluted with discharge from additional lines downstream of each connection and at the confluence of lines. Given the break density and severity designations, the criteria listed below comprise the bases for the selected sample locations.

- Where two or more breaks are located along 100 ft of pipe, the most severe and most upgradient break will be sampled.
- Where there are two or more slight breaks within 100 ft of pipe, the most upgradient break will be sampled.
- Where five or more severe breaks are clustered along 100 ft of pipe, the most upgradient break and that break nearest a downgradient connection will be sampled (*i.e.*, two breaks will be sampled if more than four severe breaks are located within 100 ft).
- Where a break is over 100 ft from other break locations, the break location will be sampled.

One soil sample will be collected within 18 in. directly below or adjacent to the line at the locations shown in Plates 5-1 to 5-6 for field screening, lithologic logging, and laboratory analyses. Additional soil will be collected for screening and logging and then will be disposed of as IDW. The sample locations are indicated on the plates using bolded circles around the keyed note symbol on the figure.

System Outfalls

The investigation of earthen channels will be limited to the area immediately downgradient of the outfalls. Soil samples will be collected at five system outfalls: at the entrance to 9th Street, at 14th Street, at the channel between 14th and 17th Streets, at 17th Street, and at 20th Street. At each outfall, five samples will be collected from 12 to 18 in. bgs, for a total of 20 samples (plus QA/QC samples) at each outfall (Plates 5-1 through 5-6). Two upgradient samples will be collected at the northern end of the 20th Street channel as a baseline for comparison with downgradient samples. Upgradient samples will be collected at the southeastern corner of 20th and G Streets and at the north

base housing SNL/NM routine surveillance monitoring perimeter soil sample location (Location No. 58).

5.10.5.1.2. Analytical Parameters

Environmental, QA/QC, and waste management samples are listed in Table 5-25 for the surface (outfall) and Table 5-26 for the shallow subsurface (line) samples at the end of this subsection. All surface and shallow subsurface samples collected near or below storm drain lines or at the system outfalls will be analyzed by an off-site laboratory (Level III) for VOCs, SVOCs, PCBs, total TAL inorganics, isotopic uranium, isotopic plutonium, and tritium, and by an on-site laboratory by gamma spectroscopy (Level II). Thirty percent of the collected soil samples (chosen on a random basis) will be analyzed for hexavalent as well as total chromium. Field screening for VOCs using a PID or FID and for alpha and beta/gamma radiation using alpha scintillation and Geiger-Mueller pancake probes will be conducted as samples are collected.

5.10.5.2 Borehole Investigation

5.10.5.2.1. Data Collection

At line break and system outfall locations where the shallow subsurface analytical data exceed either risk-based action levels (Section 4.1.2) derived in accordance with the methodology presented in the proposed 40 CFR Subpart S and/or SNL/NM background metals and radionuclide concentrations, boreholes will be drilled and additional soil samples will be collected. At those break locations where the shallow subsurface sampling does not indicate the presence of contamination, boreholes will not be drilled.

One borehole will initially be drilled at the outfall sample location or approximately 18 in. downgradient from the line break sample location. The vertical extent of potential contamination at the borehole will be determined using field screening or on-site laboratory analyses. Three additional boreholes will be located radially around the initial borehole, with one located downgradient from the initial borehole, adjacent to the pipe. The distance of these boreholes from the central borehole will be dependent upon the vertical extent of potential contamination: the distance should equal approximately one-half the vertical extent of the potential contamination, to a maximum of 25 feet. The distance and location of the radial boreholes may be modified based on available screening techniques, site clearance, and access.

At each borehole location, a hollow-stem auger will be used to collect samples for field screening (if available for COCs detected), lithologic logging, and for laboratory analysis (Level II or III).

Borehole sampling will be initiated at the depth of the shallow subsurface sample. Samples will be collected at 5-ft intervals from 5 to 50 ft (depending on the depth of the line), at 10-ft intervals from 50 to 100 ft, and at 20-ft intervals at depths greater than 100 ft. The boreholes will be drilled until two samples are determined to be uncontaminated by means of field screening or on-site analysis, as appropriate, or to the depth limits of the drilling method. Sampling will then be terminated.

Split samples will initially be collected at the two shallowest 5-ft intervals. One split from each depth will be sealed, labeled, and set aside for possible off-site laboratory analysis. The other split will be logged for lithology and field screened or analyzed at the on-site analytical laboratory as appropriate for the COCs under investigation. The samples will also be surveyed for beta/gamma radiation using a Geiger-Mueller pancake probe.

If no COCs are detected, then these two 5-ft samples will be considered uncontaminated and sent for confirmatory off-site laboratory analysis. If one of the first two samples is contaminated, then the borehole will be advanced and sampled at the intervals described above until two consecutive intervals are determined to be uncontaminated. To meet the objectives described above, at least 20 percent of the samples will be submitted for off-site laboratory verification analysis, including the sample showing the highest screening value (to characterize the nature of the COCs) and one sample from each of the two deepest uncontaminated sample intervals (to characterize the vertical extent of COCs). Other samples may be chosen by the field geologist, using professional judgement, to be representative of the sample set. Core not submitted for laboratory analysis will be disposed of as IDW.

If boreholes are determined to be necessary, they will be located as described above. For planning purposes, borehole depth is estimated to be 100 ft, but the depth may be extended based on the field screening data. Actual depth of vertical sampling may vary according to field conditions and the equipment capabilities. At least three soil samples will be collected for Level III analysis from each borehole as well as additional QA/QC samples.

5.10.5.2.2. Analytical Parameters

Table 5-27 at the end of this subsection is an example table; it lists the environmental, geotechnical, QA/QC, and waste management samples for a single borehole. Samples collected from the deep borings will be analyzed only for the parameters detected in the adjacent surface or shallow subsurface samples. Field screening for VOCs using a PID or FID and for alpha and beta/gamma radiation using alpha scintillation and Geiger-Mueller pancake probes will be conducted as samples are collected.

Table 5-26. Shallow Subsurface Soil Sample Identification and Analytical Specifications

ER SITE 096 : (Storm Drclin System)				FIELD SCREENING (c)				ON-SITE LAB ANALYSES (b) (c) (d)				OFF-SITE LAB ANALYSES (e) (f)													
FIELD NUMBER	SAMPLE ID (g)	SAMPLE METHOD (e.g. Geoprobe, Soil Boiling, Hand Auger, etc.)	SAMPLE TYPE (e.g. Surface Soil, Sediment, Rinseate Blank, Trip Blank, Duplicate, etc.)	VOCs	TPH	SOIL PH	PCBs	RADIATION (alpha, beta, gamma)	VOCs (by GC)	METALS (by DCP)	GAMMA SPEC	TPH	VOCs (824D)	TPH (8015)	SVOCs (827D)	PCBs (808D)	TAL INORGANICS (7)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCIP INORGANICS (1311) (7)	TCIP ORGANICS (1311/827D/824D)	HEX CHROMIUM	
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
				X	X	X	X	X																	

Table 5-26. (page 2 of 5)

ER SITE 096 : (Storm Drain System)				FIELD SCREENING (a)		ON-SITE LAB ANALYSES (b) (c) (d)				OFF-SITE LAB ANALYSES (e) (f) (g)																	
FIELD NUMBER	SAMPLE ID (g) See Plates 5-1 to 5-6 for Locations	SAMPLE METHOD (e.g. Geoprobe, Soil Boring, Hand Auger, etc.)	SAMPLE TYPE (e.g. Surface Soil, Sediment, Rhisate Blank, Trip Blank, Duplicate, etc.)	SAMPLE DEPTH (f)	VOCs	TPH	SOIL PH	PCBs	RADIATION (alpha, beta, gamma)	VOCs (by GC)	METALS (by DCP)	GAMMA SPEC	TPH	VOCs (B240)	TPH (B015)	SVOCs (B270)	PCBs (B080)	TAL INORGANICS (7)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCLP INORGANICS (1311) (4)	TCLP ORGANICS (1311/B270/B240)	HEX CHROMIUM		
	BH-027-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	
	BH-028-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-029-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-030	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-031-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-032-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-033-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-034-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-035-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-036-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-037	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-038-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-039-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-040-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-041-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-042-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-043-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-044-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-045-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-046-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-047-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-048-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-049-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-050-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-051-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X
	BH-052-	HAND AUGER	SOIL	LINE	X				X					X				X	X	X	X	X	X	X	X	X	X

Table 5-26. (page 3 of 5)

ER SITE 096 : (Storm Drain System)				FIELD	ON-SITE LAB	OFF-SITE LAB
FIELD NUMBER	SAMPLE ID (a)	SAMPLE METHOD	SAMPLE TYPE	SCREENING (a)	ANALYSES (b) (c) (d)	ANALYSES (e) (f) (g)
Assign Bar-Coded Sample Number in Field	See Plates 5-1 to 5-6 for Locations	(e.g. Geoprobe, Soil Boring, Hand Auger, etc.)	(e.g. Surface Soil, Sediment, Rinseate Blank, Trip Blank, Duplicate, etc.)	TFH SOIL PH PCBs RADIATION (alpha, beta, gamma)	VOCs (by GC) METALS (by DCP) GAMMA SPEC TFH	VOCs (8240) TFH (8015) SVOCs (8270) PCBs (8080) TAL INORGANICS (7) ISOTOPIC URANIUM ISOTOPIC PLUTONIUM ISOTOPIC THORIUM TRITIUM (LIQUID SCINT.) TCP INORGANICS (1311) (4) TCP ORGANICS (1311/8270/8240) HEX CHROMIUM
	BH-063-	HAND AUGER	SOIL	X		X
	BH-064-	HAND AUGER	SOIL	X		X
	BH-065-	HAND AUGER	SOIL	X		X
	BH-066-	HAND AUGER	SOIL	X		X
	BH-067-	HAND AUGER	SOIL	X		X
	BH-068-	HAND AUGER	SOIL	X		X
	BH-069-	HAND AUGER	SOIL	X		X
	BH-070-	HAND AUGER	SOIL	X		X
	BH-071-	HAND AUGER	SOIL	X		X
	BH-072-	HAND AUGER	SOIL	X		X
	BH-073-	HAND AUGER	SOIL	X		X
	BH-074-	HAND AUGER	SOIL	X		X
	BH-075-	HAND AUGER	SOIL	X		X
	BH-076-	HAND AUGER	SOIL	X		X
	BH-077-	HAND AUGER	SOIL	X		X
	BH-078-	HAND AUGER	SOIL	X		X

Appendix D

ER Site 96: Risk Assessment Analysis Report

ER SITE 96: RISK ASSESSMENT ANALYSIS

I. Site Description and History

The Technical Area I (TA-I) Storm Drain System, Environmental Restoration (ER) Site 96, serves all of TA-I. The original storm drain system was constructed between 1948 and 1950. The water is conveyed through a series of open channels and underground lines from north to south from TA-I to the Tijeras Arroyo. The storm drain system was listed as ER Site 96 based on reports that the system had received constituents of concern (COCs) from various activities. System discharges were reported to include nonpoint source surface runoff from TA-I, blowdown from an incinerator scrubbing system, and cooling tower blowdown water (possibly containing chromates and other antifoulants). In addition, there were several releases of various COCs to the storm drains from spills throughout TA-I.

The ER Site 96 boundaries are assumed to be the limits of areas where potential COCs have been detected near breaks in the lines. During the 40-year period of storm drain system operation, chemical and radiological constituents may have been released to the system via the cross-connections to the sanitary sewer, discharges associated with TA-I operations, and releases associated with unusual occurrences. These materials may have been released to the soil through pipe deficiencies and/or at system outfalls. Potential COCs included hydrochloric acid (HCl) and sodium hydroxide (NaOH) from spills; petroleum hydrocarbons from tank overflows; and chromium, chlorinated solvents, alcohols, metals, polychlorinated biphenyls (PCBs), and radionuclides. The recorded releases to the system were diluted by the water carried in the system. Thus, only dilute COCs have potentially been released to soil.

II. 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.
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<p>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.</p>
<p>Step 4. Data are described on the potential toxicity and cancer effects from exposure to the COCs and associated background constituents and subsequent intake.</p>
<p>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.</p>
<p>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.</p>
<p>Step 7. Discussion of uncertainties in the previous steps.</p>

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 96 Data Evaluation Report and the 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. Chemicals that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment (USEPA 1989a). Both radioactive and nonradioactive COCs are evaluated. The nonradioactive COCs evaluated are both metals and organics.

II.2 Step 2. Pathway Identification

ER Site 96 has been designated with a future land-use scenario of industrial (USDOE, 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 for both chemicals and radionuclides is included 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 96 is approximately 550 feet. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered to not be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the industrial land-use scenario. However, plant uptake is considered for the residential land-use scenario.

PATHWAY IDENTIFICATION

Chemical Constituents	Radionuclide Constituents
Soil Ingestion	Soil Ingestion
Inhalation (Dust and volatiles)	Inhalation (Dust and Volatiles)
Plant uptake (Residential only)	Plant uptake (Residential only)
	Direct Gamma

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 96 were evaluated using a tiered approach. First, the maximum concentrations of COCs were compared to TA-I specific background screening levels using 95th upper tolerance limits (UTLs) or percentile values (Sandia National Laboratories/New Mexico [SNL/NM], 1996). If a maximum concentration of a particular COC exceeded the TA-I specific background screening level, then the COC was 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 uranium isotopes, if a maximum concentration exceeded the SNL/NM background screening level, the isotopic ratios of U-238/U-234 and U-238/U-235 were compared to the range of TA-I specific background ratios.

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 both the TA-I or SNL/NM background screening levels or the USGS background value, all nonradiological COCs were considered in further risk assessment analyses.

For radiological COCs that exceeded both the TA-I or SNL/NM background screening levels and, as applicable, were above the range of uranium isotopic ratios, 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.

Second, if any nonradiological COC failed the initial screening step, the maximum concentration for each 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, 1989a) documentation. 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, 1989a). The combined effects of all nonradiological COCs in the soils were calculated. The combined effects of the nonradiological COCs at their respective background concentrations in the soils were also calculated. The most conservative background

concentration between the TA-I specific and SNL/NM concentration (minimum value of the 95th UTL or percentile concentration value, as applicable) was used in the risk calculation. For toxic compounds, 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 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 cancer risk estimated using USDOE's RESRAD computer code.

II.3.1 Comparison to Background and Action Levels

Nonradioactive ER Site 96 COCs are listed in Table 1, radioactive COCs are listed in Table 2. Both tables show the associated 95th percentile or UTL background levels (SNL/NM, 1996; IT, 1996). Table 3 shows the isotopic uranium ratio comparison to background. Background levels for plutonium and tritium are not applicable because these radionuclides do not occur naturally, or when due to fallout, at levels detectable by common laboratory analytical instrumentation.

The TA-I background levels have not yet been approved by the USEPA or the NMED, but are the result of statistical analyses of samples collected from background areas within TA-I. USEPA guidance (USEPA, 1989b; 1992a; and 1992b) were followed to arrive at the background levels. 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 1 supersede the background values described in an interim background study report (IT, 1994).

The background value for manganese was determined by the USGS as part of the NURE program (USGS, 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 97 (B) 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

Table 1. Nonradioactive COCs at ER Site 96 and Comparison to the Background Screening Values.

COC name	Maximum concentration (mg/kg)	TA-I 95th % or UTL Level (mg/kg)	Is maximum COC concentration less than or equal to the applicable TA-I background screening value?	SNL/NM 95th % or UTL Level (mg/kg)	Is maximum COC concentration less than or equal to the applicable SNL/NM background screening value?
Aluminum	11,900	12,055	Yes		
Antimony	0.749 JB	0.49	No	3.9	Yes
Arsenic	7.51	7.7	Yes		
Barium	312 B	654	Yes		
Beryllium	0.58	0.57	No	0.80	Yes
Cadmium	1.78 B	0.84	No	1.6	No
Chromium, total	80.8 B	11.7	No	17.3	No
Chromium VI	0.7	54	Yes		
Cobalt	11.7	6.3	No	7.10	No
Copper	41.7	10.0	No	25.5	No
Lead	97 B	17.3	No	68.0	No
Manganese	346 B	243	No	831 ⁺	Yes
Mercury	0.254	0.14	No	0.31	Yes
Nickel	94.2 B	10.6	No	25.4	No
Selenium	0.818	0.24	No	<1*	No
Silver	76.4	NC	No	2.0	No
Thallium	2.03	1.2	No	<1.1	No
Vanadium	50.2 B	34.9	No	47.2	No
Zinc	168 B	50.8	No	82.4	No

NC - not calculated

+ - regional background values from the USGS NURE Program (USGS, 1994)

B - parameter detected in method blank

J - estimated value

* - uncertainty due to detection limits

Table 2. Radioactive COCs at ER Site 96 and Comparison to the Background Screening Values.

COC name	Maximum concentration (pCi/g)	TA-I 95 th % or UTL Level (pCi/g)	Is maximum COC concentration less than or equal to the applicable TA-I background screening value?	SNL/NM 95th % or UTL Level (pCi/g)	Is maximum COC concentration less than or equal to the applicable SNL/NM background screening value?
Pu-239/240	0.0434	NC	No	NC	No
Pu-238	0.934	NC	No	NC	No
H-3	1.62	NC	No	NC	No
U-238	1.41	0.84	No	1.3	No
U-235	0.0698	0.1	Yes	0.18	Yes
U233/234	1.53	1.03	No	1.6	Yes

NC - not calculated

Table 3. Isotopic Uranium Ratio Comparison to Background Range

COC name	U-238 to U-234 Ratio	TA-I Background U-238 to U-234 Ratio Range	U-238 to U-235 Ratio	TA-I Background U-238 to U-235 Ratio Range	Are isotopic ratios within the range of TA-I background ratios
U-238	0.92	0.804 - 1.253	20.2	8.277 - 23.947	Yes

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. Because organic compounds do not have calculated background values, this screening step was skipped, and all organics are carried into the risk assessment analyses.

Because several nonradiological COCs had concentrations greater than their respective TA-I specific or SNL/NM background 95th percentile or UTL, the site fails the background screening criteria and all nonradiological COCs proceed to the proposed Subpart S action level screening procedure. Because the ER Site 96 sample set had more than 10 COCs that continued past the first screening level, the proposed Subpart S screening process was skipped. All remaining nonradiological COCs must have a Hazard Index value and cancer risk value calculated. Radioactive contamination does not have pre-determined action levels analogous to proposed Subpart S and

therefore this step in the screening process is not performed for radionuclides.

II.3.2 Identification of Toxicological Parameters

Tables 4 and 5 show the COCs that have been retained in the risk assessment and the values for the toxicological information available for those COCs. Dose conversion factors (DCFs) used in determining the incremental TEDE values for the individual pathways were the default values provided in the RESRAD computer code as developed in the following:

- For ingestion and inhalation, DCFs are taken from Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion* (USEPA, 1988a).
- The DCFs for surface contamination (contamination on the surface of the site) were taken from USDOE/EH-0070, *External Dose-Rate Conversion Factors for Calculation of Dose to the Public* (USDOE, 1988).
- The DCFs for volume contamination (exposure to contamination deeper than the immediate surface of the site) were calculated using the methods discussed in, *Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil* (Health Physics 28:193-205) (Kocher, D.C., 1983), and ANL/EAIS-8, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil* (Yu, C., et al., 1993a)..

II.3.3 Exposure Assessment and Risk Characterization

Section II.3.3.1 describes the exposure assessment for this risk assessment. Section II.3.3.2 provides the risk characterization including the Hazard Index value and the excess cancer risk for both the potential nonradiological COCs and associated background; industrial and residential land-uses. The incremental TEDE and incremental estimated cancer risk are provided for the background-adjusted radiological COCs; 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 on RAGS (USEPA, 1989a). The parameters are based on information from RAGS (USEPA, 1989a) as well as other USEPA

Table 4. Nonradioactive Toxicological Parameter Values for ER Site 96
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
Aluminum	1	--	Est.	--	--	--
Antimony	0.0004	--	L	--	--	D
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*	1	0.00000057 1	L	--	--	D
Chromium VI	0.005	--	L	--	42	A
Cobalt	0.06	--	--	--	--	--
Copper	0.04	--	Est.	--	--	D
Manganese	0.005	0.0000143	--	--	--	D
Mercury	0.0003	0.0000857	--	--	--	D
Nickel	0.02	--	--	--	--	D
Selenium	0.005	--	H	--	--	D
Silver	0.005	--	--	--	--	D
Thallium	--	--	--	--	--	D
Vanadium	0.007	--	Heast	--	--	D
Zinc	0.3	--	M	--	--	D
Acenaphthylene	--	--	--	--	--	--
Anthracene	0.3	--	L	--	--	D
Benzo(a) anthracene	--	--	--	0.73	0.61	--
Benzo(a) pyrene	--	--	--	7.3	6.1	B2
Benzo(b) fluoranthene	--	--	--	0.73	0.61	B2
Benzo(k) fluoranthene	--	--	--	0.073	0.061	B2
Benzo(g,h,i) perylene	--	--	--	--	--	D
bis(2- ethylhexyl) phthalate	0.02	--	--	0.014	--	B2
Chrysene	--	--	--	0.0073	0.0061	B2
Dibenzofuran	0.004	--	--	--	--	--
Fluoranthene	0.04	--	L	--	--	D
Fluorene	0.04	--	L	--	--	D

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 ^
Indeno(1,2,3-c,d) pyrene	--	--	--	0.73	0.61	B2
Naphthalene	0.04	--	--	--	--	D
Phenanthrene	--	--	--	--	--	D
Pyrene	0.03	--	L	--	--	D
Toluene	0.2	0.14	M	--	--	D
Xylene	2	--	M	--	--	D
PCBs (total aroclors)	--	--	--	7.7	--	B2

* 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, Est. = estimated

Heast - Heast Table from USEPA 1996b

SF_o - oral slope factor in (mg/kg-day)⁻¹

SF_{inh} - inhalation slope factor in (mg/kg-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

* total chromium assumed to be chromium III

Table 5: Radiological Toxicological Parameter Values for ER Site 96 COCs

COC name	SF _{ev} (g/pCi-yr)	SF _o (1/pCi)	Sf _{inh} (1/pCi)	Cancer Class [^]
Pu-239/240	1.3E-11	3.2E-10	2.8E-08	A
Pu-238	1.9E-11	3.0E-10	2.7E-08	A
H-3	0	7.2E-14	9.6E-14	A

SF_{ev}- external volume exposure slope factor (risk/yr per pCi/g) SF_o - oral (ingestion) slope factor (risk/pCi)

SF_{inh} - inhalation slope factor (risk/pCi)

[^] 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

guidance documents and reflect the RME approach advocated by RAGS (USEPA, 1989a). For radionuclides, the coded equations provided in the RESRAD computer code were used to estimate the excess dose and cancer risk for the individual exposure pathways. Further discussion of this process is provided in Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0 (Yu, C., et al., 1993).

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

II.3.3.2 Risk Characterization

Table 6 shows that for the ER Site 96 nonradioactive COCs, the Hazard Index value is 0.1 and the excess cancer risk is 2×10^{-5} for the designated industrial land-use scenario. The numbers presented included exposure from soil ingestion and dust inhalation for the nonradioactive COCs. Table 7 shows that for the ER Site 96 associated nonradiological background constituents, the Hazard Index is 0.08 and the excess cancer risk is 5×10^{-6} for the designated industrial land-use scenario.

Table 6. Nonradioactive Risk Assessment Values for ER Site 96 COCs.

COC Name	Maximum concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Aluminum	11,900	0.01	--	0.05	--
Antimony	0.749 JB	0.00	--	0.03	--
Arsenic	7.51	0.02	5E-6	0.43	8E-5
Barium	312 B	0.00	--	0.05	--
Beryllium	0.58	0.00	1E-6	0.00	5E-6
Cadmium	1.78 B	0.00	7E-10	1.46	1E-9
Chromium, total*	80.8 B	0.02	--	0.03	--
Chromium VI	0.7	0.00	2E-9	0.00	3E-9
Cobalt	11.7	0.00	--	0.00	--
Copper	41.7	0.00	--	0.19	--
Manganese	346 B	0.07	--	3.06	--
Mercury	0.254	0.00	--	0.44	--
Nickel	94.2 B	0.00	--	0.14	--
Selenium	0.818	0.00	--	0.29	--
Silver	76.4	0.01	--	3.15	--
Thallium	2.03	--	--	--	--
Vanadium	50.2 B	0.01	--	0.04	--
Zinc	168 B	0.00	--	0.30	--
Acenaphthylene	0.303 J	--	--	--	--
Anthracene	1.71 J	0.00	--	0.00	--
Benzo(a) anthracene	7.9	0.00	3E-06	0.00	3E-5
Benzo(a) pyrene	2.73 J	0.00	8E-06	0.00	7E-5
Benzo(b) fluoranthene	12.4	0.00	4E-06	0.00	3E-5
Benzo(k) fluoranthene	3.88	0.00	1E-07	0.00	9E-7
Benzo(g,h,i) perylene	4.24	--	--	--	--
bis(2-Ethylhexyl) phthalate	12.8	0.00	8E-08	0.00	3E-7
Chrysene	11.5	0.00	4E-08	0.00	4E-7
Dibenzofuran	0.196 J	0.00	--	0.00	--
Fluoranthene	14.5	0.00	--	0.01	--

COC Name	Maximum concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Fluorene	0.339	0.00	--	0.00	--
Indeno(1,2,3-c,d) pyrene	3.97	0.00	1E-06	0.00	7E-6
Naphthalene	0.292 J	0.00	--	0.00	--
Phenanthrene	8.01	--	--	--	--
Pyrene	18.8	0.00	--	0.01	--
Toluene	0.0393	0.00	--	0.00	--
Xylene	0.0139 J	0.00	--	0.00	--
PCBs (total aroclors)**	0.557 J	0.00	2E-06	0.00	7E-6
TOTAL		0.1	2E-05	10	2E-4

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

** PCBs are combined maximum concentrations of all aroclors

J - estimated value

B - parameter detected in method blank

-- information not available

Table 7. Nonradioactive Risk Assessment Values for ER Site 96 Background Constituents.

Constituent Name	Background concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Aluminum	12,055	0.01	--	0.05	--
Antimony	0.49	0.00	--	0.02	--
Arsenic	5.6	0.02	4E-06	0.32	6E-05
Barium	200	0.00	--	0.03	--
Beryllium	0.57	0.00	1E-06	0.00	5E-06
Cadmium	0.84	0.00	3E-10	0.69	5E-10
Chromium, total*	11.7	0.00	--	0.00	--
Chromium VI**	11.7	0.00	3E-8	0.01	4E-8
Cobalt	6.3	0.00	--	0.00	--
Copper	10.0	0.00	--	0.04	--
Manganese	243	0.05	--	2.15	--
Mercury	0.14	0.00	--	0.24	--
Nickel	10.6	0.00	--	0.00	--
Selenium	0.24	0.00	--	0.08	--
Silver	2.0	0.00	--	0.08	--
Thallium	<1.1	--	--	--	--
Vanadium	34.9	0.00	--	0.03	--
Zinc	50.8	0.00	--	0.09	--
TOTAL		0.08	5E-6	4	7E-5

-- information not available

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

** chromium background concentration assumed to be chromium III (most conservative - lowest UTL), risk calculated in terms of chromium VI (consistent with Table 6)

For the radioactive COCs, contribution from the direct gamma exposure pathway is included. The TEDE for industrial land-use is 0.06 mrem/yr.

For the residential land-use scenario, the Hazard Index value increases to 10 and the excess cancer risk is 2×10^{-4} . The numbers presented included exposure from soil ingestion, dust and volatile inhalation, and plant uptake. Although USEPA (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, NM, 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 7 shows that for the ER Site 96 associated nonradiological background constituents, the Hazard Index increases to 4 and the excess cancer risk is 7×10^{-5} .

For the radioactive COCs, contribution from the direct gamma exposure pathway is included. The TEDE for residential land-use is 0.3 mrem/yr.

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

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 also a residential land-use scenario.

For the industrial land-use scenario, the Hazard Index calculated for the nonradioactive COCs is 0.1; this is much less than the numerical standard of 1 suggested in RAGS (USEPA, 1989a). The excess cancer risk is estimated at 2×10^{-5} . In RAGS, the USEPA suggests that a range of values (10^{-6} to 10^{-4}) be used as the numerical standard; the value calculated for this site is in the middle of the suggested acceptable risk range. Therefore, for an industrial land-use scenario, the Hazard Index risk assessment values are significantly less than the established numerical standards and the excess cancer risk is in the middle of the suggested acceptable risk range. This risk assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the industrial and residential land-use scenarios. For the industrial land-use scenario, the Hazard Index is 0.08. The excess cancer risk is estimated at 5×10^{-6} . Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk. These numbers are not rounded before the difference is determined and therefore may appear to be inconsistent with numbers presented in tables and discussed within the text. The incremental Hazard Index is 0.06 and the incremental cancer risk is 1.8×10^{-5} for the industrial land-use scenario.

For the radioactive components of the industrial land-use scenario, the calculated incremental TEDE is 0.06 mrem/yr. In accordance with proposed USEPA guidance, the standard being utilized is an incremental TEDE of 15 mrem/yr (40 CFR Part 196, 1994) for the probable land-use scenario (industrial in this case); the calculated dose value for ER Site 96 for an industrial land-use is well below this standard. The cancer risk from the nonradioactive COCs and the radioactive COCs is not additive, as noted in RAGS (USEPA, 1989a). The incremental cancer risk estimate is 7×10^{-7} .

For the residential land-use scenario, the calculated Hazard Index for the nonradioactive COCs is 10, which is greater than the numerical guidance. The excess cancer risk is estimated at 2×10^{-4} ; 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 4. The excess cancer risk is estimated at 7×10^{-5} . For the residential land-use scenario, the incremental Hazard Index is 5.9 and the incremental cancer risk is 1.6×10^{-4} .

The incremental TEDE from the radioactive components is 0.3 mrem/yr. In accordance with proposed USEPA guidance, the standard being utilized is an excess TEDE of 75 mrem/yr (40 CFR Part 196, 1994) for a complete loss of institutional controls (residential land-use in this case); the calculated dose values for ER Site 96 for the residential land-use is well below this standard. It should also be noted that, consistent with the proposed guidance (40 CFR Part 196, 1994), ER Site 96 should be eligible for unrestricted radiological release as the residential scenario resulted in an incremental TEDE to the on-site receptor of less than 15 mrem/yr. The cancer risk from the nonradioactive COCs and the radioactive COCs is not additive, as noted in RAGS (USEPA, 1989a). The associated incremental cancer risk is 2×10^{-6} .

II.5 Step 7 Uncertainty Discussion

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

The main contributors to the adverse effects on human health are benzo(a)pyrene (2.73 mg/kg), benzo(b)fluoranthene (12.4 mg/kg),

benzo(a)anthracene (7.9 mg/kg), arsenic (7.51 mg/kg) and PCBs (0.557 mg/kg). Benzo(a)pyrene, benzo(a)anthracene and benzo(b)fluoranthene are components of asphalt. Since TA-I is highly industrialized, the benzo(a)pyrene, benzo(a)anthracene and benzo(b)fluoranthene are likely to have been derived from asphalt. The maximum arsenic concentration (7.51 mg/kg) was below its background screening value. PCBs are known to have been used in TA-I. The PCB concentration value is a sum of all maximum concentrations of individual aroclors. Therefore, this risk assessment is considered conservative as benzo (a) pyrene and benzo (b) fluoranthene are probably not indicative of contamination, arsenic is below its background screening value and PCB concentrations per location are significantly less than the total PCB concentration used in the calculation.

For the radiological COCs the conclusion from the risk assessment is that the potential effects on human health, for the industrial land-use scenario, are well within the proposed standard (40 CFR Part 196, 1994) and are a small fraction of the estimated 290 mrem/yr received due to natural background (NCRP, 1989).

The potential effects on human health, for the nonradiological COCs, are greater when considering the residential land-use scenario. Incremental risk between potential nonradiological COCs and associated background also indicates a increased contribution of risk from the nonradiological COCs. The increased effects on human health are primarily the result of including the plant uptake exposure pathway. 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 TA-I is an industrial site and is designated as an industrial land-use area (USDOE, 1996), the likelihood of significant plant uptake in this area is highly unlikely. The uncertainty in this conclusion is considered to be small.

For the radiological COCs the conclusion from the risk assessment is that the potential effects on human health, for the residential land-use scenario, is well within the proposed standard (40 CFR Part 196, 1994) and is a small fraction of the estimated 290 mrem/yr received due to natural background (NCRP, 1989).

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 surface and near-surface soils and because of the location and physical characteristics of the site, there is little uncertainty in the exposure pathways relevant to the analysis. This is

particularly applicable in application to the radiological COCs. Although the storm drain system constitutes a small portion of all of TA-I, and it is buried 3 to 10 feet below ground surface, it was assumed that the radiological COCs were present throughout all of TA-I (254 acres) and that they were uniformly distributed from ground surface to 7 feet below ground surface, not accounting for the 3 feet of clean cover.

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 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, 1996b) and Integrated Risk Information System (IRIS) (USEPA, 1988, 1994b) data bases. Where values are not provided, information is not available from HEAST, IRIS, or USEPA regions. The constituents without toxicological parameters have low concentrations and are judged to be insignificant contributors to the overall risk. 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 nonradiological 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 above the numerical standard, it has been determined that future land-use at this locality will not be residential (USDOE, 1996). The radiological incremental TEDE is a very small fraction of estimated background TEDE for both the industrial and residential land-use scenarios and both are well within proposed standards (40 CFR Part 196, 1994). The overall uncertainty in all of the steps in the risk assessment process is considered insignificant with respect to the conclusion reached.

III. Summary

The TA-I Storm Drain System, ER Site 96, had relatively minor contamination consisting of some inorganic and organic nonradioactive and radioactive compounds. Because of the location of the site on KAFB, the designated industrial land-use scenario (USDOE, 1996) and the nature of the contamination, the potential exposure pathways identified for this site

included soil ingestion and dust and volatile inhalation for chemical constituents and soil ingestion, dust and volatile inhalation, and direct gamma exposure for radionuclides. Plant uptake was included as an exposure pathway for the residential land-use scenario. This site is designated for industrial land-use (USDOE, 1996); the residential land-use scenario is provided for perspective only.

The main contributors to the industrial land-use scenario risk assessment values are benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, arsenic and PCBs. Benzo(a)pyrene, benzo(a)anthracene and benzo(b)fluoranthene are thought to be derived from asphalt which covers most of TA-I. The maximum arsenic concentration was below its background screening value. PCBs are known to have been used at TA-I. The PCB concentration value is a sum of all maximum concentrations of individual aroclors. Therefore, this risk assessment is considered conservative as benzo (a) pyrene and benzo (b) fluoranthene are probably not indicative of contamination, arsenic was below background and PCB concentrations per location are significantly less than the total PCB concentration used in the calculation.

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 (0.1) is significantly less than the accepted numerical guidance from the USEPA. The estimated cancer risk (2×10^{-5}) is in the middle of the suggested acceptable risk range. The incremental Hazard Index is 0.06 and the incremental cancer risk is 1.8×10^{-5} for the industrial land-use scenario. Incremental risk calculations indicate insignificant contribution to risk from the nonradiological COCs considering an industrial land-use scenario.

The incremental TEDE and corresponding estimated cancer risk from the radioactive components are much less than USEPA guidance values; the estimated incremental TEDE is 0.06 mrem/yr for the industrial land-use scenario. This value is much less than the numerical guidance of 15 mrem/yr in draft USEPA guidance. The corresponding incremental estimated cancer risk value is 7×10^{-7} for the industrial land-use scenario.

The calculations for the nonradiological COCs show that for the residential land-use scenario the Hazard Index (10) is greater than the accepted numerical guidance from the USEPA. The estimated cancer risk (2×10^{-4}) is at the upper end of the suggested acceptable risk range. The increased effects on human health are primarily the result of the inclusion of the plant uptake exposure pathway. Nonradiological constituents that posed little to no risk considering an industrial land-use scenario (some of which are below

background screening levels), contribute a significant portion of the risk associated with the residential land-use scenario. These constituents bioaccumulate in plants. Because TA-I is an industrial site (USDOE, 1996), the likelihood of significant plant uptake in this area is highly unlikely. For the residential land-use scenario, the incremental Hazard Index is 5.9 and the incremental cancer risk is 1.6×10^{-4} . Increased risk from the nonradiological COCs was evident considering residential land-use, due to plant uptake, but future use will be restricted to industrial land-use.

The incremental TEDE and corresponding estimated cancer risk from the radioactive components are much less than USEPA guidance values; the estimated incremental TEDE is 0.3 mrem/yr for the residential land-use scenario. This value is much less than the numerical guidance of 75 mrem/yr in draft USEPA guidance. The corresponding incremental estimated cancer risk value is 2×10^{-6} for the residential land-use scenario.

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 an industrial land-use scenario.

Ecological Risk Assessment

It is unlikely that activities or COCs at ER Site 96 have or will have significant impact to ecological risk. TA-I is an industrial complex and has been heavily disturbed by humans for over 50 years. Given the amount of known and potential human intrusion, a great diversity or abundance of nonhuman species has not occurred and is unlikely. Much of the relevant ecological information for TA-I can be found in the National Environmental Policy Act (NEPA) compliance document (SNL/NM, 1992).

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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).

Generic Equation for Calculation of Risk Parameter Values

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

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

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

where

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

The total risk/dose (either cancer risk or 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

Table 2. Default Parameter Values for Various Land Use Scenarios

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

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

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

^b Exposure Factors Handbook (EPA, 1989b)

^c EPA Region VI guidance.

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

^e Dermal Exposure Assessment, 1992.

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.

Summary

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.

References

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ADDITIONAL /SUPPORTING DATA

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