



Sandia National Laboratories/New Mexico

**PROPOSAL FOR
RISK-BASED NO FURTHER ACTION
ENVIRONMENTAL RESTORATION SITE 42
BUILDING 870 WATER TREATMENT FACILITY
OPERABLE UNIT 1302**

May 1997

Environmental
Restoration
Project



United States Department of Energy
Albuquerque Operations Office

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Albuquerque, New Mexico

Prepared for
U.S. Department of Energy

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ACRONYMS

ADS	activity data sheet
AMO	Albuquerque Microelectronics Operations
ASTM	American Society for Testing and Materials
bgs	below ground surface
CEARP	Comprehensive Environmental Assessment and Response Program
COC	constituents of concern
DI H ₂ O	deionized/distilled water
DOE	U.S. Department of Energy
DV	data validation
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration (Project)
ERDMS	ER data management system
ERFO	ER Field Office
ft	feet
GIS	geographic information system
KAFB	Kirtland Air Force Base
MS	matrix spike
MSD	matrix spike duplicate
NEPA	National Environmental Policy Act
NMED	New Mexico Environment Department
NFA	no further action
PID	photoionization detector
PIP	Program Implementation Plan
ppb	parts per billion
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SMO	Sample Management Office
SNL/NM	Sandia National Laboratory/New Mexico
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
TA	Technical Area
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
USAF	U.S. Air Force
UTL	upper tolerance limit
UTL/95	95 th upper tolerance limit or 95 th percentile
VOC	volatile organic compound

**PROPOSAL FOR RISK-BASED WITH CONFIRMATORY
SAMPLING NO FURTHER ACTION**

**ENVIRONMENTAL RESTORATION SITE 42, BUILDING
870 WATER TREATMENT FACILITY**

OPERABLE UNIT 1302

1. INTRODUCTION

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a No Further Action (NFA) decision for Environmental Restoration (ER) Site 42 based on confirmatory sampling and risk assessment (NFA Criterion 5, New Mexico Environment Department [NMED] et al. 1995).

1.1. ER Site Identification Number and Name

ER Site 42 (herein referred to as the site) is the Building 870 Water Treatment Facility, and is included in Operable Unit 1302.

1.2. SNL/NM NFA Process

The basis for proposing an NFA with confirmatory sampling is thoroughly described in Section 4.5.3 of the Draft *Program Implementation Plan (PIP) for Albuquerque Potential Release Sites* (SNL/NM 1994), and as Criterion 5 in Annex B of the *Environmental Restoration Document of Understanding* (NMED et al. 1995). Briefly stated, if contaminant levels at the site do not exceed regulatory or risk-based criteria, the site can be proposed to the appropriate regulatory agency for NFA. As determined by the sampling activities described in this proposal, ER Site 42 has not released hazardous waste or constituents into the environment that exceed regulatory or risk-based criteria.

1.3. Local Setting

The site is located on the south side of L Street and east of 15th Street (Figure 1; Appendix A). This site is located immediately north of Building 870 and covers one-half acre. The site is within the Technical Area (TA)-I secured area and has limited access to workers with a security clearance or an escort.

2. HISTORY OF THE SWMU

2.1. Sources of Supporting Information

Information regarding the site can be found in the following pertinent documents:

- Decommissioning of Building 870 (SNL/NM 1990).
- Soil Sampling and Analysis Plan for Demolition and Reconstruction Areas at Building 870, Sandia National Laboratories, Albuquerque, New Mexico (PRC 1993a).
- *History of Building 870 and Chemical Releases at the Site* (PRC 1993b).
- *Results of Soil Sampling Activities At Building 870, Sandia National Laboratories, Albuquerque, New Mexico* (PRC 1993c).
- *Hazardous and Solid Waste Amendments Permit for Sandia National Laboratories, U.S. Environmental Protection Agency (EPA) I.D. No. NM 5890110518* (EPA 1992).
- *Program Implementation Plan for Albuquerque Potential Release Sites [DRAFT]* (SNL/NM 1994).
- *Technical Area I (ADS 1302) Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Work Plan* (SNL/NM 1995).

2.2. Previous Audits, Inspections, and Findings

This site was identified during the 1987 Comprehensive Environmental Assessment and Response Program (CEARP) (U.S. Department of Energy [DOE] 1987). The area was declared an ER site as a result of known historical releases of potential constituents of concern (COCs), discussed below.

2.3. Historical Operations.

The site consists of soil beneath several existing chemical holding tanks and open areas where documented spills flowed across the land surface. The tanks associated with the historic spills are no longer in use, and there are no future plans for use or removal of the tanks. The holding tanks supplied chemicals for microelectronics operations in Building 870. Building 870 was constructed in 1960 for use as a material reclamation building. In 1975, it was converted into a microelectronics design laboratory with two clean rooms and associated support areas. Since 1975, the building has been used for semiconductor production and has had numerous expansions and modifications. The building has been a facility for various operations,

including clean-room, packaging, failure-analysis laboratories, electrical test areas, chemical storage areas, semiconductor manufacturing support, and offices. As described elsewhere (PRC 1993a), a variety of chemicals have been used in manufacturing operations since 1975.

In late 1989, DOE and the operating contractor, Albuquerque Microelectronics Operations (AMO), agreed to phase out operations over a 3-year period. With the exception of office areas in the south end of the building, the building was vacant between late 1992 and 1996 (SNL/NM 1990; PRC 1993a).

Three documented releases of chemicals occurred at this site. Two releases were documented during CEARP interviews (DOE 1985) and review of SNL/NM Unusual Occurrence Reports (Parker 1984; Jercinovic 1984) that led to the spill area being designated as an ER site in the CEARP Phase 1 (DOE 1987). The third release was discovered during the background investigation for this work plan.

The first release (herein referred to as the HCl release) occurred on November 21, 1983, when a valve was being changed on an aboveground 8,000-gal tank that was thought to be empty. The tank contained approximately 1,000 gal of 30 percent hydrochloric acid (HCl) that spilled onto the surrounding ground surface. As part of emergency response, the spilled acid was diluted and washed into the storm sewer system by the SNL/NM Hazmat Team and the Kirtland Air Force Base (KAFB) Fire Department. Acid neutralizer was applied to an area approximately 20 feet (ft) in diameter around the tank (Parker 1984). All of the acid solution flowed on pavement, and the surrounding soil was not affected. Therefore, no soil was removed as a result of this incident (Miller 1993). Soil samples collected at the spill site (presumably of soils from below the pavement) indicated pH values greater than 2.0 (Parker 1984); therefore, no soil was classified as hazardous waste by definition of characteristics criteria, and no soil was removed in response to this spill.

The second release (herein referred to as the NaOH release) occurred on November 4, 1984, during transfer and dilution procedures. An aboveground 7,700-gal bulk storage tank containing a 50-percent sodium hydroxide (NaOH) solution was being emptied to transfer and dilute the base to 20-percent NaOH for use in the microelectronics fabrication process. The 50-percent NaOH solution was mixed with water in a 55-gal aboveground tank to make the 20-percent NaOH solution. A float valve on the 55-gal aboveground tank failed, the tank overflowed, and approximately 200 gal of the 20-percent NaOH solution was released onto the ground surface over a two-hour period (Jercinovic 1984; Miller 1993). The diluted NaOH solution flowed to the west; KAFB Fire Department responded and used water to dilute and wash the NaOH solution into the storm drain system. Immediately after the release, a water sample from the storm drain system had a pH of 8.0 (Jercinovic 1984). Later, the SNL/NM Hazmat Team removed soil from this location, but the volume of soil removed was not reported. After the release, the extent of contaminated soil was not determined since there was soil wet with NaOH solution visible at the bottom of the excavation (Miller 1993).

The third release (herein referred to as the former acid-neutralizing tank release) occurred in the early 1980s (exact date unknown). That release involved the initial acid neutralization system that was the first process in neutralizing wastewater solutions generated by the microelectronics laboratory. The system consisted of a buried fiberglass tank that contained a layer of limestone that received an estimated 50 gal of waste acidic solution discharge daily (PRC 1993a). After several months (exact duration unknown) of use, personnel discovered that the bottom of the fiberglass tank had disintegrated. At the time, untreated or partially treated solutions containing acids (primarily hydrofluoric), bases, and dilute solvents (ethylene, acetone, butyl acetate, trichloroethylene, etc.) were flowing directly into the soil (PRC 1993a). Clean-up operations were initiated for the site, and the fiberglass tank and limestone were removed and replaced with a polyethylene tank with a similar limestone lining (PRC 1993b). Subsequent construction excavation in this area has revealed that soil containing COCs may still be present (SNL/NM 1990), although there are no quantitative data to support such a claim.

3. EVALUATION OF RELEVANT EVIDENCE

3.1. Unit Characteristics

The conceptual model in the Work Plan identified the following potential COCs: acids, bases, and a variety of metals and volatile organic compounds (VOCs) that may have been associated with the solutions. Although historical information does not indicate the release of any metals, the potential exists for metals to be associated with processes in the microelectronics operations. Due to the proximity of processes and possible intermingling of solutions after the releases occurred, elevated levels of metals could occur anywhere on site.

Any residual effects of the aboveground releases were not anticipated to extend significantly below the surface. It was reported that the HCl release was entirely contained (vertically) by paved surfaces (Miller 1993), and any HCl leaking through cracks or joints in the pavement would be quickly neutralized by the alkalinity of the native soil. Unlike the situation with the HCl release, there is no buffer in the native soil available to neutralize the NaOH release. It is not known how deep the NaOH solution could have migrated. Because of the lack of natural neutralizing capabilities, it is probable that the NaOH solution would have migrated deeper than the HCl release. However, it is extremely unlikely that strong acids or bases would remain after a period of years. Thermodynamic potential would drive systems to neutralize/decompose such materials, especially acids.

The release associated with the former acid neutralizing tank has the potential to migrate. Assuming that several months of untreated solutions containing acids (primarily hydrofluoric), bases, and dilute solvents (ethylene, acetone, butyl acetate, trichloroethylene, etc.) flowed directly into the soil (PRC 1993a), it is possible that contaminants from this release could have migrated farther into the subsurface soils than the two surface releases. Although acids would have been neutralized by materials in the tank and native soil, the bases and solvents would not be readily neutralized or absorbed by the soil column.

3.2. Operating Practices

No written procedures for operating the site are known.

3.3. Presence or Absence of Visual Evidence

Field personnel conducting site visits and sampling activities in 1995 were unable to find any visual evidence of contaminated soils (borehole logs; Appendix B).

3.4. Results of Previous Sampling/Surveys

Prior to the RFI, limited sampling or analysis of soil had been conducted at this site, as described below.

Investigation of the HCl Release

Analytical results from the soil samples from the HCl release could not be located. However, the unusual occurrence report for the incident states that the pH values of soil samples collected at the site were greater than 2.0 (Parker 1984).

Investigation of the NaOH Release

Analytical results from the water samples from the NaOH release could not be located. However, the unusual occurrence report for the incident states that a water sample from the storm drain system had a pH of 8.0 (Jercinovic 1984).

1993 Investigation

Analytical results from sampling on the south edge of the site were the only data available before the RFI (PRC 1993c). In October 1993, soil samples were collected at four borehole locations (spaced 40 ft apart) north of Building 870 to assess the potential for contaminant migration from the site south toward Building 870 (Carlson 1994a, b). Soil samples were collected at multiple depth intervals from 2 to 22 ft and analyzed for VOCs (EPA Method 8240), ethylene glycol (Enseco method 8000), semivolatile organic compounds (SVOCs) (EPA Method 8270), metals (EPA Methods 6010, 7060, 7421, 7470, and 7740), toxicity characteristic leaching procedure (TCLP) metals (extracted by EPA Method 1311, analyzed by EPA Methods 6010, 7470, and 7740), and soil pH (Method 9045). Xylene was the only quantifiable VOC identified, with a concentration of 34 mg/kg (detection limit of 5 mg/kg) at 10 to 12 ft below ground surface (bgs). This concentration of xylene is significantly lower than the recommended corrective action guideline for xylene in soils of 200,000 mg/kg (proposed Subpart S, Appendix A, EPA 1990). Deeper samples (15 to 17 ft bgs and 20 to 22 ft bgs) did not have reportable concentrations of xylene. No quantifiable concentrations of SVOCs or ethylene glycol were detected. Results of the metals analyses indicate there are no elevated concentrations of metals in the soil. Soil pH values (7.8 to 9.2) for these samples reflect the alkaline conditions of the native soils in this area (Hacker 1977). Based on these results, it was concluded that the HCl and NaOH releases from the site had not impacted the soil immediately north of Building 870 (Carlson 1994a, b; PRC 1993c).

3.5. Assessment of Gaps in Information

Limited sampling and analysis of soil had been conducted at this site. The RFI sampling strategy (Appendix C) identified information gaps and was designed to fully characterize the site.

3.6. Confirmatory Sampling

3.6.1. Sampling Strategy

The RFI sampling and analysis plan for the site is provided in Appendix C. Field sampling started on September 5 and was completed on September 13, 1995. Soil samples were collected from 31 locations using a Geoprobe™ and from nine locations using a hand auger for a total of 40 locations (GP001 to GP040, Figure 2; Appendix A).

Compared to the Work Plan, changes were made to some sample locations or to sample strategy due to conflicts with underground utilities. In addition, sample locations were moved to accommodate nearby on-going construction activities. For example, many of the proposed sample locations on the east side of the site and along the road in the southeastern portion of the site were not accessible because of construction site trailers, heavy equipment, and materials and soil piles. A discussion with site owners suggested that the proposed eastern and southeastern sample locations were not along the flow direction of the release, and did not add value to the investigation (Roma 1995). To compensate for the decreased number of proposed sample locations, more locations were added to the western portion of the site in the direction of the surface flow that occurred during the NaOH release.

For 36 of the 40 locations (Figure 2; Appendix A), samples were collected from the surface (0 to 2 ft below ground surface [bgs]) and the shallow subsurface (4 to 5 ft bgs).

At four locations (GP033, GP034, GP039, and GP040, Figure 2; Appendix A), samples were collected at approximately 5-ft intervals from 0 to 30 ft bgs. Samples were analyzed for Target Analyte List (TAL) inorganics and VOCs (at the four deep locations) by an offsite laboratory. Samples were also collected for the Environmental Restoration Field Office (ERFO) onsite laboratory to be analyzed for VOCs and pH. In addition, field determination of pH was completed at all locations and depths to help guide the investigation. Sixty-three samples were collected for offsite laboratory analysis and 122 for onsite analysis. This does not include quality assurance (QA)/quality control (QC) samples.

Sampling equipment included a truck-mounted Geoprobe™ and associated supplies and tools, 3-inch stainless-steel bucket augers with T-bar handles and extensions, stainless-steel bowls and hand scoops, nitrile gloves, work gloves, a pick-ax, a shovel, miscellaneous hand tools, and decontamination equipment (brushes, plastic containers).

All sample locations at the site were first field-screened for possible radioactive contamination using a micro-R-meter. Only background radiation levels were encountered. A photoionization detector (PID) was used to screen for VOCs at all sampling locations, in the breathing zone, on collected soil, and on soil gas. No VOCs were detected by the PID.

In accordance with the strategy specified in the Work Plan, soil sampling at the site consisted of 40 boreholes. Nine of these were augered by hand and 31 were completed with a Geoprobe™ rig. The nine hand-augered boreholes and 27 of the 31 Geoprobe™ boreholes were sampled at 0 to 2 ft bgs for pH and at 4 to 5 ft bgs for pH and TAL inorganics. The remaining four Geoprobe™ locations that encircled the former acid neutralization tank were completed to depths of 10 to 30 ft bgs; samples were collected from various 5-ft intervals for TAL inorganic and VOC analysis. In addition, pH samples were collected every 5 ft from surface to total depth at all four locations.

The Geoprobe™ sampling consisted of a hydraulic-driven probe that collected relatively undisturbed soil in acetate sleeves encased in stainless-steel probe sections 3 ft in length. For VOC samples, the acetate sleeves were removed and cut to the appropriate length, capped, and taped for shipment to an onsite or offsite laboratory. For TAL inorganic samples, the soil was removed from the acetate sleeve, placed in a stainless-steel bowl, mixed, and transferred to an appropriate sample jar for shipment to an offsite laboratory. The pH samples were collected in the same manner and placed in Ziplock bags for delivery to the ERFO onsite laboratory.

The hand-augered boreholes were advanced to depth with 3-inch stainless-steel bucket augers. TAL inorganic samples were collected with the auger and placed in a stainless-steel bowl. TAL samples were then transferred to an appropriate sample jar for shipment to an offsite laboratory. The pH samples were collected in the same manner and transferred to Ziplock bags for delivery to the ERFO onsite laboratory.

The soil collected at the site was generally very uniform, consisting predominantly of fine to silty sand with varying proportions of medium to coarse sand and fine gravel. The lithology of the coarse fraction mainly consisted of limestone, granite, and various metamorphic rock types. Soil color (determined using a Munsell[®] rock-color chart) varied from moderate yellowish brown (10 YR 5/4) near surface through very pale orange (10 YR 8/2) to grayish orange (10 YR 7/4) and light brown (5 YR 6/4 and 5 YR 5/6) at 3 to 5 ft. The borehole logs in Appendix B contain more detailed lithologic descriptions.

Samples were brought to the SNL/NM Sample Management Office (SMO) on a daily basis. SMO personnel cross-checked the information on the sample labels against the information on the chain-of-custody form and refrigerated the soil samples at 4° C. Samples were then shipped by overnight delivery for analyses. The onsite soil samples were hand carried to the ERFO laboratory and analyzed within a few days after sample collection.

The field team located the sampling points by measuring distances from known points, such as building corners. Location information was then provided to the SNL/NM ER Project's Geographic Information System (GIS) database. A table of survey data, including north and east coordinates generated by ER GIS, is presented in Table 1 (Appendix D).

QA/QC samples collected at the site included field duplicates, field blanks, rinsate blanks, and trip blanks. Field duplicates, field blanks, and rinsate blanks were collected at a rate of 5 percent of the number of environmental samples sent for offsite analysis. One each of a duplicate sample, field blank sample, matrix spike (MS) and matrix spike duplicates (MSD), and rinsate blank sample were collected for this RFI. A trip blank accompanied the offsite shipment of VOC soil samples.

The VOC duplicate sample was collected by using two acetate sleeves in the thin-walled sampler. The sampler collected soil samples immediately adjacent (beneath) one another. The rinsate sample was collected by passing deionized water over decontaminated equipment. The field blank was a glass jar filled with clean soil that was exposed to the atmosphere in the vicinity of the work area. The trip blanks were sealed jars of clean soil or water that were placed in sample coolers sent to the laboratories. SMO supplied both the field blank and trip blank soils and jars. The offsite laboratory supplied the aqueous trip blanks.

All offsite analytical sample information was handled by the SMO after the field team relinquished custody of the samples. When the samples were shipped to the analytical laboratory, the SMO entered sample information into a database and tracked the status of the analytical results. When data became available, the SMO received the results with a summary data report and laboratory QC sample results.

The SMO reviewed the data summary reports and field collection documentation for completeness and accuracy, as required by SNL/NM TOP94-03. SMO personnel performed level 1 and 2 data validations (DV1/DV2) on all packages received from the laboratory. DV1 included reviewing the data package completeness, making sure that all requested analyses were performed and that all reports were signed by laboratory managers. DV2 included reviewing holding times and laboratory QC samples (method blanks, surrogate recovery samples, MS/MSDs, and laboratory control samples), comparing reported detection limits to contract-required detection limits, and making sure the case narrative was correct and complete. The SMO was responsible for submitting all parts of the data packages to the Environmental Operations Record Center. This submittal included the original field collection and custody documentation, the laboratory data report and DV1/DV2 review documentation. Also, the analytical laboratories submitted analytical data in an electronic format for loading into the ER data management system (ERDMS). Geochemical analytical data tables in this report were generated by the ERDMS. Onsite soil data were managed by the ERFO laboratory.

3.6.2. Analytical Results

All soil samples collected at the site were analyzed using EPA-approved methods for VOCs (EPA 8240/8260) and TAL inorganics. (The 6010 and 7000 series list is provided in the Work Plan.) For aqueous QA/QC rinsate samples, separate containers were required for mercury (EPA 7470/7471) and cyanide (EPA 9010) that were not required for the soil (solid) samples. In addition, soil pH and VOC (EPA 8240/8260)

concentrations were determined by the ERFO onsite laboratory. In-field pH analyses were performed with pH paper according to American Society for Testing and Materials (ASTM) procedure D-4972 (ASTM 1989).

3.6.2.1. Soil VOC Analysis

As required by the Work Plan, soil gas was monitored in the field at all sample locations and depths. A PID was used to monitor any gases emanating from the soil samples. The concentrations were recorded on the borehole logs (Appendix B) and showed all PID readings were at background levels.

Twenty four soil samples from 4 locations were analyzed for VOCs by the ERFO laboratory, and include:

- GP033 (at 2, 5, 10, 15, 20, 25, and 30 ft bgs),
- GP034 (at 2, 5, 10, 15, 20, 25, and 30 ft bgs),
- GP039 (at 2, 5, and 10 ft bgs), and
- GP040 (at 2, 5, 10, 15, 20, 25, and 30 ft bgs).

(Borehole GP039 could not be drilled any deeper due to refusal at the same depth [approximately 12 ft bgs] during two attempts.) All results were nondetect for all VOC analytes (Lewis 1995).

An additional seven VOC samples were sent to the offsite laboratory for confirmatory analysis. For all samples, all analytes were nondetect except for acetone and methylene chloride (Table 2; Appendix D). Acetone concentrations in the samples ranged from 4.7 (J) to 19 parts per billion (ppb) with 6 of the seven results being J-values; concentrations found in associated equipment blanks, field blanks, and trip blanks ranged up to 1200 ppb (Table 3; Appendix D). The "J" qualifier for these results indicates that the value was estimated and the observed value is greater than the method detection limits, but less than the practical quantitation limit. All six of the methylene chloride concentrations in the samples were J-values and ranged from 1.3 to 1.9 ppb; concentrations found in associated equipment blanks, field blanks, and trip blanks ranged up to 10 (J) ppb (Table 2 and Table 3; Appendix D).

3.6.2.2. Soil pH Analysis

In-addition to the field determination of pH, soils were sent to the ERFO laboratory for pH analyses using calcium chloride (CaCl_2) and deionized/distilled water ($\text{DI H}_2\text{O}$) methods as required by the ASTM procedure D-4972 (ASTM 1989; Lewis 1995). As seen on Table 4 (Appendix D), the range of pH values determined by the CaCl_2 method (7.4 to 9.0) were similar to the range found in TA-I background soils (7.7 to 9.1); and the values determined by the $\text{DI H}_2\text{O}$ method (8.0 to 9.6) were similar to the range found in background soils (8.3 to 9.3) (SNL/NM 1996; Strong 1995). The pH

determined in the field with pH paper had values that only ranged from 7 to 8 and were consistently lower than the values determined in the laboratory (compare the values in Table 4; Appendix D to the values in the borehole logs in Appendix B).

3.6.2.3. *Metals Analysis*

The results of the metals analysis are summarized in Table 5 (Appendix D), and include comparison to the 95th upper tolerance limit (UTL) or the 95th percentile (herein collectively referred to simply as UTL/95) calculated for TA-I background at the 20 ft depth (SNL/NM 1996), Site-Wide background for subsurface soils (IT Corp. 1996), and proposed Subpart S (EPA 1990; IT Corp. 1994) levels. Seven metals had 5% of the samples exceeding TA-I background concentrations, with calcium having the greatest percentage of samples (>45%) exceeding the UTL/95. [The 5% cut-off is used because the data set is being compared to the UTL/95 of the background data set.] Four metals exceeded the Site-Wide background concentrations, with arsenic having the greatest percent of samples (>21%) exceeding the UTL/95. Only beryllium exceeded the Proposed Subpart S action levels. However, beryllium concentrations were below the TA-I background and Site-Wide background levels.

Further discussion of metals concentrations is provided in Section 3.7 and the Risk Assessment presented as Appendix E.

3.6.2.4. *Sample Blanks and Duplicates*

The laboratory reported all nondetects for the VOC analyses of trip blank TB001 through TB003, field blank FB001, and equipment blanks EB001 and EB002 (Table 3; Appendix D). These blanks had acetone and methylene chloride detections, most likely attributable to laboratory contamination. Sets of duplicate samples were collected at six locations, and sent offsite for TAL inorganics and VOC analysis. All results from the duplicate sets were comparable.

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

Due to the presence of metals in concentrations greater than background levels, it was necessary to perform a risk assessment analysis for the site. The risk assessment process results in a quantitative evaluation of the potential adverse human health effects caused by COCs in the site's soil. ER Site 42 has been recommended for industrial land-use (DOE and U.S. Air Force [USAF] 1996). However, the risk assessment analysis considered the evaluation of the potential for adverse health

effects for both an industrial land-use scenario and also a residential land-use scenario. A complete discussion to the risk assessment process, results, and uncertainties is provided in Appendix E.

For the industrial land-use scenario, the Hazard Index calculated for the site is 0.2, which is significantly less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). The excess cancer risk is estimated to be 6×10^{-6} , at the low end of the range of acceptable risk (10^{-6} and 10^{-4} ; EPA 1989).

This risk assessment also determined risks considering background concentrations of the potential COCs for the industrial land-use scenarios: the Hazard Index is 0.08 and the excess cancer risk is estimated at 4×10^{-6} . Incremental risk is determined from subtracting risk associated with background from potential COC risk. The incremental Hazard Index is 0.08 and the incremental cancer risk is 1.6×10^{-6} for the industrial land-use scenario.

In summary, the potential effects on human health are small compared to established numerical standards, and the uncertainty of such a conclusion is considered to be small. The only metal to show any potential hazard (high risk assessment value) was arsenic. Arsenic is not a contaminant of concern (based on historical information) at the site. Although the concentrations found at the 3 to 5 ft depth at the site exceed 20 ft background levels, the concentrations are statistically similar to the 2 ft background levels (Tharp 1996), and therefore probably represent a naturally occurring abundance. In addition, the maximum concentration of arsenic is less than one-half the action level for arsenic, so that, if present as the only contaminant, arsenic would not pose an unacceptable risk.

The residential land-use scenarios for this site are provided only for comparison in the risk assessment report (Appendix E). The report concludes that Site 226 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 this site will have much impact on ecological risk. TA-I has been heavily disturbed by human beings for over 50 years. Given the amount of known and potential human intrusion at TA-I, a great diversity or abundance of nonhuman species is unlikely. In addition, the majority of the site surface is covered with concrete and asphalt, and the remainder is covered with 6 inches of river gravel. The site contains no vegetation and no natural or landscaped habitat for any major fauna, and no burrowing animals or nesting of any species were discovered during the field investigation. Much of the relevant ecological information for the TA-I area can be found in the National Environmental Policy Act (NEPA) compliance document (SNL/NM 1992). Due to the lack of contamination at this site, no further ecological evaluation will be performed. The site does not present a danger to ecological species and should be considered for NFA.

3.8. Rationale for Pursuing a Risk-Based NFA Decision

3.8.1. Evaluation of Concentrations

The concentrations of acetone and methylene chloride detected in the soil samples are most likely nondetects because the reported soil sample values are less than 10 times the reported values in the blanks (EPA 1988).

The pH values determined for the site were similar to range of values found in TA-I background (7.7 to 9.3). The larger range of values at the site may be a reflection of the site data set being larger than the background data set (98 samples at the site compared to 34 for the background). The pH values in the site soils reflect the moderately alkaline conditions prevalent in soils in the area (Hacker 1977; SNL/NM 1995). None of the pH values approached limits of the action levels based on 40 CFR 261.22 criteria for corrosive hazardous waste (pH less than 2.0 or greater than 12.5).

All metals results compared favorably with the available (calculated) proposed Subpart S levels with the exception of beryllium. Beryllium levels at the site were below those found in the TA-I and Site-Wide background levels. Some of the metals that exceeded TA-I background concentrations did not have Site-Wide background or Subpart S levels for comparison. Two of these metals (calcium and magnesium), are essential nutrient elements used in relatively large amounts by plants (Brady 1974). As discussed in the Risk Assessment (Appendix E), the occurrence of arsenic in soils above background levels has been shown to be a negligible risk to human health.

3.8.2. Data Summary and Recommendations

The site has been sufficiently characterized by soil sampling at 40 locations over an area of 0.5 acres, with soils sampled from at least two depths to 5 or 30 ft bgs. The data show that the site soils do not contain significant concentrations of any COCs.

An NFA is recommended for this site, based on the following:

- No significant VOCs were detected in the soil samples by the onsite and offsite laboratories.
- No visibly contaminated soils were detected in soil borings.
- No concentrations of VOCs were detected during field screening using a PID.
- No metals were present in concentrations deemed hazardous to human health for an industrial land-use setting.

Based on the data collected during this RFI sampling program, it is evident that ER Site 42 has not released hazardous waste or constituents into the environment. Therefore, further investigations and/or voluntary corrective measures are not warranted. Upon acceptance of the NFA proposal, the site will be permanently removed from the list of ER sites in the Hazardous and Solid Waste Amendments module of the RCRA Part B Permit (EPA 1992), through the permit modification process.

4. CONCLUSION

Based upon the evidence cited above, no potential remains for a release of hazardous waste (including hazardous constituents) which may pose a threat or risk to human health or the environment. Therefore, ER Site 42 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.

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5.3. Aerial Photographs

No specific aerial photographs were used to support this NFA.

APPENDIX A
ER SITE 42 FIGURES

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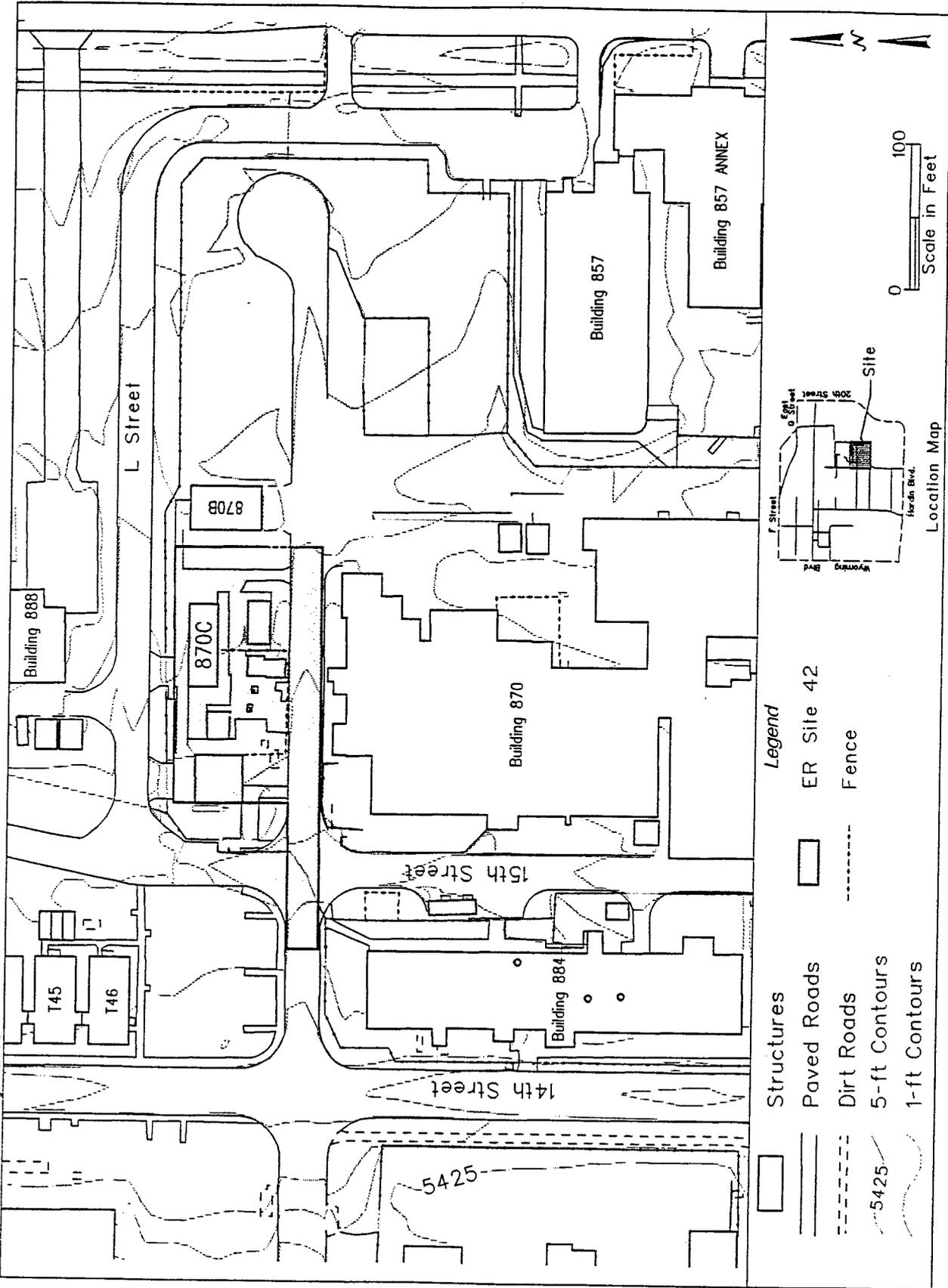
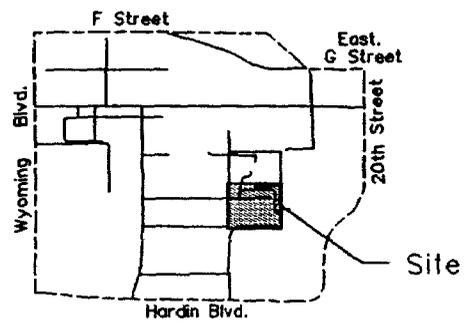
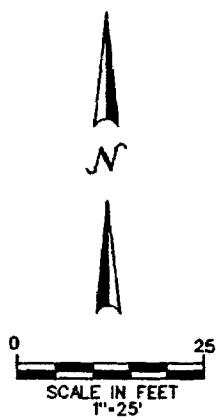
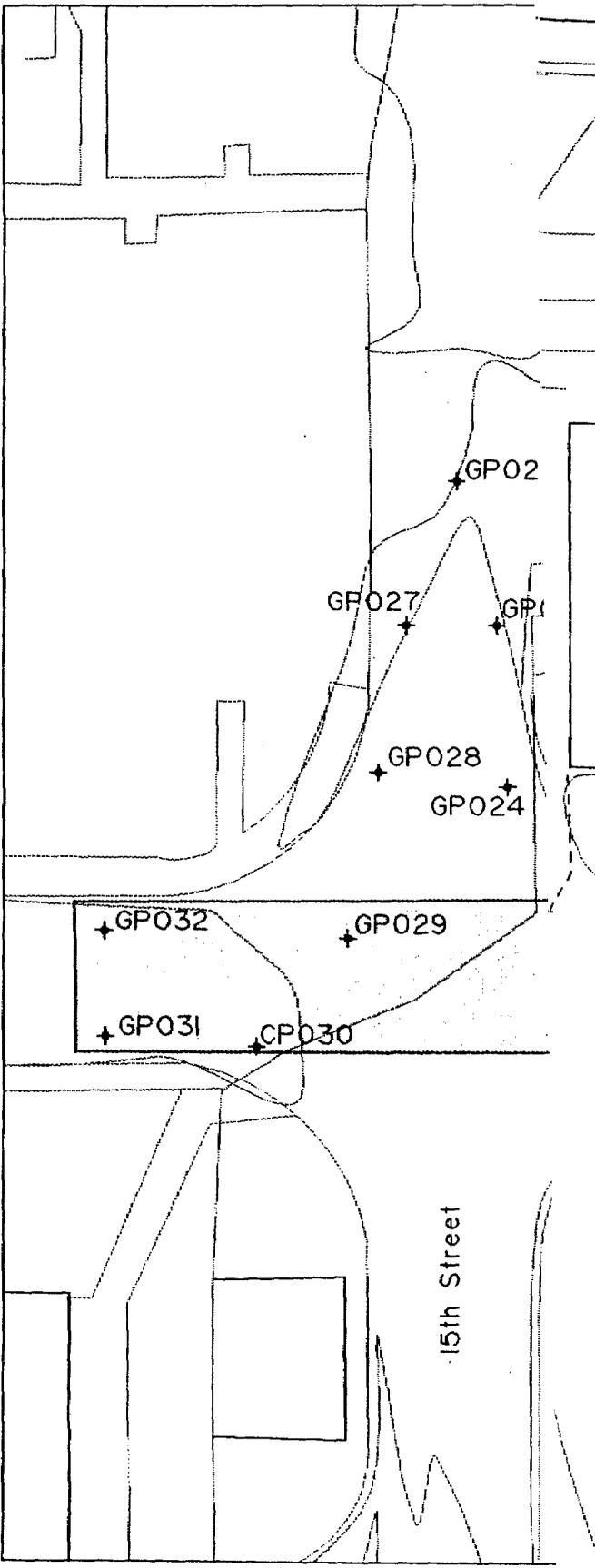


Figure 1
ER Site 42: Building 870 Water Treatment Facility

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Location Map

Legend

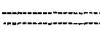
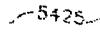
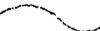
-  Structures
-  Paved Roads
-  Dirt Roads
-  5-ft Contours
-  1-ft Contours
-  ER Site 42
-  Geoprobe™ Surface/Near-Surface Sample Locations
-  Geoprobe™ Surface/Near-Surface Sample Locations that were also analyzed for VOCs.

Figure 2
 ER Site 42:
 Geoprobe™ Surface and
 Near-Surface Soil Sampling Locations

APPENDIX C

SECTION 5.4 OF THE TA-I RFI WORK PLAN (SNL/NM 1995)

5.4 ER Site 42, Building 870 Water Treatment Facility

5.4.1 Site Description and History

ER Site 42 is located north of Building 870 on the south side of L Street and east of 15th Street in the east-central part of TA-I (Figure 5-15). The site covers approximately one-half acre and consists of soil beneath several existing chemical holding tanks and open areas where documented spills flowed across the land surface. The holding tanks supplied chemicals for microelectronics operations in Building 870.

Building 870 was constructed in 1960 for use as a material reclamation building. In 1975, it was converted into a microelectronics design laboratory with two clean rooms and associated support areas. Since 1975, the building has been used for semiconductor production and has had numerous expansions and modifications. The building has been a facility for various operations, including clean-room, packaging, failure-analysis laboratories, electrical test areas, chemical storage areas, semiconductor manufacturing support, and offices. As described elsewhere (PRC 1993a), a variety of chemicals has been used in manufacturing operations since 1975.

In late 1989, DOE and the operating contractor, Albuquerque Microelectronics Operations (AMO), agreed to phase out operations over a 3-year period. With the exception of office areas in the south end of the building, the building has been vacant since late 1992 (SNL/NM 1990; PRC 1993a).

Three documented releases of chemicals occurred at this site. Two releases were documented during CEARP interviews (DOE 1985) and review of SNL/NM Unusual Occurrence Reports (Parker 1984; Jercinovic 1984) that led to the spill area being designated as an ER site in the CEARP Phase 1 (DOE 1987). The third release was discovered during the background investigation for this work plan.

The first release (herein referred to as the HCl release) occurred on 21 November 1983, when a valve was being changed on an aboveground 8,000-gal tank (Figure 5-16) that was thought to be empty. The tank contained approximately 1,000 gal of 30 percent hydrochloric acid (HCl) that spilled onto the surrounding ground surface. As part of emergency response, the spilled acid was diluted and washed into the storm sewer system by the SNL/NM Hazmat Team and the KAFB Fire Department. Acid neutralizer was applied to an area approximately 20 ft in diameter around the tank (Parker 1984). All of the acid solution flowed on pavement, and the surrounding soil was not affected.

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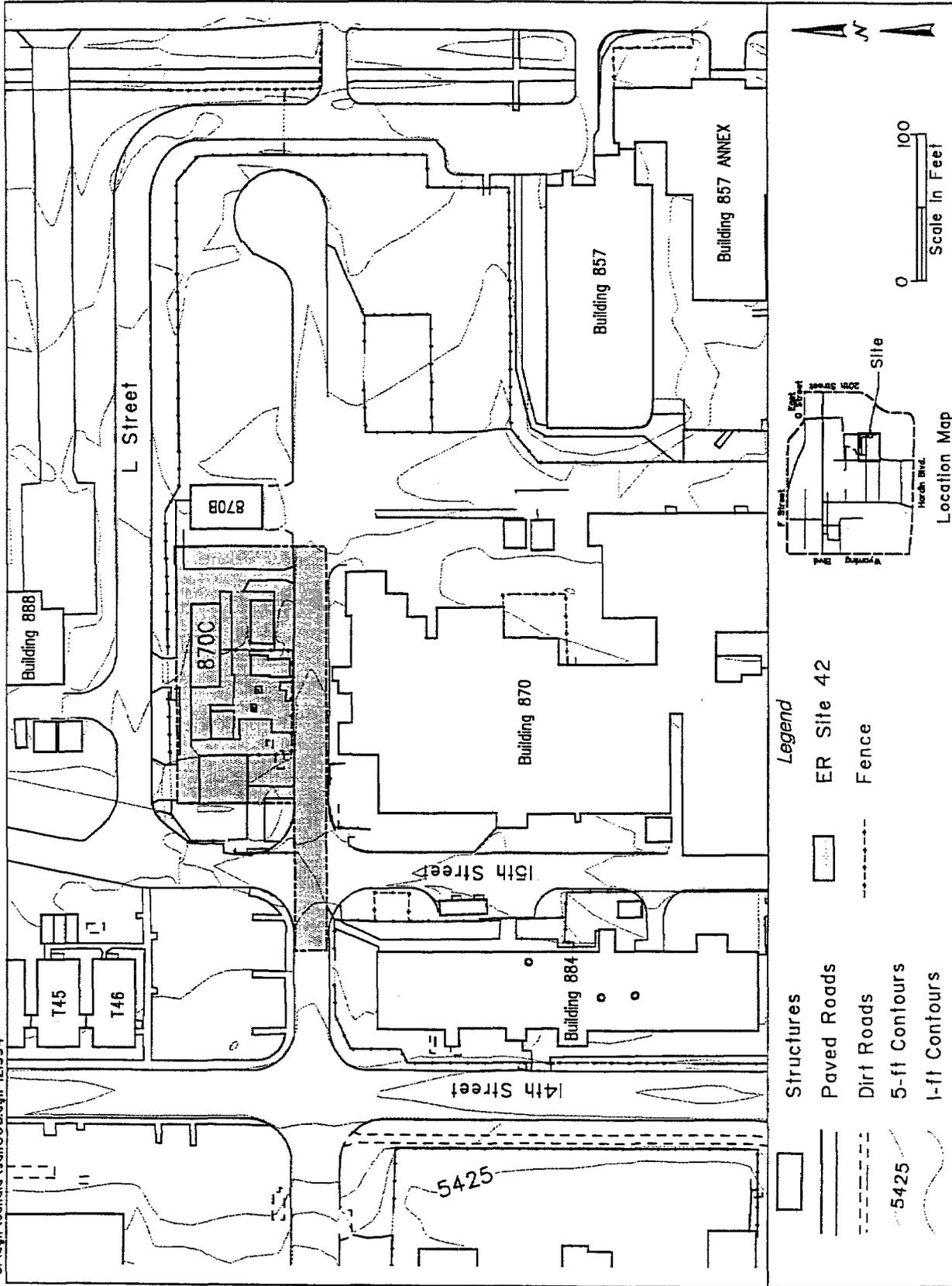
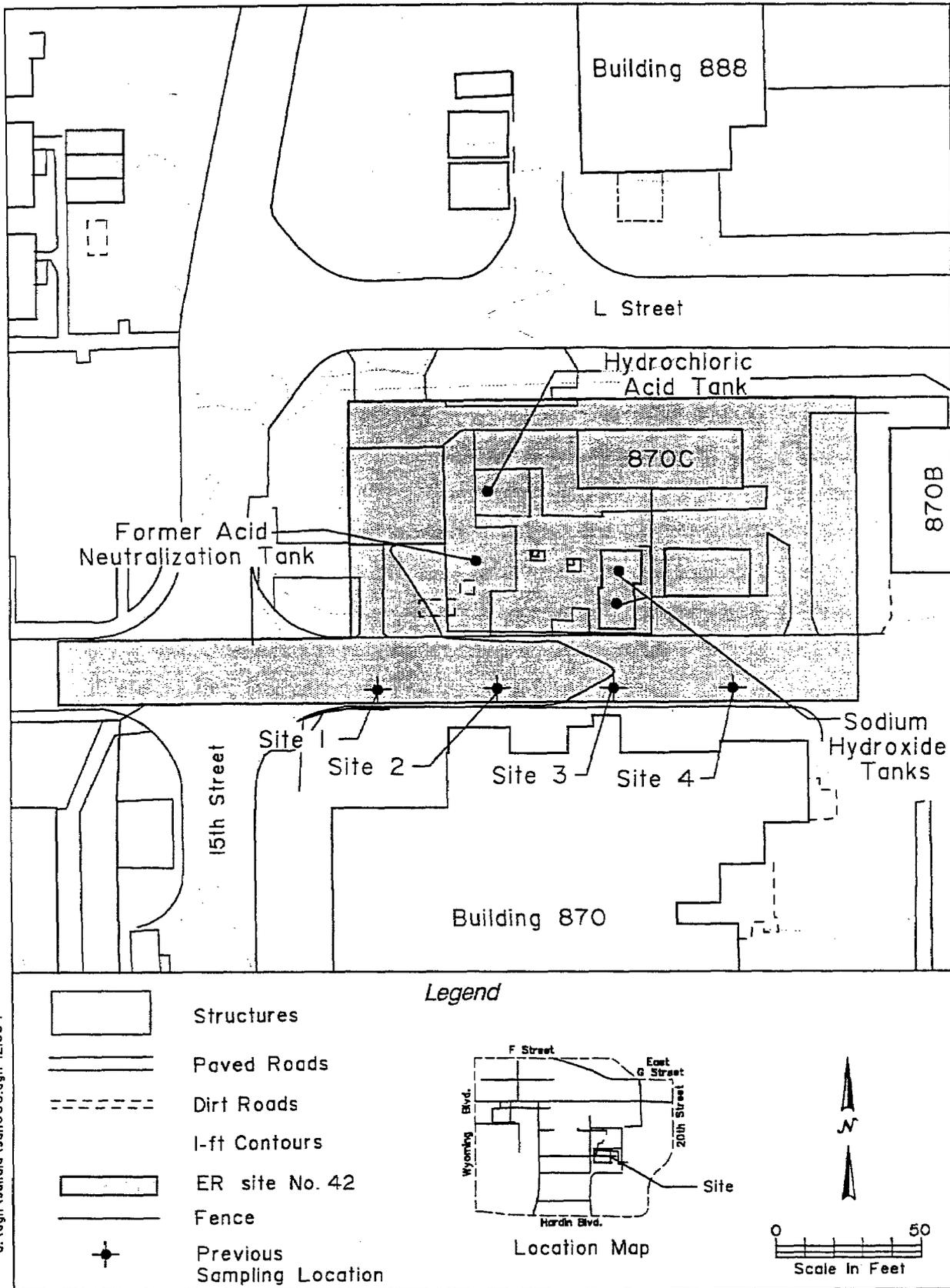


Figure 5-15
ER Site 42: Building 870 Water Treatment Facility



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Figure 5-16
 ER Site 42: Location of Surface and Subsurface Releases and
 Approximate Sampling Locations from Previous Investigations

Therefore, no soil was removed as a result of this incident (Miller 1993c). Soil samples collected at the spill site (presumably of soils from below the pavement) indicated pH values greater than 2.0 (Parker 1984); therefore, no soil was classified as hazardous waste by definition of characteristics criteria, and no soil was removed in response to this spill.

The second release (herein referred to as the NaOH release) occurred on 4 November 1984, during transfer and dilution procedures. An aboveground 7,700-gal bulk storage tank (Figure 5-16) containing a 50-percent NaOH solution was being emptied to transfer and dilute the base to 20-percent NaOH for use in the microelectronics fabrication process. The 50-percent NaOH solution was mixed with water in a 55-gal aboveground tank to make the 20-percent NaOH solution. A float valve on the 55-gal aboveground tank failed, the tank overflowed, and approximately 200 gal of the 20-percent NaOH solution was released onto the ground surface over a two-hour period (Jercinovic 1984; Miller 1993c). The diluted NaOH solution flowed to the west; KAFB Fire Department responded and used water to dilute and wash the NaOH solution into the storm drain system. Immediately after the release, a water sample from the storm drain system had a pH of 8.0 (Jercinovic 1984). Later, the SNL/NM Hazmat Team removed soil from this location, but the volume of soil removed was not reported. After the release, the extent of contaminated soil was not determined since there was soil wet with NaOH solution visible at the bottom of the excavation (Miller 1993c). Currently the area of the first two releases is covered with pavement and concrete.

The third release (herein referred to as the former acid-neutralizing tank release) occurred in the early 1980s (exact date unknown). That release involved the initial acid neutralization system that was the first process in neutralizing wastewater solutions generated by the microelectronics laboratory. The system consisted of a buried fiberglass tank (Figure 5-16) that contained a layer of limestone that received an estimated 50 gal of waste acidic solution discharge daily (PRC 1993a). After several months (exact duration unknown) of use, personnel discovered that the bottom of the fiberglass tank had disintegrated. At the time, untreated or partially treated solutions containing acids (primarily hydrofluoric), bases, and dilute solvents (ethylene, acetone, butyl acetate, trichloroethylene, etc.) were flowing directly into the soil (PRC 1993a). Clean-up operations were initiated for the site, and the fiberglass tank and limestone were removed and replaced with a polyethylene tank with a similar limestone lining (PRC 1993b). Subsequent construction excavation in this area has revealed that soil containing COCs may still be present (SNL/NM 1990), although there are no quantitative data to support such a claim.

The tanks associated with the historic spills are no longer in use, and there are no future plans for the tanks. However, extensive remodeling of Building 870 is slated for 1995 as part of the DOE reconfiguration program. Because of past process knowledge involving the use of solvents, acids, and bases in the building, and because of the location of ER Site 42, a sampling and analysis plan was implemented to define the nature and extent of potential contamination that may be impacted by remodeling activities (PRC 1993a, c). The results of the soil sample analysis, discussed below, will be used to further refine the conceptual model and to justify the sampling plan for ER Site 42.

5.4.2 Previous Investigations

5.4.2.1 *Investigation of the HCl Release*

Analytical results from the soil samples from the HCl release could not be located. However, the unusual occurrence report for the incident states that the pH values of soil samples collected at the site were greater than 2.0 (Parker 1984).

5.4.2.2 *Investigation of the NaOH Release*

Analytical results from the water samples from the NaOH release could not be located. However, the unusual occurrence report for the incident states that a water sample from the storm drain system had a pH of 8.0 (Jercinovic 1984).

5.4.2.3 *1993 Investigation*

Analytical results from recent sampling on the south edge of the site are the only data available (PRC 1993c). In October 1993, soil samples were collected at four borehole locations (spaced 40 ft apart) north of Building 870 (Figure 5-16) to assess the potential for contaminant migration from the water treatment facility (ER Site 42) south toward Building 870 (Carlson 1994a, b). Soil samples were collected at multiple depth intervals from 2 to 22 ft and analyzed for VOCs (EPA Method 8240), ethylene glycol (Enseco method 8000), SVOCs (EPA Method 8270), TC metals (EPA Methods 6010, 7060, 7421, 7470, and 7740), TCLP metals (extracted by EPA Method 1311, analyzed by EPA Methods 6010, 7470, and 7740), and soil pH (Method 9045). Xylene was the only quantifiable VOC identified with a concentration of 34 $\mu\text{g}/\text{kg}$ (detection limit of 5 $\mu\text{g}/\text{kg}$). This concentration of xylene is significantly lower than the recommended correction action guideline for

xylene in soils of 200,000 mg/kg (proposed Subpart S, Appendix A, EPA 1990b). Deeper samples (15 to 17 ft and 20 to 22 ft) did not have reportable concentrations of xylene. No quantifiable concentrations of SVOCs or ethylene glycol were detected. Results of the metals analyses indicate there are no elevated concentrations of metals in the soil. Soil pH values (7.8 to 9.2) for these samples reflect the alkaline conditions of the native soils in this area (Hacker 1977). Based on these results, it was concluded that the HCl and NaOH releases from ER Site 42 have not impacted the soil immediately north of Building 870 (Carlson 1994a, b; PRC 1993c).

5.4.3 Nature and Extent of Contamination

The available analytical results document the southern extent of contaminated soil must lie north of the line of boreholes sampled in 1993. The extent of potentially contaminated soils in the other directions is not identified. The flow path of contaminants would have been toward the storm drain inlets along L Street, M Street, and 15th Street. The vertical extent of potentially contaminated soil is unknown. The aboveground HCl release flowed over paved areas into the storm drain system and would not significantly affect sub-grade soils. The NaOH release is documented as flowing over not only paved areas but also non-paved areas, presumably near the tank that was the source of the release. An unknown portion of NaOH-contaminated soil has been removed, although some NaOH-contaminated soil remained after the removal action (Miller 1993c). Although site clean-up operations for the release associated with the former acid neutralization tank included removal and replacement of the fiberglass tank, an assessment of the potentially contaminated soils was not performed.

5.4.4 Conceptual Model

The conceptual model for releases is based on available historical information and data collected from limited previous investigations. Potential COCs include acids, bases, a variety of metals, and VOCs that may have been associated with the solutions. Although historical information does not indicate the release of any metals, the potential exists for metals to be associated with processes in the microelectronics operations. Due to the proximity of processes and possible intermingling of solutions after the releases occurred, elevated levels of metals could occur anywhere on site.

Any residual effects of the aboveground releases are not anticipated to extend significantly below the surface. It was reported that the HCl release was entirely contained (vertically) by paved surfaces

(Miller 1993c), and any HCl leaking through cracks or joints in the pavement would be quickly neutralized by the alkalinity of the native soil. Unlike the situation with the HCl release, there is no buffer in the native soil available to neutralize the NaOH release. It is not known how deep the NaOH solution could have migrated. Because of the lack of natural neutralizing capabilities, it is probable that the NaOH solution would have migrated deeper than the HCl release. However, it is extremely unlikely that strong acids or bases would remain after a period of years. Thermodynamic potential would drive systems to neutralize/decompose such materials, especially acids.

The release associated with the former acid neutralizing tank has the potential to migrate. Assuming that several months of untreated solutions containing acids (primarily hydrofluoric), bases, and dilute solvents (ethylene, acetone, butyl acetate, trichloroethylene, etc.) flowed directly into the soil (PRC 1993a), it is possible that contaminants from this release could have migrated further into the subsurface soils at this location. Although acids would have been neutralized by materials in the tank and native soil, the bases and solvents would not be readily neutralized or absorbed by the soil column.

The potential COCs at ER Site 42 may pose only a slight direct human-exposure risk because the release areas are mostly paved and COCs occur in surface soils or shallow subsurface soils, but the site is only partially fenced, which would allow for direct contact with COCs in the soil. Access to the site is controlled by the guards at the KAFB gates, and the security fence partially encircling ER Site 42 is posted with warning signs that forbid digging or disturbing the soil. The release areas covered by asphalt or concrete would prevent direct exposure to the source. Continued maintenance of the cover will ensure that human exposure and infiltration of precipitation is minimized. If site maintenance requires removal of the overlying asphalt and/or concrete, monitoring will be instituted to ensure worker safety.

Preliminarily identified corrective measures that may be considered include

- Institutional controls.
- Maintenance of a concrete or asphalt cover.
- Excavation and removal.
- Excavation and treatment.

If contaminated soils are identified and determined to be shallow, the soils could be excavated and removed for treatment. The potentially contaminated soils could be treated on site or transported off site to a licensed treatment and/or disposal facility. *In situ* treatment such as soil vapor extraction and treatment (for solvent contamination) or injection of neutralizing materials (for acid/base contamination) could be a potential corrective measure. Data required to evaluate corrective measures will be collected as described in the Sampling Plan presented below. No additional data are required to evaluate the effectiveness of institutional controls and covers during the RFI/CMS. It is assumed that the data collected in the course of characterizing the nature and extent of the potential release will be sufficient to approve waste for off-site transport and treatment.

5.4.5 Sampling Plan

The investigation proposed in this sampling plan will determine the nature and extent of potential contamination persisting from historic releases at and within the current boundary of ER Site 42. The extent of the contaminant releases at the surface is defined by historical information, although vertical extent and current nature of the contamination have not been characterized. In addition, lateral migration at greater depths needs to be defined. The sampling strategy discussed here assumes that the extent of the HCl release would be discernable by lowered soil pH values, the extent of the NaOH release would be discernable by elevated soil pH values, and the release at the former acid neutralization tank would be discernable by detectable concentrations of VOCs and lower soil pH values.

General DQOs for the TA-I RFI are given in Section 4.3. Site-specific DQOs for ER Site 42 include

- Determining if acids or bases exist in soils along the flow paths at concentrations detectable by field pH test (Level I and II).

- Determining if VOCs exist in soils near the former acid neutralization tank at concentrations detectable by on-site field laboratory (Level II).
- Characterizing the vertical and horizontal extent of potentially contaminated soils by Geoprobe soil sampling and analysis (Level II and III).
- Characterizing the vertical extent of VOCs or anomalous pH levels in soils by collecting analytical samples from deep boreholes (Level III).

These DQOs will be achieved by analyzing soil samples collected using the strategy described below. If contaminants are detected in the soil samples at concentrations above action levels, additional samples (*i.e.*, borehole soil samples) will be collected. Analytical Levels I, II, and III will be required for analytical procedures identified under this Plan. Data will be collected during Geoprobe surface and shallow subsurface soil sampling, and deep borehole investigations.

5.4.5.1 *Geoprobe Surface and Shallow Subsurface Soil Sampling*

5.4.5.1.1 Data Collection

The Geoprobe surface and shallow subsurface soil sampling (herein referred to as Geoprobe sampling) will be used for reconnaissance over the areas of the suspected releases. Forty points at the locations shown in Figure 5-17 will be sampled at interval depths of 0 to 2 ft, 3 to 5 ft, 8 to 10 ft, etc. The surface soil samples will be collected at 0-to-2 ft deep in unpaved areas or at the interval immediately below pavement and sub-base materials. For example, if pavement and sub-base gravel extends to a depth of 1.5 ft, the surface soil sample will be collected from a depth of 1.5 to 3.0 ft.

The Geoprobe soil sampler will be advanced until 2 samples are determined to be clean by means of field screening or on-site laboratory VOC analysis. Samples will be collected every 5 ft for lithologic logging, field screening (Level I and II), and laboratory analysis (Level II and III). Initially the Geoprobe soil sampler will be advanced to 5 ft bgs with split samples collected at 2 and 5 ft. One split from each depth will be sealed, labeled, and set aside for possible off-site laboratory verification analysis. The other split will be screened in the field or at an on-site laboratory for soil pH and for locations near the former acid neutralization tank described below for VOCs to determine the occurrence of anomalous soil pH levels (less than 2.0 or greater than 12.5; action level based on 40 CFR 261.22 criteria for corrosive hazardous waste) or the presence of VOCs. If no VOCs or anomalous pH levels are detected by the field screening, the 2-ft and 5-ft samples will be considered clean. No further drilling and sampling would be required at these locations.

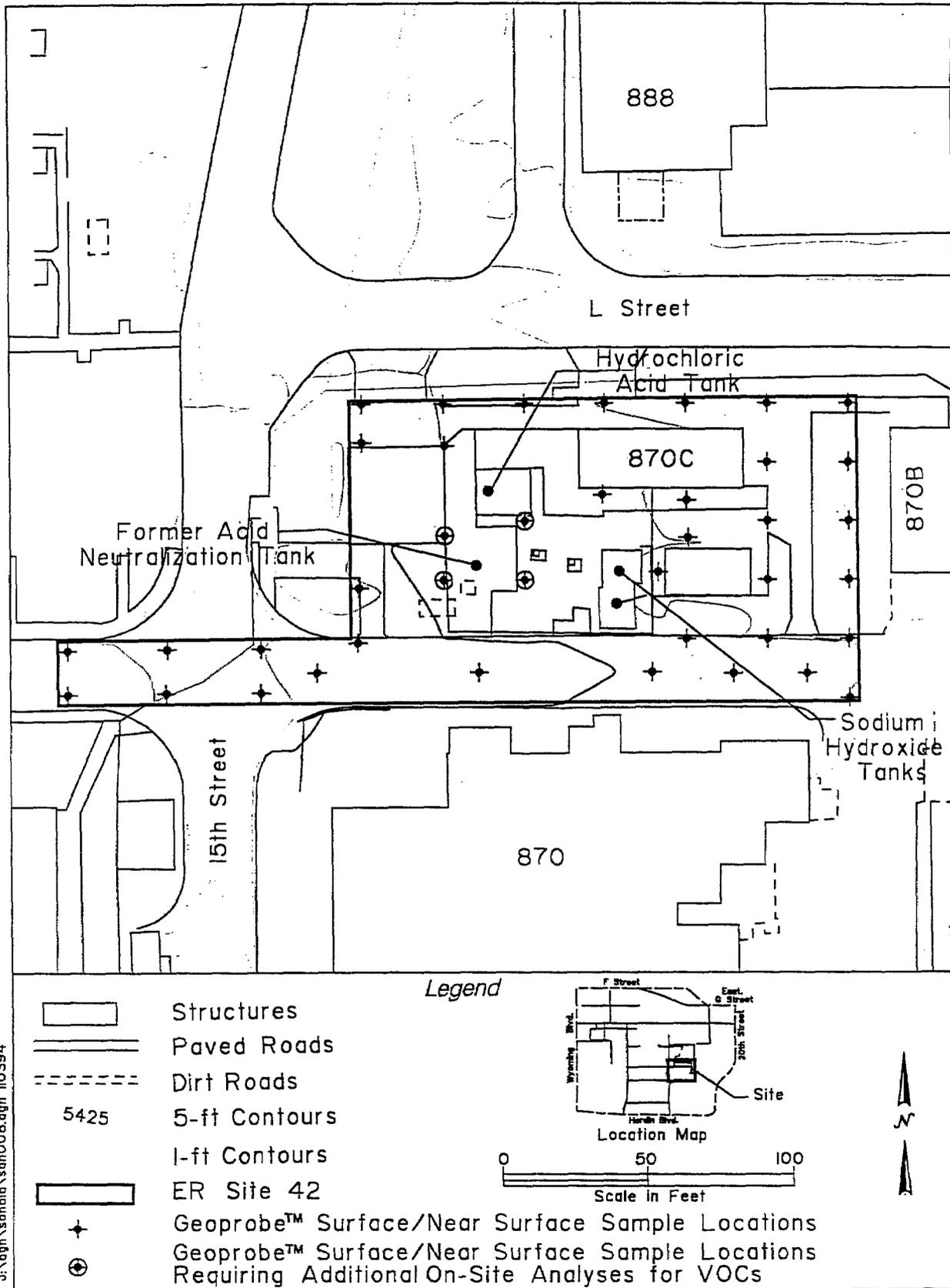


Figure 5-17
 ER Site 42: Proposed Geoprobe™ Surface and Near-Surface Soil Sampling Locations

If anomalous pH levels or VOCs are detected in the 2-ft and/or 5-ft samples by field screening, then the Geoprobe soil sampler will continue to be advanced and split samples will be collected at 5-ft intervals. Geoprobe sampling will continue until two 5-ft depth intervals have negative (non-detect) field screening and/or on-site laboratory analytical results, or to the maximum depth capabilities of the equipment.

Surface and shallow subsurface soil sampling by hand auger or hand-held power auger may be used to complement the Geoprobe sampling. This sampling may be easier at some of the 40 locations in Figure 5-17, or may be necessary in locations that are inaccessible to the Geoprobe rig. At these locations, samples will be collected with a scoop or hand auger at the same depth intervals (to the extent practical) and analyzed for the same parameters as the Geoprobe soil samples. Actual soil sampling may be modified somewhat from those shown in Figure 5-17 based on site clearance and access issues.

5.4.5.1.2. Analytical Parameters

At the 40 locations shown in Figure 5-17, as many as 120 Geoprobe samples will be collected for laboratory analysis and as many as 280 for field screening. Of these 40 locations, the 4 nearest the former acid neutralizing tank will be analyzed for soil pH and TCL VOCs at all depths, with the addition of TAL inorganics analysis for samples from the 3 to 5 ft depth. The soil pH will be determined in the field following appropriate procedures (Level II). The VOC field screening analysis will be done at an on-site laboratory (Level II). The ability of the Geoprobe sampler to easily revisit a location to collect a deeper sample provides a flexibility that allows quick turnaround time on-site analysis to be field screening. When results are available, a location could easily be revisited and a deeper sample collected if needed. Split samples of at least 20 percent of the on-site laboratory analysis will go to off-site laboratory for confirmatory analysis (Level III). During sampling, VOC screening will also be performed with a properly calibrated FID. Results of on-site laboratory analysis and FID screening will be compared to determine the feasibility of using FID screening to guide the borehole sampling program. If VOCs are detected at any of the four locations, samples from adjacent locations will be analyzed for VOCs. Additional VOC sampling will continue, as needed, to determine the areal extent of COCs in the surface and shallow subsurface soil. The TAL inorganics will be analyzed at an off-site laboratory (Level III) and there will not be any field screening of TAL inorganics to guide sampling.

If there are no VOC detections, or if the areal extent of VOCs has been delineated, the site assessment at the NaOH Spill and HCl Spill releases will be limited to soil pH at all depths, with the addition of TAL inorganics at the 3 to 5 ft depth. Table 5-15 provided at the end of this subsection lists the analytical parameters, EPA analytical method, analytical level, sample type, sample collection method, sample container, preservative and number of environmental and QA/QC samples.

5.4.5.2 *Borehole Investigation*

5.4.5.2.1. Data Collection

Locations showing contamination ("hot spots") at the deepest sample interval collected during Geoprobe sampling will require a deep borehole investigation. At those Geoprobe locations where the screening and verification sampling do not detect potential COCs, boreholes will not be drilled. Boreholes will be located in groups of up to four boreholes clustered around each hot spot location requiring vertical characterization. One borehole will be placed at the Geoprobe sampling hot spot location with sampling starting below the deepest sample interval (most likely 30 ft bgs, based on equipment capabilities). The other boreholes (up to three) will be equally spaced around the central borehole in order to define the vertical and horizontal extent of any contamination. The number of perimeter boreholes and the distance from these boreholes to the central borehole will be based on the concentration of the contaminant and the depth of contamination identified in the central borehole, as well as site clearance/access issues. If multiple adjacent Geoprobe soil sampling locations identify hot spots in the deepest sample interval, surrounding each Geoprobe sampling location with boreholes may be inefficient. In this case, the deep borehole locations may be optimized to characterize the entire group of Geoprobe soil sampling locations.

The deep boreholes will be drilled with a hollow-stem auger until two samples are determined clean by means of field screening. Samples will be collected at 5-ft intervals from 30- to 50-ft bgs, at 10-ft intervals from 50- to 100-ft bgs, and at 20-ft intervals at depths greater than 100 ft for lithologic logging, field screening (Level I and II), and possibly for laboratory analysis. Initially the borehole will be sampled 5 ft below the deepest Geoprobe sample with split samples collected at two consecutive 5-ft intervals. One split from each depth will be sealed, labeled, and set aside for possible laboratory analysis. The other split will be screened for soil pH or VOCs (described below) to determine the occurrence of anomalous soil pH levels (<2 or >12.5) or the presence of VOCs. If no anomalous pH levels or VOCs are detected by the field screening, these two 5-ft samples will be

considered clean and sent for confirmation to the off-site laboratory (Level III). No further drilling and sampling would be required at these locations.

If anomalous pH levels or VOCs are detected in the two consecutive 5-ft samples by field screening, then the borehole will continue to be advanced and split samples will be collected at appropriate intervals. Borehole soil sampling will continue until two consecutive depth intervals have negative field screening results. Three samples per location will be sent for laboratory analysis: one sample from the depth showing the greatest field screening results (to characterize the nature of the COCs), and one sample from each of the two deepest clean sample intervals (to characterize the vertical extent of COCs).

It is assumed that, to characterize to the vertical extent of contamination, approximately 1600 ft of borings will be needed. This drilling footage is based on the conservative estimate that four clusters of four boreholes (each drilled to 50 ft bgs) may be needed along the paths of the HCl and NaOH releases. At the former neutralizing tank, the volume of solutions released through the bottom of the tank is unknown, and the potential for a large solution released must therefore be addressed.

Therefore, a cluster of four boreholes to 200 ft may be needed. If these assumptions appear to be erroneous as the investigation proceeds, additional boreholes may be drilled. Sampling in any additional boreholes would be similar to that described above.

5.4.5.2.2. Analytical Parameters

As many as 60 laboratory analytical samples (from up to 20 boreholes, with 3 samples from each) and as many as 140 field screening samples are proposed for the deep borehole. Depending on the COCs at each hot spot (determined by the on-site and off-site laboratory analysis of Geoprobe soil samples), the samples from the boreholes may be analyzed for soil pH, TCL VOCs, and TAL inorganics (Table 5-15). The soil pH will be determined in the field following appropriate procedures (Level II). In contrast to the laboratory analysis for VOCs used in the Geoprobe sampling strategy, VOC-screening for determining the total depth of the borehole will be performed with a properly calibrated PID (Level I). The inflexibility of completing deep boreholes (compared to using a Geoprobe) logistically does not allow for the use of on-site laboratory analysis for determining the total depth of the borehole. The VOC samples collected from each borehole will be analyzed at an on-site laboratory (Level II). Split samples of at least 20 percent of the on-site laboratory analyses will go to an off-site laboratory for confirmatory analysis (Level III). The TAL inorganics will be

analyzed at an off-site laboratory (Level III). Table 5-15 lists the analytical parameters, EPA analytical method, analytical level, sample type, sample collection method, sample container, preservative, and number of environmental and QA/QC samples.

Table 5-15. ER Site 42: Sample Identification and Analytical Specifications

ER SITE 42 : Building 870 Water Treatment Facility				FIELD SCREENING (a)			ON-SITE LAB ANALYSES (b) (c) (d)			OFF-SITE LAB ANALYSES (e) (f) (g)															
FIELD NUMBER	SAMPLE ID (g)	SAMPLE METHOD (e.g. Geoprobe, Soil Boring, Hand Auger, etc.)	SAMPLE TYPE (e.g. Surface Soil, Sediment, Rinseate Blank, Trip Blank, Duplicate, etc.)	SAMPLE DEPTH (ft)	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 (h)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCLP INORGANICS (I311) (h)	TCLP ORGANICS (I311/B270/B240)	
<p>Geoprobe Sampling: The total number of locations sampled for VOCs, the depth of the Geoprobe boreholes, the sample intervals, and the number of samples will be based on field screening results. Samples collected near the former acid neutralization tank:</p>																									
	GP001-002-SS	Geoprobe	Surface soil	0-2	X					X															
	GP001-005-S	Geoprobe	Shallow subsurface soil	3-5	X					X															
	GP001-010-S	Geoprobe	Shallow subsurface soil	8-10	X					X															
	GP001-015-S	Geoprobe	Shallow subsurface soil	13-15	X					X															
	GP001-020-S	Geoprobe	Shallow subsurface soil	18-20	X					X															
	GP001-025-S	Geoprobe	Shallow subsurface soil	23-25	X					X															
	GP001-030-S	Geoprobe	Shallow subsurface soil	28-30	X					X															
	GP002-002-SS	Geoprobe	Surface soil	0-2	X					X															
	GP002-005-S	Geoprobe	Shallow subsurface soil	3-5	X					X															
	GP002-010-S	Geoprobe	Shallow subsurface soil	8-10	X					X															
	GP002-015-S	Geoprobe	Shallow subsurface soil	13-15	X					X															
	GP002-020-S	Geoprobe	Shallow subsurface soil	18-20	X					X															
	GP002-025-S	Geoprobe	Shallow subsurface soil	23-25	X					X															
	GP002-030-S	Geoprobe	Shallow subsurface soil	28-30	X					X															
	GP003-002-SS	Geoprobe	Surface soil	0-2	X					X															
	GP003-005-S	Geoprobe	Shallow subsurface soil	3-5	X					X															
	GP003-010-S	Geoprobe	Shallow subsurface soil	8-10	X					X															
	GP003-015-S	Geoprobe	Shallow subsurface soil	13-15	X					X															
	GP003-020-S	Geoprobe	Shallow subsurface soil	18-20	X					X															
	GP003-025-S	Geoprobe	Shallow subsurface soil	23-25	X					X															
	GP003-030-S	Geoprobe	Shallow subsurface soil	28-30	X					X															
	GP004-002-SS	Geoprobe	Surface soil	0-2	X					X															
	GP004-005-S	Geoprobe	Shallow subsurface soil	3-5	X					X															
	GP004-010-S	Geoprobe	Shallow subsurface soil	8-10	X					X															
	GP004-015-S	Geoprobe	Shallow subsurface soil	13-15	X					X															
	GP004-020-S	Geoprobe	Shallow subsurface soil	18-20	X					X															
	GP004-025-S	Geoprobe	Shallow subsurface soil	23-25	X					X															
	GP004-030-S	Geoprobe	Shallow subsurface soil	28-30	X					X															

Table 5-15. (page 2 of 13)

ER SITE 42 : Building 870 Water Treatment Facility				FIELD SCREENING (a)			ON-SITE LAB ANALYSES (b) (c) (d)			OFF-SITE LAB ANALYSES (e) (f) (g)															
FIELD NUMBER	SAMPLE ID (g)	SAMPLE METHOD (e.g. Geoprobe, Soil Boring, Hand Auger, etc.)	SAMPLE TYPE (e.g. Surface Soil, Sediment, Rinsate Blank, Trip Blank, Duplicate, etc.)	SAMPLE DEPTH (ft)	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 (h)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TANTALUM (LIQUID SCINT.)	TCLP INORGANICS (I311) (h)	TCLP ORGANICS (I311/B270/B240)	
QA/QC Samples:																									
	GP041-005-S	Geoprobe	Soil field duplicate	3 - 5																					
	EB001-001-W	Grab	Aqueous field blank	N/A																					
	EB001-001-W	Grab	Aqueous equip. blank	N/A																					
	TB001-001	Grab	Trip blank	N/A																					
Other Geoprobe locations:																									
	GP005-002-S	Geoprobe	Surface soil	0 - 2																					
	GP005-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP005-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					
	GP005-015-S	Geoprobe	Shallow subsurface soil	13 - 15																					
	GP005-020-S	Geoprobe	Shallow subsurface soil	18 - 20																					
	GP005-025-S	Geoprobe	Shallow subsurface soil	23 - 25																					
	GP005-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					
	GP006-002-S	Geoprobe	Surface soil	0 - 2																					
	GP006-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP006-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					
	GP006-015-S	Geoprobe	Shallow subsurface soil	13 - 15																					
	GP006-020-S	Geoprobe	Shallow subsurface soil	18 - 20																					
	GP006-025-S	Geoprobe	Shallow subsurface soil	23 - 25																					
	GP006-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					
	GP007-002-S	Geoprobe	Surface soil	0 - 2																					
	GP007-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP007-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					
	GP007-015-S	Geoprobe	Shallow subsurface soil	13 - 15																					
	GP007-020-S	Geoprobe	Shallow subsurface soil	18 - 20																					
	GP007-025-S	Geoprobe	Shallow subsurface soil	23 - 25																					
	GP007-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					
	GP008-002-S	Geoprobe	Surface soil	0 - 2																					
	GP008-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP008-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					

Table 5-15. (page 3 of 13)

ER SITE 42 : Building 870 Water Treatment Facility				FIELD SCREENING (A)			ON-SITE LAB ANALYSES (B) (C) (D)			OFF-SITE LAB ANALYSES (E) (F) (G)														
FIELD NUMBER	SAMPLE ID (g)	SAMPLE METHOD	SAMPLE TYPE	SAMPLE DEPTH (ft)	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 (H)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCLP INORGANICS (I311) (M)	TCLP ORGANICS (I311/B270/B240)
	GP008-015-S	Geoprobe	Shallow subsurface soil	13 - 15			X																	
	GP008-020-S	Geoprobe	Shallow subsurface soil	18 - 20			X																	
	GP008-025-S	Geoprobe	Shallow subsurface soil	23 - 25			X																	
	GP008-030-S	Geoprobe	Shallow subsurface soil	28 - 30			X																	
	GP008-002-S	Geoprobe	Surface soil	0 - 2			X																	
	GP009-005-S	Geoprobe	Shallow subsurface soil	3 - 5			X																	
	GP009-010-S	Geoprobe	Shallow subsurface soil	8 - 10			X																	
	GP009-015-S	Geoprobe	Shallow subsurface soil	13 - 15			X																	
	GP009-020-S	Geoprobe	Shallow subsurface soil	18 - 20			X																	
	GP009-025-S	Geoprobe	Shallow subsurface soil	23 - 25			X																	
	GP009-030-S	Geoprobe	Shallow subsurface soil	28 - 30			X																	
	GP010-002-S	Geoprobe	Surface soil	0 - 2			X																	
	GP010-005-S	Geoprobe	Shallow subsurface soil	3 - 5			X																	
	GP010-010-S	Geoprobe	Shallow subsurface soil	8 - 10			X																	
	GP010-015-S	Geoprobe	Shallow subsurface soil	13 - 15			X																	
	GP010-020-S	Geoprobe	Shallow subsurface soil	18 - 20			X																	
	GP010-025-S	Geoprobe	Shallow subsurface soil	23 - 25			X																	
	GP010-030-S	Geoprobe	Shallow subsurface soil	28 - 30			X																	
	GP011-002-S	Geoprobe	Surface soil	0 - 2			X																	
	GP011-005-S	Geoprobe	Shallow subsurface soil	3 - 5			X																	
	GP011-010-S	Geoprobe	Shallow subsurface soil	8 - 10			X																	
	GP011-015-S	Geoprobe	Shallow subsurface soil	13 - 15			X																	
	GP011-020-S	Geoprobe	Shallow subsurface soil	18 - 20			X																	
	GP011-025-S	Geoprobe	Shallow subsurface soil	23 - 25			X																	
	GP011-030-S	Geoprobe	Shallow subsurface soil	28 - 30			X																	
	GP012-002-S	Geoprobe	Surface soil	0 - 2			X																	
	GP012-005-S	Geoprobe	Shallow subsurface soil	3 - 5			X																	
	GP012-010-S	Geoprobe	Shallow subsurface soil	8 - 10			X																	
	GP012-015-S	Geoprobe	Shallow subsurface soil	13 - 15			X																	
	GP012-020-S	Geoprobe	Shallow subsurface soil	18 - 20			X																	
	GP012-025-S	Geoprobe	Shallow subsurface soil	23 - 25			X																	

Table 5-15. (page 4 of 13)

ER SITE 42 : Building 870 Water Treatment Facility				FIELD SCREENING (a)			ON-SITE LAB ANALYSES (b) (c) (d)			OFF-SITE LAB ANALYSES (e) (f) (g)															
FIELD NUMBER	SAMPLE ID (g)	SAMPLE METHOD	SAMPLE TYPE	SAMPLE DEPTH (ft)	VOCs	TPH	SOIL pH	PCBs	RADIATION (alpha, beta, gamma)	VOCs (by GC)	METALS (by DCP)	GAMMA SFEC	TPH	VOCs (B240)	TPH (B015)	SVOCs (B270)	PCBs (B080)	TAL INORGANICS (h)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCLP INORGANICS (I311) (i)	TCLP ORGANICS (I311/B270&80)	
	TI042-	(e.g. Geoprobe, Soil Boring, Hand Auger, etc.)	(e.g. Surface Soil, Sediment, Rinseate Blank, Trip Blank, Duplicate, etc.)																						
	GP012-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					
	GP013-002-S	Geoprobe	Surface soil	0 - 2																					
	GP013-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP013-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					
	GP013-015-S	Geoprobe	Shallow subsurface soil	13 - 15																					
	GP013-020-S	Geoprobe	Shallow subsurface soil	18 - 20																					
	GP013-025-S	Geoprobe	Shallow subsurface soil	23 - 25																					
	GP013-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					
	GP014-002-S	Geoprobe	Surface soil	0 - 2																					
	GP014-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP014-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					
	GP014-015-S	Geoprobe	Shallow subsurface soil	13 - 15																					
	GP014-020-S	Geoprobe	Shallow subsurface soil	18 - 20																					
	GP014-025-S	Geoprobe	Shallow subsurface soil	23 - 25																					
	GP014-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					
	GP015-002-S	Geoprobe	Surface soil	0 - 2																					
	GP015-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP015-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					
	GP015-015-S	Geoprobe	Shallow subsurface soil	13 - 15																					
	GP015-020-S	Geoprobe	Shallow subsurface soil	18 - 20																					
	GP015-025-S	Geoprobe	Shallow subsurface soil	23 - 25																					
	GP016-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					
	GP016-002-S	Geoprobe	Surface soil	0 - 2																					
	GP016-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP016-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					
	GP016-015-S	Geoprobe	Shallow subsurface soil	13 - 15																					
	GP016-020-S	Geoprobe	Shallow subsurface soil	18 - 20																					
	GP016-025-S	Geoprobe	Shallow subsurface soil	23 - 25																					
	GP016-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					
	GP017-002-S	Geoprobe	Surface soil	0 - 2																					
	GP017-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					

Table 5-15. (page 6 of 13)

ER SITE 42 : Building 870 Water Treatment Facility				FIELD SCREENING (a)		ON-SITE LAB ANALYSES (b) (c) (d)		OFF-SITE LAB ANALYSES (e) (f) (g) (h)																	
FIELD NUMBER	SAMPLE ID (g)	SAMPLE METHOD	SAMPLE TYPE	SAMPLE DEPTH (ft)	VOCs	TPH	SOIL pH	PCBs	RADIATION (alpha, beta, gamma)	VOCs (by GC)	METALS (by DCP)	GAMMA SPEC	TPH	VOCs (BZ40)	TPH (B015)	SVOCs (B270)	PCBs (B080)	TAL INORGANICS (h)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCLP INORGANICS (1311) (h)	TCLP ORGANICS (1311/B270/B240)	
	GP021-025-S	Geoprobe	Shallow subsurface soil	23 - 25			X																		
	GP021-030-S	Geoprobe	Shallow subsurface soil	29 - 30			X																		
	GP022-002-S	Geoprobe	Surface soil	0 - 2			X																		
	GP022-005-S	Geoprobe	Shallow subsurface soil	3 - 5			X																		
	GP022-010-S	Geoprobe	Shallow subsurface soil	8 - 10			X																		
	GP022-015-S	Geoprobe	Shallow subsurface soil	13 - 15			X																		
	GP022-020-S	Geoprobe	Shallow subsurface soil	18 - 20			X																		
	GP022-025-S	Geoprobe	Shallow subsurface soil	23 - 25			X																		
	GP022-030-S	Geoprobe	Shallow subsurface soil	29 - 30			X																		
	GP023-002-S	Geoprobe	Surface soil	0 - 2			X																		
	GP023-005-S	Geoprobe	Shallow subsurface soil	3 - 5			X																		
	GP023-010-S	Geoprobe	Shallow subsurface soil	8 - 10			X																		
	GP023-015-S	Geoprobe	Shallow subsurface soil	13 - 15			X																		
	GP023-020-S	Geoprobe	Shallow subsurface soil	18 - 20			X																		
	GP023-025-S	Geoprobe	Shallow subsurface soil	23 - 25			X																		
	GP023-030-S	Geoprobe	Shallow subsurface soil	29 - 30			X																		
	GP024-002-S	Geoprobe	Surface soil	0 - 2			X																		
	GP024-005-S	Geoprobe	Shallow subsurface soil	3 - 5			X																		
	GP024-010-S	Geoprobe	Shallow subsurface soil	8 - 10			X																		
	GP024-015-S	Geoprobe	Shallow subsurface soil	13 - 15			X																		
	GP024-020-S	Geoprobe	Shallow subsurface soil	18 - 20			X																		
	GP024-025-S	Geoprobe	Shallow subsurface soil	23 - 25			X																		
	GP024-030-S	Geoprobe	Shallow subsurface soil	29 - 30			X																		
	GP025-002-S	Geoprobe	Surface soil	0 - 2			X																		
	GP025-005-S	Geoprobe	Shallow subsurface soil	3 - 5			X																		
	GP025-010-S	Geoprobe	Shallow subsurface soil	8 - 10			X																		
	GP025-015-S	Geoprobe	Shallow subsurface soil	13 - 15			X																		
	GP025-020-S	Geoprobe	Shallow subsurface soil	18 - 20			X																		
	GP025-025-S	Geoprobe	Shallow subsurface soil	23 - 25			X																		
	GP025-030-S	Geoprobe	Shallow subsurface soil	29 - 30			X																		
	GP026-002-S	Geoprobe	Surface soil	0 - 2			X																		

Table 5-15. (page 8 of 13)

ER SITE 42 : Building 870 Water Treatment Facility				FIELD SCREENING (a)		ON-SITE LAB ANALYSES (b),(c),(d)		OFF-SITE LAB ANALYSES (e),(f),(g),(h)																	
FIELD NUMBER	SAMPLE ID (g)	SAMPLE METHOD	SAMPLE TYPE	SAMPLE DEPTH (ft)	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 (h)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCLP INORGANICS (1311) (h)	TCLP ORGANICS (1311/B270/B240)	
	TI042-	(e.g. Geoprobe, Soil Boring, Hand Auger, etc.)	(e.g. Surface Soil, Sediment, Rinseate Blank, Trip Blank, Duplicate, etc.)																						
	GP030-020-S	Geoprobe	Shallow subsurface soil	18 - 20																					
	GP030-025-S	Geoprobe	Shallow subsurface soil	23 - 25																					
	GP030-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					
	GP031-002-S	Geoprobe	Surface soil	0 - 2																					
	GP031-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP031-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					
	GP031-015-S	Geoprobe	Shallow subsurface soil	13 - 15																					
	GP031-020-S	Geoprobe	Shallow subsurface soil	18 - 20																					
	GP031-025-S	Geoprobe	Shallow subsurface soil	23 - 25																					
	GP031-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					
	GP032-002-S	Geoprobe	Surface soil	0 - 2																					
	GP032-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP032-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					
	GP032-015-S	Geoprobe	Shallow subsurface soil	13 - 15																					
	GP032-020-S	Geoprobe	Shallow subsurface soil	18 - 20																					
	GP032-025-S	Geoprobe	Shallow subsurface soil	23 - 25																					
	GP032-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					
	GP033-002-S	Geoprobe	Surface soil	0 - 2																					
	GP033-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP033-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					
	GP033-015-S	Geoprobe	Shallow subsurface soil	13 - 15																					
	GP033-020-S	Geoprobe	Shallow subsurface soil	18 - 20																					
	GP033-025-S	Geoprobe	Shallow subsurface soil	23 - 25																					
	GP033-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					
	GP034-002-S	Geoprobe	Surface soil	0 - 2																					
	GP034-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP034-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					
	GP034-015-S	Geoprobe	Shallow subsurface soil	13 - 15																					
	GP034-020-S	Geoprobe	Shallow subsurface soil	18 - 20																					
	GP034-025-S	Geoprobe	Shallow subsurface soil	23 - 25																					
	GP034-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					

Table 5-15. (page 9 of 13)

ER SITE 42 : Building 870 Water Treatment Facility				FIELD SCREENING (a)			ON-SITE LAB ANALYSES (b)(c)(d)			OFF-SITE LAB ANALYSES (d)(e)(f)															
FIELD NUMBER	SAMPLE ID (g)	SAMPLE METHOD	SAMPLE TYPE	SAMPLE DEPTH (ft)	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 (h)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCLP INORGANICS (I311) (h)	TCLP ORGANICS (I311/B270/B240)	
	GP035-002-S	Geoprobe	Surface soil	0 - 2																					
	GP035-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP035-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					
	GP035-015-S	Geoprobe	Shallow subsurface soil	13 - 15																					
	GP035-020-S	Geoprobe	Shallow subsurface soil	18 - 20																					
	GP035-025-S	Geoprobe	Shallow subsurface soil	23 - 25																					
	GP035-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					
	GP036-002-S	Geoprobe	Surface soil	0 - 2																					
	GP036-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP036-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					
	GP036-015-S	Geoprobe	Shallow subsurface soil	13 - 15																					
	GP036-020-S	Geoprobe	Shallow subsurface soil	18 - 20																					
	GP036-025-S	Geoprobe	Shallow subsurface soil	23 - 25																					
	GP036-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					
	GP037-002-S	Geoprobe	Surface soil	0 - 2																					
	GP037-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP037-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					
	GP037-015-S	Geoprobe	Shallow subsurface soil	13 - 15																					
	GP037-020-S	Geoprobe	Shallow subsurface soil	18 - 20																					
	GP037-025-S	Geoprobe	Shallow subsurface soil	23 - 25																					
	GP037-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					
	GP038-002-S	Geoprobe	Surface soil	0 - 2																					
	GP038-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP038-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					
	GP038-015-S	Geoprobe	Shallow subsurface soil	13 - 15																					
	GP038-020-S	Geoprobe	Shallow subsurface soil	18 - 20																					
	GP038-025-S	Geoprobe	Shallow subsurface soil	23 - 25																					
	GP038-030-S	Geoprobe	Shallow subsurface soil	28 - 30																					
	GP039-002-S	Geoprobe	Surface soil	0 - 2																					
	GP039-005-S	Geoprobe	Shallow subsurface soil	3 - 5																					
	GP039-010-S	Geoprobe	Shallow subsurface soil	8 - 10																					

Table 5-15. (page 12 of 13)

ER SITE 42 : Building 870 Water Treatment Facility				FIELD		ON-SITE LAB		OFF-SITE LAB										
FIELD NUMBER	SAMPLE ID (g)	SAMPLE METHOD	SAMPLE TYPE	SAMPLE DEPTH (ft)	SCREENING (a)	ANALYSES (b) (c) (d)	ANALYSES (e) (f) (g)	VOCs (8240)	TPH (8015)	SVOCs (8270)	PCBs (8080)	TAL INORGANICS (h)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCLP INORGANICS (1311) (i)	TCLP ORGANICS (1311) (j) (k) (l)
	through				VOCs													
	BH020-035-S	Soil boring	Subsurface soil	33 - 35	X													
	BH020-040-S	Soil boring	Subsurface soil	38 - 40	X													
	BH020-045-S	Soil boring	Subsurface soil	43 - 45	X													
	BH020-050-S	Soil boring	Subsurface soil	48 - 50	X													
	BH020-060-S	Soil boring	Subsurface soil	58 - 60	X													
	BH020-070-S	Soil boring	Subsurface soil	69 - 70	X													
	BH020-080-S	Soil boring	Subsurface soil	78 - 80	X													
	BH020-090-S	Soil boring	Subsurface soil	88 - 90	X													
	BH020-100-S	Soil boring	Subsurface soil	98 - 100	X													
	BH020-120-S	Soil boring	Subsurface soil	118 - 120	X													
	BH020-140-S	Soil boring	Subsurface soil	138 - 140	X													
	BH020-160-S	Soil boring	Subsurface soil	158 - 160	X													
	BH020-180-S	Soil boring	Subsurface soil	178 - 180	X													
	BH020-200-S	Soil boring	Subsurface soil	198 - 200	X													
	QA/OC Samples:																	
	BH024-050-S	Soil boring	Soil field duplicate	48 - 50														
	BH025-050-S	Soil boring	Soil field duplicate	48 - 50														
	BH026-050-S	Soil boring	Soil field duplicate	48 - 50														
	FB006-001-W	Grab	Aqueous field blank	N/A														
	FB007-001-W	Grab	Aqueous field blank	N/A														
	FB008-001-W	Grab	Aqueous field blank	N/A														
	EB006-001-W	Grab	Aqueous equip. blank	N/A														
	EB007-001-W	Grab	Aqueous equip. blank	N/A														
	EB008-001-W	Grab	Aqueous equip. blank	N/A														
	TB002-001	Grab	Trip blank	N/A														
	TB002-001	Grab	Trip blank	N/A														
	TB002-001	Grab	Trip blank	N/A														

Table 5-15. (page 13 of 13)

ER SITE 42 : Building 870 Water Treatment Facility				FIELD SCREENING (a)	ON-SITE LAB ANALYSES (b) (c) (d)	OFF-SITE LAB ANALYSES (e) (f) (g)																		
FIELD NUMBER	SAMPLE ID (g)	SAMPLE METHOD	SAMPLE TYPE	VOCs	TPH	SOL 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 (h)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT.)	TCLP INORGANICS (1311) (h)	TCLP ORGANICS (1311/270/240)	
Waste Management Samples:																								
The actual number of waste management samples will be based on soil analytical results, and types and number of containers used.																								
	DRM001-001-S	Grab	Solid Waste	N/A																				
	DRM002-001-S	Grab	Solid Waste	N/A																				
	DRM003-001-S	Grab	Solid Waste	N/A																				
	DRM004-001-S	Grab	Solid Waste	N/A																				
TOTAL SAMPLES				50	400				40				24				127	4	4	4	4	4	4	
Total Samples: Field Screening = 400; On-site Lab = 40; Off-site Lab = 136.																								

Notes:
 (a) Analytical Level I Data: Field screening methods and rationale are discussed in the text.
 (b) Analytical Level II Data: On-site lab sample container volume/type requirements will be determined by the on-site laboratory during mobilization.
 (c) On-site lab analytical methods will be determined at a later date.
 (d) All geochemical laboratory samples will be preserved on ice unless otherwise noted.
 (e) Analytical Level III Data: Consists of duplicate of 20% of the on-site laboratory analytical samples.
 (f) Off-site lab sample container volume/type requirements for soil and water will be determined by the Sample Management Office during mobilization.
 (g) The Sample ID contains information regarding location, matrix, depth, etc.; this sample identification scheme is described in Section 4.4.
 (h) Inorganic analytical methods include 8010 and 7000 series analysis.

APPENDIX D

ER SITE 42 TABLES

Table 1
New Mexico State Plane Coordinates for
ER Site 42 Soil Sample Locations

Location	North (ft)	East (ft)	Location	North (ft)	East (ft)
T1042-GP001	1473293.4	413126.5	T1042-GP021	1473292.0	413167.9
T1042-GP002	1473307.7	413127.9	T1042-GP022	1473248.2	413231.4
T1042-GP003	1473306.9	413164.2	T1042-GP023	1473232.4	413210.9
T1042-GP004	1473306.7	413194.7	T1042-GP024	1473243.1	413092.1
T1042-GP005	1473308.1	413228.7	T1042-GP025	1473266.3	413090.6
T1042-GP006	1473308.3	413262.1	T1042-GP026	1473287.1	413084.8
T1042-GP007	1473308.2	413287.9	T1042-GP027	1473266.4	413077.5
T1042-GP008	1473260.6	413275.7	T1042-GP028	1473245.1	413073.5
T1042-GP009	1473272.1	413290.0	T1042-GP029	1473221.2	413069.1
T1042-GP010	1473239.7	413271.8	T1042-GP030	1473205.6	413055.8
T1042-GP011	1473254.7	413295.6	T1042-GP031	1473207.0	413033.8
T1042-GP012	1473273.6	413237.6	T1042-GP032	1473222.3	413033.6
T1042-GP013	1473276.5	413108.6	T1042-GP033	1473245.4	413186.5
T1042-GP014	1473292.7	413107.6	T1042-GP034	1473262.7	413185.5
T1042-GP015	1473278.8	413125.4	T1042-GP035	1473274.7	413167.0
T1042-GP016	1473263.4	413105.7	T1042-GP036	1473246.3	413150.9
T1042-GP017	1473264.1	413127.4	T1042-GP037	1473223.7	413169.6
T1042-GP018	1473241.1	413132.4	T1042-GP038	1473223.7	413222.5
T1042-GP019	1473244.7	413106.3	T1042-GP039	1473256.4	413167.7
T1042-GP020	1473228.9	413123.8	T1042-GP040	1473247.6	413163.7

Table 2
ER Site 42 Soil VOC Concentrations

Sample Number	Depth (ft)	Analyte	Concentration (ug/kg)
T1042-GP033-020	20.0	ACETONE	6.6 J
		METHYLENE CHLORIDE	1.9 J
T1042-GP034-020	20.0	ACETONE	8.5 J
		METHYLENE CHLORIDE	1.8 J
T1042-GP034-030	30.0	ACETONE	4.7 J
		METHYLENE CHLORIDE	1.9 J
T1042-GP040-010	10.0	ACETONE	5.0 J
T1042-GP040-020	20.0	ACETONE	6.0 J
		METHYLENE CHLORIDE	1.4 J
T1042-GP040-022	25.0	ACETONE	9.4 J
		METHYLENE CHLORIDE	1.4 J
T1042-GP040-030	30.0	ACETONE	19
		METHYLENE CHLORIDE	1.3 J

Notes:

J = Result is detected below the reporting limit or is an estimated concentration.

Samples analyzed by Quanterra Laboratories in Arvada, Colorado.

Table 3
ER Site 42 QA/QC Samples

Sample Number	Depth (ft)	Analyte	Concentration (ug/kg)
T1042-EB002-001	NA	ACETONE	2.4 J
T1042-FB001-001	NA	ACETONE	330
		METHYLENE CHLORIDE	10 J
T1042-TB001-001	NA	METHYLENE CHLORIDE	1.5 JB
T1042-TB002-001	NA	ACETONE	1200
T1042-TB003-001	NA	ACETONE	12
		METHYLENE CHLORIDE	1.2J

Notes:

B = Compound is also detected in the laboratory method blank.

J = Result is detected below the reporting limit or is and estimated concentration.

NA = Not Applicable.

Samples analyzed by Quanterra Laboratories in Arvada, Colorado.

Table 4
ER Site 42 Soil pH Values

Sample Number	Depth (ft)	pH Determined with CaCl ₂	pH Determined with DI H ₂ O
T1042-GP001-002	2.0	8.3	9.6
T1042-GP001-005	5.0	8.4	8.7
T1042-GP002-002	2.0	8.2	9.6
T1042-GP002-005	5.0	8.3	8.9
T1042-GP003-002	2.0	8.2	9.5
T1042-GP003-005	5.0	8.7	9.4
T1042-GP004-002	2.0	8.4	9.3
T1042-GP004-005	5.0	8.5	8.6
T1042-GP005-002	2.0	8.4	9.2
T1042-GP005-005	5.0	8.5	8.7
T1042-GP006-002	2.0	8.3	9.2
T1042-GP006-005	5.0	8.4	8.8
T1042-GP007-002	2.0	9.0	9.6
T1042-GP007-005	5.0	8.3	9.2
T1042-GP008-002	2.0	8.3	9.1
T1042-GP008-005	5.0	8.1	9.2
T1042-GP009-002	2.0	7.9	8.8
T1042-GP009-005	5.0	8.3	8.5
T1042-GP010-002	2.0	8.4	8.9
T1042-GP010-005	5.0	8.2	8.5
T1042-GP011-002	2.0	8.2	9.0
T1042-GP011-005	5.0	8.2	9.2
T1042-GP012-002	2.0	8.2	9.3
T1042-GP012-005	5.0	8.2	9.1
T1042-GP013-002	2.0	7.4	9.5
T1042-GP013-005	5.0	7.6	8.4
T1042-GP014-002	2.0	8.3	9.1
T1042-GP014-005	5.0	8.0	8.5
T1042-GP015-002	2.0	9.0	9.5
T1042-GP015-005	5.0	8.2	9.1
T1042-GP016-002	2.0	7.9	8.5
T1042-GP016-005	5.0	7.9	8.8
T1042-GP016-006	6.0	8.0	8.7
T1042-GP017-002	2.0	7.9	8.9
T1042-GP017-005	5.0	8.1	8.3
T1042-GP018-002	2.0	8.2	9.0
T1042-GP018-005	5.0	8.5	9.5
T1042-GP019-002	2.0	8.1	8.6
T1042-GP019-005	5.0	8.1	8.8
T1042-GP020-002	2.0	8.1	8.9
T1042-GP020-005	5.0	8.2	8.8
T1042-GP021-002	2.0	8.1	9.0
T1042-GP021-005	5.0	8.0	8.0
T1042-GP022-002	2.0	8.2	9.2
T1042-GP022-005	5.0	8.3	9.4
T1042-GP023-002	2.0	8.1	9.2
T1042-GP023-005	5.0	7.7	9.1
T1042-GP024-002	2.0	8.1	9.6
T1042-GP024-005	5.0	8.2	9.1
T1042-GP025-002	2.0	8.2	9.0
T1042-GP025-003	3.0	8.2	9.1
T1042-GP025-005	5.0	8.2	8.5

Table 4
ER Site 42 Soil pH Values

Sample Number	Depth (ft)	pH Determined with CaCl ₂	pH Determined with DI H ₂ O
T1042-GP026-002	2.0	8.1	8.4
T1042-GP026-005	5.0	8.2	8.6
T1042-GP027-002	2.0	8.2	8.6
T1042-GP027-005	5.0	8.3	8.7
T1042-GP028-002	2.0	8.3	9.2
T1042-GP028-005	5.0	8.3	9.3
T1042-GP029-002	2.0	8.3	9.0
T1042-GP029-005	5.0	8.4	8.7
T1042-GP030-002	2.0	8.3	9.1
T1042-GP030-005	5.0	8.2	8.7
T1042-GP031-002	2.0	8.3	9.0
T1042-GP031-005	5.0	8.3	9.0
T1042-GP032-002	2.0	8.3	9.1
T1042-GP032-005	5.0	8.2	9.3
T1042-GP033-002	2.0	8.3	8.8
T1042-GP033-005	5.0	8.6	8.7
T1042-GP033-010	10.0	8.7	8.9
T1042-GP033-015	15.0	8.3	9.1
T1042-GP033-020	20.0	7.9	8.9
T1042-GP033-025	25.0	8.5	9.4
T1042-GP033-030	30.0	8.2	8.7
T1042-GP034-002	2.0	8.0	9.0
T1042-GP034-005	5.0	8.1	8.8
T1042-GP034-010	10.0	8.1	9.1
T1042-GP034-015	15.0	8.2	9.2
T1042-GP034-020	20.0	8.3	9.1
T1042-GP034-025	25.0	8.2	9.0
T1042-GP034-030	30.0	8.3	8.9
T1042-GP035-002	2.0	8.1	8.6
T1042-GP035-005	5.0	8.2	8.8
T1042-GP036-002	2.0	8.2	9.1
T1042-GP036-005	5.0	8.8	9.4
T1042-GP037-002	2.0	8.1	9.0
T1042-GP037-005	5.0	8.2	8.3
T1042-GP038-002	2.0	8.1	8.6
T1042-GP038-005	5.0	8.4	8.8
T1042-GP039-002	2.0	8.0	8.5
T1042-GP039-005	5.0	7.9	8.7
T1042-GP039-010	10.0	8.1	8.5
T1042-GP040-002	2.0	8.1	8.4
T1042-GP040-005	5.0	8.6	8.6
T1042-GP040-010	10.0	8.4	9.0
T1042-GP040-015	15.0	8.2	9.0
T1042-GP040-020	20.0	8.2	9.4
T1042-GP040-025	25.0	8.2	8.9
T1042-GP040-030	30.0	8.1	8.6

Notes:

Samples analyzed by SNL/NM ERFO Laboratory (Bldg. 6540) using ASTM D-4972 (Lewis 1995).

Table 5
Summary of ER Site 42 Metals Data (mg/kg)

Analyte	Range of Concentrations at ER Site 42	Percent Nondetect at ER Site 42	TA-I Background Soils UTL/95 Concentration (20 ft Depth) ^a	Sitewide Background Soils UTL/95 Concentration (Subsurface) ^a
ALUMINUM	2910 - 6820	0.0	12055.07	NA
ANTIMONY	ND (<2.1) - 4.5	95.2	0.79	3.90
ARSENIC	ND (<0.3) - 8.5	4.8	4.24	4.40
BARIUM	44 - 701	0.0	225.63	336.00
BERYLLIUM	ND (<0.2) - 0.32	14.3	0.57	0.80
CADMIUM	ND (<0.49) - 0.66	97.6	0.84	0.90
CALCIUM	15600 - 154000	0.0	42228.01	NA
CHROMIUM	2 - 10.3	0.0	12.42	12.80
COBALT	2.5 - 8.8	0.0	5.77	8.80
COPPER	ND (<0.4) - 28.3	2.4	9.98	88.20
CYANIDE, TOTAL	ND (<0.5) - 0.33	21.4	0.42	NA
IRON	4740 - 14100	0.0	17803.43	NA
LEAD	ND (<3.1) - 8.3	45.2	7.26	11.20
MAGNESIUM	2580 - 8320	0.0	6080.19	NA
MANGANESE	55.3 - 293	0.0	274.00	NA
MERCURY	ND (<0.02) - 0.051	95.2	0.14	<0.1
NICKEL	3.4 - 518	0.0	42.43	25.40
POTASSIUM	490 - 1620	0.0	2173.17	NA
SELENIUM	ND (<0.5) - 1.4	78.6	0.68	<1
SILVER	ND (<0.3) - 0.49	97.6	NA	<1
SODIUM	ND (<105.0) - 457	19.0	1267.86	NA
THALLIUM	ND (<1.0)	100.0	2.04	<1.1
VANADIUM	13.8 - 43.6	0.0	34.94	42.80
ZINC	10.7 - 35.6	0.0	40.50	82.40

~~NA - not applicable.~~
 ND - not detected.

Table 5
Summary of ER Site 42 Metals Data (mg/kg)

Analyte	Proposed Subpart S Action Level ^a	Percent of Samples Exceeding TA-I Background Concentrations	Percent of Samples Exceeding Sitewide Background Concentrations	Percent of Samples Exceeding Proposed Subpart S Action Levels
ALUMINUM	NA	0.0	0.0	NA
ANTIMONY	30	4.8	2.4	0.0
ARSENIC	20	21.4	21.4	0.0
BARIUM	6000 ^b	23.8	11.9	0.0
BERYLLIUM	0.2	0.0	0.0	30.1
CADMIUM	80 ^c	0.0	0.0	0.0
CALCIUM	NA	45.2	NA	NA
CHROMIUM	400 ^d	0.0	0.0	0.0
COBALT	NA	4.8	0.0	NA
COPPER	NA	4.8	0.0	NA
CYANIDE, TOTAL	2000	0.0	0.0	0.0
IRON	NA	0.0	NA	NA
LEAD	400 ^e	2.4	0.0	0.0
MAGNESIUM	NA	16.7	NA	NA
MANGANESE	400 ^f	4.8	NA	0.0
MERCURY	20 ^g	0.0	0.0	0.0
NICKEL	2000	9.5	11.9	0.0
POTASSIUM	NA	0.0	NA	NA
SELENIUM	400	21.4	11.9	0.0
SILVER	400	NA	0.0	0.0
SODIUM	NA	0.0	NA	NA
THALLIUM	NA	0.0	0.0	NA
VANADIUM	600 ^h	21.4	4.8	0.0
ZINC	20000	0.0	0.0	0.0

Notes:

ND = Nondetect; detection limit is provided in parenthesis.

NA = Not available.

a) TA-I background (SNL/NM 1996); Sitewide background (IT Corp. 1996); Proposed Subpart S (IT 1994).

b) Action level is provided for ionic barium.

c) Action level is provided for cadmium (food).

d) Action level is provided for the more restrictive chromium (VI); chromium (III) has an action level of 8000 mg/kg.

e) Action level provided for lead is from EPA 1994.

f) Action level is provided for the more restrictive manganese (water); manganese (food) has an action level of 10000 mg/kg.

g) Action level is provided for inorganic mercury.

h) Action level is provided for metallic vanadium.

APPENDIX E

ER SITE 42: RISK ASSESSMENT ANALYSIS

ER SITE 42: RISK ASSESSMENT ANALYSIS

I. Site Description and History

The Building 870 Water Treatment Facility, Environmental Restoration (ER) Site 42 is located north of Building 870 on the south side of L Street and east of 15th Street in the east-central part of Technical Area I (TA-I). The site covers approximately one-half acre and consists of soil beneath several existing chemical holding tanks and open areas where documented spills flowed across the land surface. The holding tanks supplied chemicals for microelectronics operations in Building 870.

Three documented releases of chemicals occurred at this site. The first release occurred on 21 November 1983, when approximately 1,000 gal of 30-percent hydrochloric acid spilled onto the surrounding ground surface. The second release occurred on 4 November 1984, when approximately 200 gal of 20-percent Sodium Hydroxide (NaOH) solution was released onto the ground surface over a two-hour period. The third release occurred in the early 1980s (exact date unknown). That release involved a failure of the initial acid neutralization system allowing untreated or partially treated solutions containing acids (primarily hydrofluoric), bases, and dilute solvents (acetone, butyl acetate, trichloroethylene, etc.) to flow directly into the soil. Potential constituents of concern (COCs) include acids, bases, a variety of metals, and volatile organic compounds (VOCs) that may have been associated with the solutions. Although historical information does not indicate the release of any metals, the potential exists for metals that were associated with processes in the microelectronics operations.

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.

Step 3. The potential intake of these COCs by the representative population is calculated using a tiered approach. The tiered approach includes screening steps, followed by potential intake calculations and a discussion or evaluation of the uncertainty in those calculations. Potential intake calculations are also applied to background screening data.
Step 4. Data are described on the potential toxicity and cancer effects from exposure to the COCs and associated background constituents and their respective subsequent intake.
Step 5. Potential toxicity effects (specified as a Hazard Index) and cancer risks are calculated for both COCs and background.
Step 6. Potential COC values are compared with standards established by the United States (U.S.) Environmental Protection Agency (USEPA) to determine if further evaluation, and potential site clean-up, is required. COC risk values are also compared to background risk so that an incremental risk may be calculated.
Step 7. Discussion of uncertainties in the previous steps.

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 42 Data Evaluation Report and the No Further Action Proposal (NFA). Chemicals that are essential nutrients such as iron, magnesium, calcium, potassium and sodium were not included in this risk assessment (USEPA 1989a). 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. The site is a nonradioactive site and thus only nonradioactive COCs were sampled for and evaluated. The evaluated nonradioactive parameters are all inorganics; all reported organics (acetone and methylene chloride) were determined to be laboratory contaminants.

II.2 Step 2. Pathway Identification

ER Site 42 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 is included because of the potential for dust inhalation. No contamination at depth was detected or expected and therefore no pathways to the groundwater are considered appropriate. Depth to groundwater beneath Site 42 is approximately 550 feet. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered insignificant. No intake routes through plant, meat, or milk ingestion

are considered appropriate for the industrial land-use scenario. However, plant uptake is considered for the residential land-use scenario.

II.3 Steps 3-5. Exposure Assessment and Risk Characterization

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 42 were evaluated using a tiered approach. First, the maximum concentrations of COCs were compared to TA-I specific background screening levels using 95th 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). The maximum concentration of each COC was used in order to provide a conservative estimate of the associated risk. If any COCs were above both the TA-I and SNL/NM background screening levels or the USGS background value, all COCs were considered in further risk assessment analyses.

Second, the maximum COC concentrations were 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. Accordingly, all calculations were based on the assumption that receptor doses from both toxic and potentially carcinogenic compounds result most significantly from ingestion of contaminated soil. Because the samples were all taken from the surface or near-surface, this assumption is considered valid. 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. Otherwise the COCs would continue in further risk assessment analyses. 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 COCs in the soils were calculated. The combined effects of all associated background constituents in the soils were also calculated. The most conservative background concentration

between TA-I specific and SNL/NM concentration (minimum value of the 95th percentile or UTL as applicable) was used in the risk calculation. For toxic compounds, the combined effect was determined 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} . Incremental risk was then determined between the COCs and associated background.

II.3.1 Comparison to Background and Action Levels

ER Site 42 COCs are listed in Table 1, along with the 95th percentile or UTL background levels (SNL/NM, 1996; IT, 1996). The TA-I background levels have not yet been approved by the USEPA or the New Mexico Environment Department (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 also have not yet been approved, 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 SNL/NM report was submitted for regulatory review in early 1996. The SNL/NM 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 had maximum measured values greater than background screening levels. Therefore all COCs were retained for further analysis with the exception of lead. The maximum concentration value for lead is 8.3 (J) mg/kg. The USEPA intentionally does not provide any toxicological data on lead and therefore no risk parameter values can be calculated. However, EPA guidance for the screening value for lead for an industrial land-use scenario is 2000 mg/kg (EPA, 1996a); for a residential land-use scenario, the EPA screening guidance value is 400 mg/kg (EPA, 1994a). The maximum concentration value for lead at this site is less than both of those screening values and therefore lead is eliminated from further consideration in this risk assessment.

Because several 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 COCs proceed to the proposed Subpart S action level screening procedure. However, since there were more than 10 COCs, the proposed Subpart S screening procedure was skipped. All COCs must have a Hazard Index value and cancer risk value calculated.

Table 1. COCs at ER Site 42 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	6,820	12,055	Yes		
Antimony	4.5 J	0.79	No	3.90	No
Arsenic	8.5	4.2	No	4.40	No
Barium	701	226	No	336	No
Beryllium	0.32	0.57	Yes		
Cadmium	0.66	0.84	Yes		
Chromium*	10.3	12.4	Yes		
Cobalt	8.8	5.8	No	8.8	Yes
Copper	28.3	10.0	No	88.2	Yes
Cyanide, total	0.33 JB	0.42	Yes		
Lead	8.3 J	7.3	No	11.2	Yes
Manganese	293	274	No	831 ⁺	Yes
Mercury	0.051 J	0.14	Yes		
Nickel	518	42.4	No	25.4	No
Selenium	1.4	0.68	No	<1	No
Silver	0.49	NC	No	<1 [^]	No
Thallium	<0.5	2.0	Yes		
Vanadium	43.6	34.9	No	42.8	No
Zinc	35.6	40.5	Yes		

NC - not calculated

+ Regional background values from the USGS NURE Program (USGS, 1994).

J - estimated value

B - parameter detected in method blank

* chromium assumed to chromium III (most conservative - lowest UTL)

[^] uncertainty due to detection limits

II.3.2 Identification of Toxicological Parameters

Table 2 shows the COCs that have been retained in the risk assessment and the values for the toxicological information available for those COCs.

II.3.3 Exposure Assessment and Risk Characterization

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

II.3.3.1 Exposure Assessment

Appendix 1 shows the general 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 default parameters for both industrial and residential land-use scenarios. The equations are based on RAGS (USEPA, 1989a). The parameter values are based on information from RAGS (USEPA, 1989a) as well as other USEPA guidance documents and reflect the RME approach advocated by RAGS (USEPA, 1989a).

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

II.3.3.2. Risk Characterization

Table 3 shows that for the ER Site 42 COCs, the Hazard Index value is 0.2 and the excess cancer risk is 6×10^{-6} for the designated industrial land-use scenario. The numbers presented included exposure from soil ingestion and dust inhalation for the ER Site 42 COCs. Table 4 shows that for the ER Site 42 associated background constituents, the Hazard Index is 0.08 and the excess cancer risk is 4×10^{-6} for the designated industrial land-use scenario.

For the residential land-use scenario, the Hazard Index value increases to 6 and the excess cancer risk is 9×10^{-5} . The potential pathways considered for this calculation includes both soil ingestion, dust 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. Table 4 shows that

Table 2. Toxicological Parameter Values

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*	0.005	--	L	--	42	A
Cobalt	0.06	--	--	--	--	--
Copper	0.04	--	Est.	--	--	D
Cyanide, total	0.02	--	M	--	--	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

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 Tables 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

* chromium assumed to be chromium VI (most conservative)

Table 3. Risk Assessment Values for ER Site 42 COCs.

COC Name	Maximum concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Aluminum	6820	0.01	--	0.03	--
Antimony	4.5 J	0.01	--	0.21	--
Arsenic	8.5	0.03	5E-06	0.49	9E-05
Barium	701	0.01	--	0.11	--
Beryllium	0.32	0.00	6E-07	0.00	3E-06
Cadmium	0.66	0.00	3E-10	0.54	4E-10
Chromium*	10.3	0.00	3E-08	0.01	4E-08
Cobalt	8.8	0.00	--	0.00	--
Copper	28.3	0.00	--	0.13	--
Cyanide, total	0.33 JB	0.00	--	0.00	--
Manganese	293	0.06	--	2.59	--
Mercury	0.051 J	0.00	--	0.09	--
Nickel	518	0.03	--	0.76	--
Selenium	1.4	0.00	--	0.49	--
Silver	0.49	0.00	--	0.02	--
Thallium	<0.5	--	--	--	--
Vanadium	43.6	0.01	--	0.03	--
Zinc	35.6	0.00	--	0.06	--
TOTAL		0.2	6E-06	6	9E-05

-- information not available

J - estimated value

* chromium assumed to be chromium VI (most conservative)

Table 4. Risk Assessment Values for ER Site 42 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	0.79	0.00	--	0.04	--
Arsenic	4.2	0.01	3E-06	0.24	5E-05
Barium	226	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*	12.4	0.00	3E-08	0.01	5E-08
Cobalt	5.8	0.00	--	0.00	--
Copper	10.0	0.00	--	0.04	--
Cyanide, total	0.42	0.00	--	0.00	--
Manganese	274	0.06	--	2.42	--
Mercury	0.14	0.00	--	0.24	--
Nickel	25.4	0.00	--	0.00	--
Selenium	0.68	0.00	--	0.24	--
Silver	<1.0	--	--	--	--
Thallium	<1.1	--	--	--	--
Vanadium	34.9	0.00	--	0.03	--
Zinc	40.5	0.00	--	0.07	--
TOTAL		0.08	4E-06	4	6E-05

-- information not available

J - estimated value

* chromium background concentration assumed to be chromium III (most conservative - lowest UTL), risk calculated in terms of chromium VI (consistent with Table 3)

for the ER Site 42 associated background constituents, residential land-use scenario, the Hazard Index increases to 4 and the excess cancer risk is 6×10^{-5} .

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 potential COCs for both an industrial land-use scenario, which is the designated land-use for this site, and also a residential land-use scenario.

For the industrial land-use scenario, the Hazard Index calculated is 0.2. This value is significantly less than the numerical standard of 1 suggested in RAGS (USEPA, 1989a). The excess cancer risk is estimated at 6×10^{-6} . 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 low end of the suggested acceptable risk range. Therefore, for an industrial land-use scenario, the risk assessment values for non-carcinogenic parameters are less than the established numerical standards and the potentially carcinogenic COC (arsenic) is in the low end of the suggested acceptable risk range. This risk assessment also determined risks considering background concentrations of the potential COCs for both the industrial and residential land-use scenarios. For the industrial land-use scenario, the Hazard Index is 0.08. The excess cancer risk is estimated at 4×10^{-6} . Incremental risk is determined from subtracting risk associated with background from potential COC risk. These numbers are not rounded before the difference is determined and therefore may appear to be inconsistent with numbers presented in tables and within the text. The incremental Hazard Index is 0.08 and the incremental cancer risk is 1.6×10^{-6} for the industrial land-use scenario.

For the residential land-use scenario, the calculated Hazard Index is 6. This value is greater than the numerical standard of 1. The excess cancer risk is estimated at 9×10^{-5} ; this value is in the upper end of the accepted risk range. Therefore, for a residential land-use scenario, the risk assessment values for non-carcinogenic parameters are greater than the established numerical standards and the potentially carcinogenic COC (arsenic) is in the upper end of the suggested acceptable risk range. The Hazard Index for the associated background concentrations of the potential COCs is 4. The excess cancer risk is estimated at 6×10^{-5} . For the residential land-use scenario, the incremental Hazard Index is 1.5 and the incremental cancer risk is 3.8×10^{-5} .

II.5 Step 7 Uncertainty Discussion

The conclusion from the risk assessment analysis is that the potential effects caused by potential COCs on human health are within the acceptable range compared to established numerical standards for the industrial land-use

scenario. Calculated incremental risk between potential COCs and associated background indicate small contribution of risk from COCs when considering the industrial land-use scenario.

Although the maximum arsenic concentration (8.5 mg/kg) exceeds the calculated UTL, it is within the range of arsenic concentration values measured in the SNL/NM background study and may be part of background. Therefore, this risk assessment is conservative as arsenic is a significant contributor to both the Hazard Index and the excess cancer risk when considering the industrial land-use scenario.

The potential effects on human health are greater when considering the residential land-use scenario. Incremental risk between potential COCs and associated background also indicate a significant contribution of risk from the 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 Site 42 is mostly covered by asphalt and concrete, the likelihood of significant plant uptake in this area is highly unlikely as is the likelihood that this site will be residential in the near future (USDOE, 1996). The uncertainty in this conclusion is considered to be small.

Because of the location, history of the site, and the future land-use (USDOE, 1996), there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in the making the risk assessment analysis. Because the COCs are found in 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.

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 2 shows the uncertainties (confidence) in the toxicological parameter values. There is a mixture of estimated values and values from the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1996b) and Integrated Risk Information System (IRIS) (USEPA, 1988 and 1994b) data bases. Where values are not provided, information is not available from HEAST, IRIS or

USEPA regions. Because of the conservative nature of the RME approach, the uncertainties in the toxicological values are not expected to be of high enough concern to change the conclusion from the risk assessment analysis.

The overall uncertainty in all of the steps in the risk assessment process is considered not significant with respect to the conclusion reached.

III. Summary

The Building 870 Water Treatment Facility, ER Site 42, had relatively minor contamination consisting of some inorganic nonradioactive 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 include soil ingestion and dust inhalation for the industrial land-use scenario and inhalation, ingestion, and plant uptake for the residential land-use scenario. Because this site is located in SNL/NM's TA-I, this site is expected to have an industrial land-use for the foreseeable future (USDOE, 1996); the residential land-use scenario is provided for perspective only.

Using conservative assumptions and employing a RME approach to the risk assessment, the calculations show that for the industrial land-use scenario, the Hazard Index (0.2) is significantly less than the accepted numerical standard of 1 from the USEPA. The estimated cancer risk (6×10^{-6}) is in the low end of the suggested USEPA acceptable risk range. The maximum arsenic concentration (8.5 mg/kg) is within the range of arsenic concentration values measured in the background study and may be part of background. Therefore, this risk assessment is conservative as arsenic is a significant contributor to both the Hazard Index and the estimated cancer risk for the industrial land-use. The incremental Hazard Index is 0.08 and the incremental cancer risk is 1.6×10^{-6} for the industrial land-use scenario. Incremental risk calculations indicate insignificant contribution to risk from the COCs considering an industrial land-use scenario.

Calculation of the Hazard Index for a residential land-use scenario (6) is above the numerical standard of 1. The estimated cancer risk (9×10^{-5}) is in the upper end of the acceptable risk range. The majority of the risk for the residential land-use scenario is associated with the inclusion of the plant uptake exposure pathway. Constituents that posed little to no risk considering an industrial land-use scenario (some of which are below background screening levels), contribute a significant portion of the risk associated with the residential land-use scenario. These constituents bioaccumulate in plants. For the residential land-use scenario, the incremental Hazard Index is 1.5 and the incremental cancer risk is 3.8×10^{-5} . Increased incremental risk from the COCs was evident considering

residential land-use, due to plant uptake, but future use will be restricted to industrial land-use (USDOE, 1996).

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

Ecological Risk Assessment

It is unlikely that activities or COCs at ER Site 42 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).

IV. References

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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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