MKM Engineers, Inc.

FINAL REPORT

FINAL REPORT FOR THE PHASE I REMEDIAL INVESTIGATION AT LOAD LINE 6 (RVAAP 33)

Ravenna Army Ammunition Plant
8451 State Route. 5
Ravenna, Ohio 44266

Prepared for:

US Army Joint Munitions Command (JMC)
Rock Island, Illinois 61299-6000

Prepared By:

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4153 Bluebonnet Drive
Stafford, TX 77477

Contract No. DAAA09-02-C-0036

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LIST OF ACRONYMS

95% UCL–L	log–normal 95% upper confidence level
95% UCL–N	normal 95% upper confidence level
AET	apparent effects threshold
ABS_{GI}	gastrointestinal absorption fraction
amsl	above mean sea level
AOC	area of concern
AST	above–ground storage tank
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	ambient water quality criteria
BCF	bioconcentration factor
BERA	baseline ecological risk assessment
bgs	below ground surface
BHHRA	baseline human health risk assessment
BRACD	Base Realignment and Closure Division
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
C	Celsius
CDI	chronic daily intake
cm/s	centimeter(s) per second
COC	chemical of concern
COPC	chemical of potential concern
CSF	cancer slope factor

1	CSM	conceptual site model
2	DDE	dichlorodiphenyldichloroethylene
3	DLF	dust loading factor
4	DoD	Department of Defense
5	DQO	data quality objective
6	Eco–SSL	ecological soil screening level
7	EDQL	ecological data quality level
8	EEQ	estogenic equivalent
9	Eh	oxidation–reduction potential
10	EPC	exposure point concentration
11	ESL	ecological screening level
12	ESV	ecological screening value
13	F	Fahrenheit
14	F_{oc}	fraction of organic carbon
15	ft	foot or feet
16	FWSAP	Facility-Wide Sampling and Analysis Plan
17	GAF	gastrointestinal absorption factor
18	GOCO	government–owned, contractor–operated
19	GPD/ft	gallon(s) per day per foot
20	GPM	gallon(s) per minute
21	GPL	General Physics Laboratories
22	HI	hazard index
23	HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine

HQ	hazard quotient
HSA	hollow–stem auger
IDW	investigation–derived waste
ILCR	incremental lifetime cancer risk
in	inch or inches
IRP	Installation Restoration Program
IRIS	Integrated Risk Information System
JMC	Joint Munitions Command
Kd	soil–water distribution coefficient
K_{oc}	organic carbon partition coefficient
K_{ow}	octanol/water partition coefficent
km	kilometer(s)
L	liter(s)
LL	load line
LOAEL	lowest–observed–adverse–effect level
LOEC	lowest–observed–effect concentration
LPD/m	liter(s) per day per meter
LPM	liter(s) per minute
m	meter(s)
MCL	maximum contaminant level
MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
mg/L	milligrams per liter

1	mg/m^3	milligrams per cubic meter
2	MI	mobility index
3	MKM	MKM Engineers, Inc.
4	ml/g	milliliters per gram
5	mm	millimeter(s)
6	mph	miles per hour
7	MS/MSD	matrix spike/matrix spike duplicate
8	MW	monitoring well
9	NAAQS	National Ambient Air Quality Standards
10	NAPL	non–aqueous phase liquids
11	nc	non–carcinogenic
12	NCEA	National Center for Environmental Assessment
13	NO_3	nitrate
14	NOAEL	no–observed–adverse–effect level
15	NOEC	no–observed–effect concentration
16	NTU	Nephelometric Turbidity Unit
17	NWS	National Weather Service
18	Ohio EPA	Ohio Environmental Protection Agency
19	OHARNG	Ohio Army National Guard
20	OMZM	outside mixing zone maximum
21	PAH	polycyclic aromatic hydrocarbon
22	PBT	persistent, bioaccumulative, and toxic
23	PCB	polychlorinated biphenyl

PEC	probable effects concentration
PEF	particulate emission factor
PETN	pentaerythritol tetranitrate
pH	Measurement used to express the intensity of the acid or alkaline condition of a solution
PM10	particulate matter ≤10 microns in diameter
PPRTV	peer–reviewed toxicity value
PRG	preliminary remediation goal
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QCSR	Quality Control Summary Report
RAGS	Risk Assessment Guidance for Superfund
RBSC	risk–based screening concentration
RCRA	Resource Conservation and Recovery Act
RDA	recommended daily allowance
RDI	recommended daily intake
RDF	regional disposal facility
RDX	hexahydro–1,3,5–trinitro–1,3,5–triazine
RfC	reference concentration
RfD	reference dose
RGO	remedial goal option

1	RI	remedial investigation
2	RME	reasonable maximum exposure
3	RRSE	Relative Risk Site Evaluation
4	RTLS	Ravenna Training and Logistics Site
5	RVAAP	Ravenna Army Ammunition Plant
6	SAIC	Science Applications International Corporation
7	SdSL	sediment screening level
8	SDWA	Safe Drinking Water Act
9	SERA	Screening Ecological Risk Assessment
10	SQG	soil quality guideline
11	SRC	site related chemical
12	SRV	sediment reference value
13	SSL	soil screening levels
14	SSSL	shallow soil screening level
15	STL	Severn Trent Laboratories, Inc.
16	STSC	Superfund Health Risk Technical Support Center
17	SVOC	semi–volatile organic compound
18	SWSL	surface water screening level
19	TAL	target analyte list
20	TCE	trichloroethene
21	TEC	threshold effect concentration
22	TNT	2,4,6–trinitrotoluene
23	TOC	total organic carbon

1	TRV	toxicity reference value
2	TSCA	Toxic Substances Control Act
3	UCL	upper confidence level
4	µg/kg	micrograms per kilogram
5	µg/L	micrograms per liter
6	USACE	U.S. Army Corps of Engineers
7	USAEC	U.S. Army Environmental Command
8	USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
9	USEPA	U.S. Environmental Protection Agency
10	USP&FO	U.S. Property and Fiscal Officer
11	UTL	upper tolerance limit
12	UXO	unexploded ordnance
13	VF	volitization factor
14	VOC	volatile organic compound
15	WBG	Winklepeck Burning Grounds
16	WQC	water quality criteria

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EXECUTIVE SUMMARY

This Phase I Remedial Investigation (RI) Report characterizes the nature and extent of contamination, evaluates the fate and transport of contaminants, and assesses the potential risk to human health and the environment resulting from past operations at Load Line 6 (LL–6), also known as RVAAP–33, at the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio.

This RI Report fulfills the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) at RVAAP. This information will be used in conjunction with other reports to prioritize environmental restoration at installation areas of concern (AOCs) on the basis of their relative potential threat to human health. The specific objectives of the RI were to:

- Define the vertical and horizontal extent of contamination at LL–6;
- Define potential transport pathways and receptor populations;
- Gather sufficient data to conduct a Baseline Human Health Risk Assessment (BHHRA) and a Screening Ecological Risk Assessment (SERA); and
- Provide sufficient data for the selection of remedial action alternatives.

To fulfill these objectives, field investigations were conducted in March 2002 and October to December 2003. During the field investigations, samples were collected from surface soils, subsurface soil borings, surface water, sediments, and groundwater. Samples were analyzed for possible contamination resulting from the production of artillery fuzes, fulminate mixing, and research and development of various types of charges (i.e., shaped, fragmenting disc, etc.) for armor penetration. Target analytes included explosives, propellants, metals, nitrates, cyanide, sulfides, semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), and polychlorinated biphenyls (PCBs). The surface and subsurface soils, groundwater, surface water, and sediment results are summarized for each matrix.

Surface Soils (0-1 ft below ground surface [bgs])

One propellant (nitrocellulose), one explosive (octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine [HMX]), one PCB (aroclor 1254), SVOCs (including benzo[a]pyrene and bis[2-ethylhexyl]phthalate) and metals (including aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, vanadium, and zinc) were detected in surface soils at concentrations greater than RVAAP installation background (USACE, 2001b) concentrations, Region 9 residential soil preliminary remediation goals (PRGs), or both. Nitrocellulose was detected in five surface soil samples and one duplicate.

However, four of the six results were qualified as estimated (J), or (B) the concentration of nitrocellulose in the method blank was detected above the reporting limit, or both (B) (J).

Subsurface Soil (>1 ft bgs)

One propellant (nitrocellulose), one SVOC (benzo[a]pyrene), and metals (including aluminum, arsenic, barium, beryllium, cadmium, chromium, lead, and mercury) were detected at concentrations greater than RVAAP installation background criteria, Region 9 residential soil PRGs or both. Nitrocellulose was detected in five subsurface soil samples and one duplicate at concentrations above the method detection limit but below the reporting limit. However, the nitrocellulose results were qualified as estimated (J), or (B) the concentration of nitrocellulose in the method blank was detected above the reporting limit, or both (B) (J).

Groundwater

One propellant (nitrocellulose), two SVOCs (4–nitroaniline and bis[2–ethylhexyl] phthalate), and metals (including antimony, arsenic, copper, manganese, and selenium) were detected at concentrations greater than RVAAP installation background criteria, Region 9 tap water PRGs or both. Nitrocellulose was detected in five groundwater samples at concentrations above the method detection limit but below the reporting limit. However, the nitrocellulose results were qualified as estimated (J) and (B) the concentration of nitrocellulose in the method blank was detected above the reporting limit.

Surface Water

One propellant (nitrocellulose), two explosives (HMX and hexahydro–1,3,5–trinitro–1,3,5–triazine [RDX]), SVOCs (4-methylphenol), and metals (including aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, vanadium, and zinc) were detected at concentrations greater than RVAAP installation background criteria, Region 9 tap water PRGs or both. Nitrocellulose was detected in one surface water sample duplicate at a concentrations above the method detection limit but below the reporting limit. However, the nitrocellulose result was qualified as estimated (J) and (B) the concentration of nitrocellulose in the method blank was detected above the reporting limit.

Sediment

One propellant (nitrocellulose), one pesticide (4,4- dichlorodiphenyldichloroethylene [DDE]), one PCB (aroclor 1260), SVOCs (including 2-methylnaphthalene, benzo[a]pyrene, and bis[2-ethylhexyl]phthalate) and metals (including aluminum, arsenic, barium, beryllium, cadmium, chromium, lead, and mercury) were detected at concentrations greater than RVAAP installation background criteria, Region 9 residential soil PRGs or both. Nitrocellulose was detected in two sediment samples and one duplicate sample at concentrations above the method detection limit

but below the reporting limit. However, the nitrocellulose results were qualified as estimated (J) and (B) the concentration of nitrocellulose in the method blank was detected above the reporting limit.

Fate and Transport

The primary contaminant migration pathways for contaminants at LL–6 are:

- Leaching from soils to groundwater,
- Leaching from sediments to surface water,
- Leaching from sewer lines to groundwater, and
- Transport in surface drainage channels.

Baseline Human Health Risk Assessment (BHHRA)

A Baseline Human Health Risk Assessment (BHHRA) was performed to assess the current and potential future risks associated with human exposure to site-related contaminants found at LL–6. Future land uses assumed for this risk assessment included National Guard training, recreational hunting and fishing, and residential farming. Risks were evaluated for a National Guard trainee; a National Guard resident trainer; a hunter/trapper; a security maintenance worker; and a resident farmer (adult and child). The risk assessment demonstrated that some potential risks exist for the following receptors:

- National Guard resident trainer – HI>1; The total cancer risk estimate for the National Guard resident trainer exceeds USEPA target risk range of 1E-04 to 1E-06 only when the future domestic use of the shallow groundwater resource is evaluated. The total cancer risk estimate exceeds Ohio Environmental Protection Agency's (Ohio EPA) target risk value of 1E-05; however, arsenic is the only contributor to risk exceedance.
- National guard trainee – HI=1; The total carcinogenic risk estimate is within USEPA target risk range of 1E-04 to 1E-06. However, Ohio EPA's target of 1E-05 is exceeded if shallow groundwater is used for domestic purposes (arsenic is the only contributor).
- Adult resident farmer – HI>1; The total non-cancer risk estimate exceeds the USEPA target risk range (1E-04 to 1E-06) and Ohio EPA's target risk (1E-05) if it is assumed the receptor is using the shallow groundwater for domestic purposes and if the ingestion of foodstuffs is evaluated (arsenic is the primary contributor to risk).
- Child resident farmer – HI>1; The target-organ specific total non-cancer risk estimate is greater than one for direct exposure if it is assumed that groundwater is used for domestic purposes. The total non-cancer risk estimate equals one (HI=1) for arsenic's target organs when direct exposure to media other than groundwater is evaluated. The

total non-cancer risk estimate is greater than one (HI>1) for indirect exposure via the ingestion of vegetables (arsenic is the primary contributor to risk).

- Lifelong resident farmer – The total cancer risk estimate exceeds the USEPA target risk range and Ohio EPA's target risk value for direct exposure only if it is assumed that the shallow groundwater is exposed to sediment and used for domestic purposes (arsenic is primary contributor to risk).

Several significant uncertainties associated with the risk assessment were identified (as outlined in Section 6.7) and must be considered when making risk management decisions for LL–6. A significant uncertainty is the fact that the nature and extent of the contamination in soil, sediment, surface water, and groundwater at LL-6 have not been completely defined. Therefore, the results of the human health risk assessment are preliminary and subject to change based on the data collected in the Phase II RI.

Screening Ecological Risk Assessment (SERA)

A Screening Ecological Risk Assessment (SERA) was performed to assist in identifying potential ecological risks and to assess whether ecological impacts are present at LL–6 as a result of site-related contaminants detected. Ecological impact was evaluated for plants, soil and sediment invertebrates, aquatic organisms, and terrestrial wildlife. The ecological risk calculations showed that aluminum, copper, iron, lead, and zinc were retained as chemicals of potential concern (COPCs) for aquatic organisms in surface water. However, the drainage ditches and pond at LL–6 provide poor ecological habitats. Based on these factors, it does not appear that the site needs further Baseline Ecological Risk Assessment (BERA) because of metals in surface water. However, the nature and extent of the contamination in soil, sediment, surface water, and groundwater at LL–6 have not been determined. Therefore, the results of the ecological risk assessment are preliminary and subject to change based on the data collected in the Phase II RI.

Conclusions

Contaminants in surface soil, subsurface soil, and sediments were detected at concentrations greater than the RVAAP installation background concentrations, Region 9 residential soil PRGs, or both. The lateral and vertical extent of contamination including explosives, propellants, metals, and SVOCs in surface soils, subsurface soil, and sediments were not fully delineated during the Phase I RI. In addition, the presence of metals and SVOCs in groundwater and surface water at concentrations greater than RVAAP-specific background criteria (USACE, 2001b) indicate that contamination present in soils and sediment may be leaching into surface water and groundwater.

The total cancer risk estimate (summarized for each receptor and each media) for the primary receptor of concern (the National Guard trainee) equals 3E-05, and only the cancer risk

estimate developed for ingestion of arsenic in groundwater (assuming domestic use) exceeds 1E-05. The total non–cancer risk hazard index (HI) estimate (summarized for each receptor and each media) equals 1.0, but HIs calculated for other target organs and COPCs do not exceed unity. However, significant uncertainties were identified for the risk estimates for arsenic in groundwater and for the inhalation pathway and should be considered by the risk management team for RVAAP when making further remedial decisions for LL–6.

The total cancer risk estimate (summarized for each receptor and each media) for the National Guard resident trainer exceeds 1E-04 only when the future domestic use of the shallow groundwater resource is evaluated. The total HI (summarized for each receptor and each media) for the trainer exceeds 1.0 for the future domestic use of the shallow groundwater resource and for exposure to surface water. Cancer risk estimates and HIs for all other media do not exceed 1E-04 and 1.0, respectively. As noted above, significant uncertainties were identified for the risk estimates for arsenic in groundwater and should be considered by the risk management team for RVAAP when making further remedial decisions for LL–6.

The total cancer risk estimate (summarized for each receptor and each media) for the hypothetical future resident farmer exposed by the direct contact exposure pathways exceeds 1E-04 only when future domestic use of the shallow groundwater resource is evaluated. Cancer risk estimates for soils and sediments evaluated for the direct contact exposure pathways exceed 1E-05 but do not exceed 1E-04. Total non-cancer risk estimates (HI) calculated on a target-organ-specific basis exceed 1.0 only when future domestic use of the shallow groundwater resource is evaluated for the adult farmer. For the child farmer, total HI calculated on a target-organ-specific basis exceed 1.0 when future domestic use of the shallow groundwater resource is evaluated and equal 1.0 for arsenic's target organs when direct exposure to media other than groundwater are evaluated. However, cancer and non–cancer risk estimates developed for the indirect–exposure pathways exceed both cancer and non–cancer risk benchmarks (i.e., 1E-04 and HI = 1, respectively) for consumption of homegrown foodstuffs (vegetables). Significant uncertainties were identified for the risk estimates for arsenic in groundwater and for the evaluation of the indirect exposure pathways and should be considered by the risk management team for RVAAP when making further remedial decisions for LL–6.

Ecological risks at LL–6 are unlikely. Based on the Step 3a refinement procedure, it was determined that site-related risks were not great enough to proceed with the ecological risk assessment process.

Recommendations

Concentrations of target analytes (primarily explosives, metals, SVOCs, and propellants) were detected in surface soil, subsurface soil, and sediment samples at concentrations exceeding RVAAP installation background (USACE, 2001b) concentrations, Region 9 residential soil

PRGs, or both. Most of the contaminants (except for metals) were detected in very few samples and there are insufficient occurrences to provide statistically valid analysis for contaminant distribution. Therefore, the nature and extent of the contamination in soil, sediment, surface water and groundwater at LL–6 have not been fully determined and additional sampling is necessary to fully identify the lateral and vertical extent of the contamination at LL–6.

The conclusions of the risk assessments are based on available data. If data collected in the Phase II RI alters the conceptual site model presented in this Phase I RI, then the risk assessment findings presented in this report will require revision. Although the BHHRA indicated potential risk to a National Guard trainee because of exposure to arsenic in groundwater, conservative toxicity and exposure values were used to calculate the potential risk. Therefore, the risk estimates presented for arsenic likely overestimate the potential for non-carcinogenic risk. Additionally, the arsenic concentrations detected in the environmental media may represent RVAAP installation background conditions. It is recommended that the risk management team consider the need for any further remedial action based on the risk assessment results presented for this receptor.

No additional action is recommended based on ecological risk because, based on the Step 3a refinement protocol, it was determined that site-related risks were not great enough to warrant proceeding further into the ecological risk assessment process.

1.0 INTRODUCTION

This report documents the results of the Phase I Remedial Investigation (RI) conducted at Load Line 6 (LL–6) by MKM Engineers, Inc. (MKM) under Contract Number DAAA09–98–G–0001/DAAA09–02–C–0070. LL–6 is located at the U. S. Army Base Realignment and Closure Division (BRACD) Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio (Figure 1–1). The RI was conducted under the U.S. Department of Defense (DoD) Installation Restoration Program (IRP) and performed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The RI was conducted in accordance with work plans reviewed and approved by the Ohio Environmental Protection Agency (Ohio EPA) (MKM, 2003a).

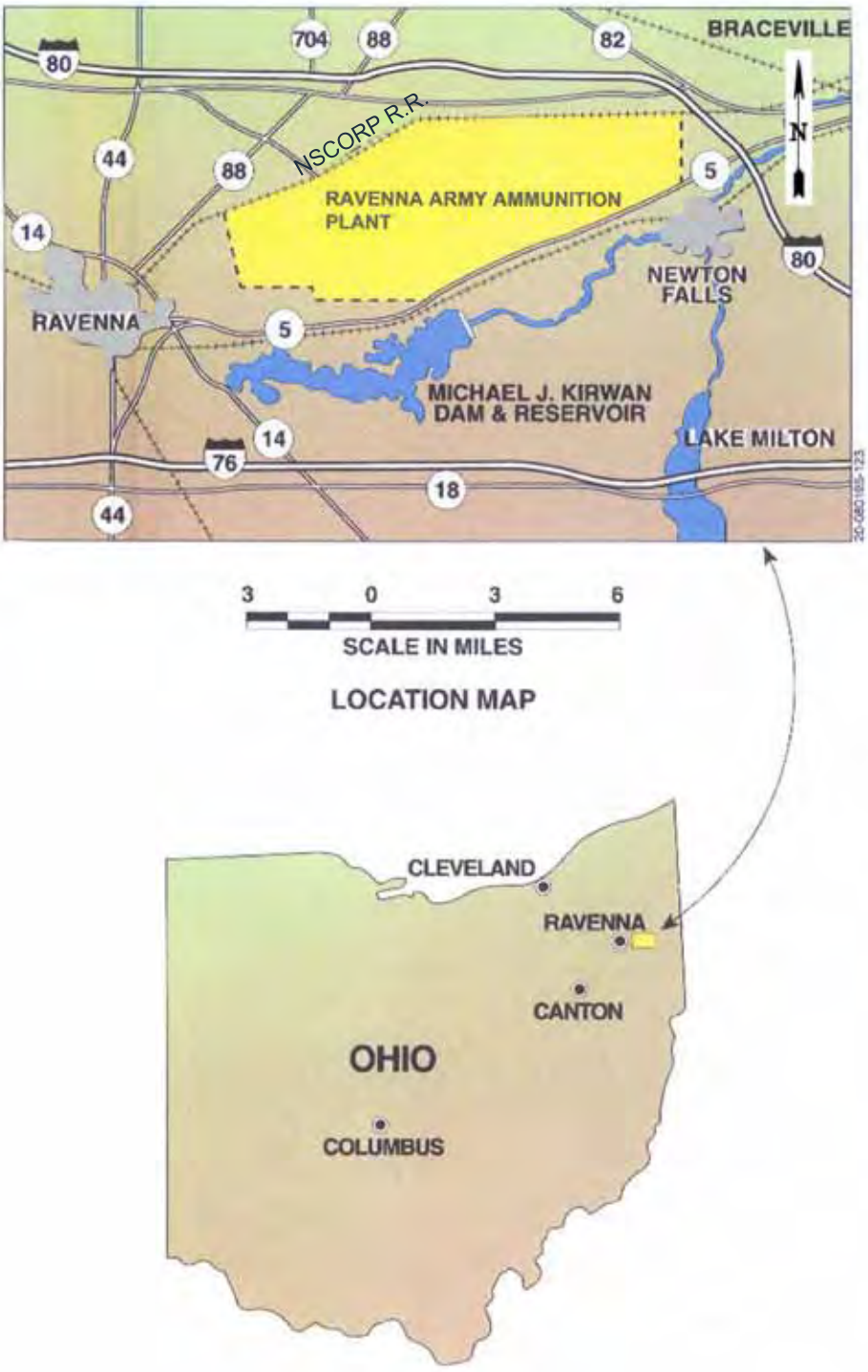
This document summarizes the results of the field activities conducted during March 2002 (azide screening) and the RI conducted from October 2003 to December 2003 at LL–6. The environmental setting, fieldwork, nature, and extent of contamination are discussed. Human health and ecological risk assessments were performed as part of the RI. Results of the data analysis and risk assessments have been used to develop a revised conceptual model for LL–6. The conclusions and recommendations of the RI form the framework for decisions regarding future remedial actions at LL–6.

1.1 Purpose and Scope

The purposes of this RI Report are to (1) describe the investigations conducted at RVAAP LL–6; (2) evaluate and identify the environmental impact posed by past DoD industrial operations; (3) determine if there is contamination that poses a risk; or exceeds a preliminary remediation goal (PRG); (cleanup criteria established by the United States Environmental Protection Agency [USEPA])". The specific objectives of the RI are to:

- Characterize the physical environment of LL–6 and its surroundings to the extent necessary to define potential transport pathways and receptor populations and provide sufficient data for preliminary screening of remedial action alternatives;
- Measure the nature and extent of contamination at LL–6 such that a baseline risk assessment can be conducted to evaluate the potential threats to human health and the environment; and
- Evaluate the locations, types and amounts, potential releases, physical and chemical properties, and engineering characteristics of the sources of contamination at LL–6 to propose remedial actions.

Investigation-specific objectives were developed using the data quality objective (DQO) approach presented in the *Revised Facility-Wide Sampling and Analysis Plan (FWSAP) for the Ravenna Army Ammunition Plant* (USACE, 2001).



NOT TO SCALE

Figure 1-1. Ravenna Army Ammunition Plant Location Map

The investigative approach to the RI at LL–6 involved a combination of field screening and laboratory activities to characterize the area of concern (AOC). Field investigation techniques included surface soil sampling, subsurface soil sampling, surface water sampling, sediment sampling, monitoring well installation and development, groundwater sampling, aquifer testing, and sampling location survey. The field program was conducted in accordance with the *FWSAP* (USACE, 2001) and the *SAP Addendum for the Remedial Investigation at Load Line 6 (RVAAP 33)* (MKM, 2003b).

1.2 Background

This section briefly describes the RVAAP facility and LL–6, previous investigations, and the regulatory guidance followed in conducting the RI.

1.2.1 General Facility Description

The RVAAP is a government-owned facility, jointly operated by the Base Realignment and Closure (BRAC) Division and the National Guard Bureau. The current caretaker contractor for the BRACD is MKM Engineers, Inc. (MKM).

Until 1999, the RVAAP was defined as a 21,419-acre installation. The Ohio Army National Guard (OHARNG) surveyed the property boundary and the total acreage was found to be 21,683 acres. Currently, RVAAP consists of 1,280 acres in several distinct parcels scattered throughout the confines of the OHARNG's Ravenna Training and Logistics Site (RTLS). RVAAP's remaining parcels of land are located completely within the RTLS, and are completely enclosed by the RTLS perimeter fence.

The RTLS is located in northeastern Ohio within Portage and Trumbull counties, approximately 4.8 kilometers (km) (3 miles [mi]) east/northeast of the City of Ravenna and approximately 1.6 km (1 mile) northwest of the City of Newton Falls. The RVAAP portions of the property are completely located within Portage County. The RTLS (inclusive of RVAAP) is a parcel of property approximately 17.7 km (11 mi) long and 5.6 km (3.5 mi) wide. The facility is bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad on the south; Garrett, McCormick, and Berry Roads on the west; the Norfolk Southern Railroad on the north; and State Route 534 on the east.

The RTLS is surrounded by several communities: Windham on the north, Garrettsville 9.6 km (6 mi) to the northwest; City of Newton Falls 1.6 km (1 mile) to the southeast; Charlestown to the southwest, and Wayland 4.8 km (3 mi) to the south. RTLS did not exist when the RVAAP was operational, and the entire 21,683-acre parcel was a government-owned, contractor-operated (GOCO) industrial facility. The RVAAP Installation Restoration Program (IRP) encompasses investigation and cleanup of past activities over the entire 21,683 acres of the former RVAAP,

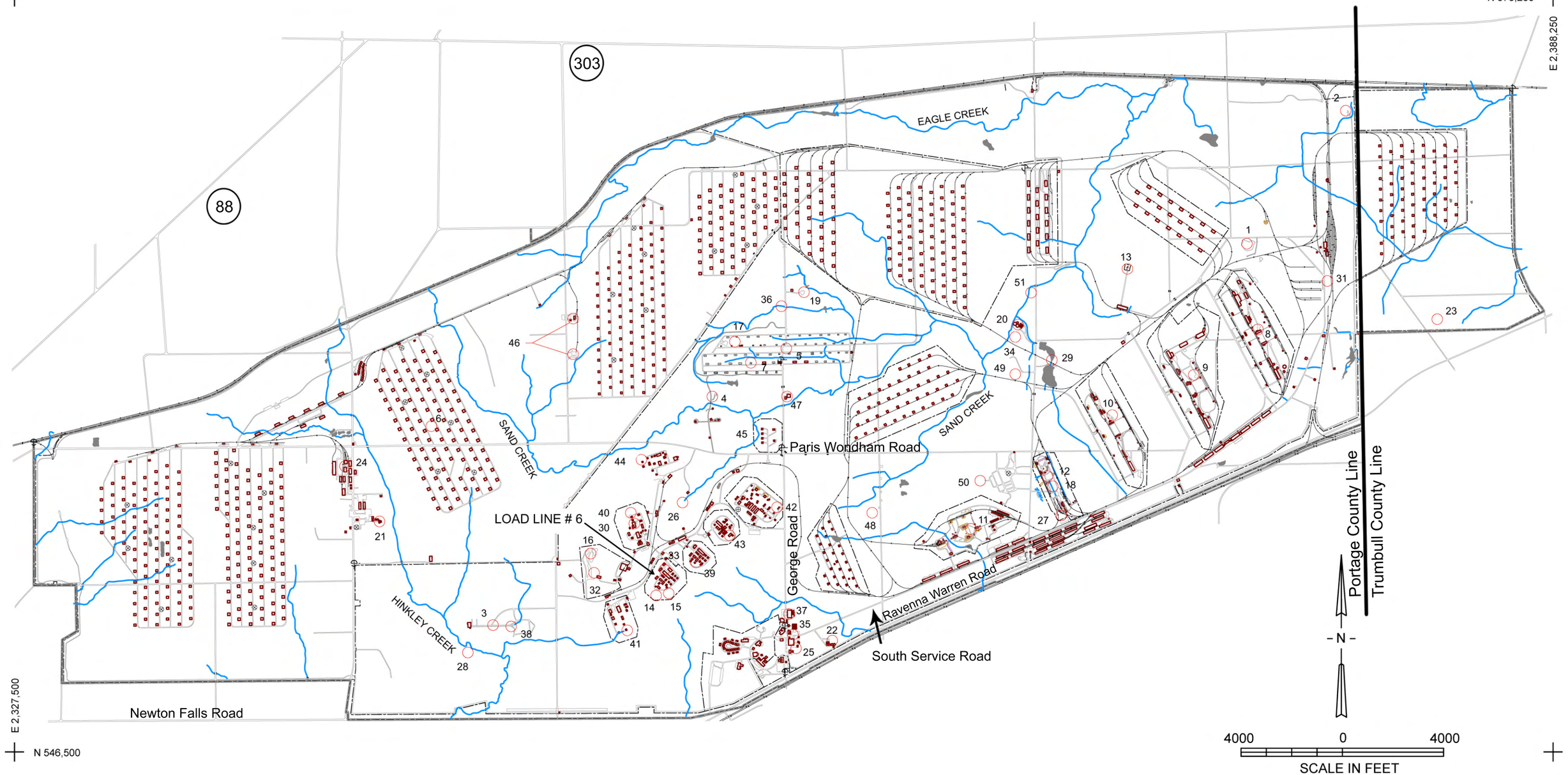
so references to the RVAAP in this document consider the historical extent of the RVAAP, inclusive of the combined acreages of the current RTLS and RVAAP, unless otherwise specifically stated.

Past Department of Defense (DoD) activities at RVAAP began in 1940 and have included manufacturing, loading, handling, storage, and disposition of military ammunition and explosives. The industrial operations at RVAAP consisted of 12 munitions assembly facilities referred to as "load lines" (Figure 1–2). Load Lines 5 through 11 were used to manufacture fuzes, primers, and boosters. Complete 40 millimeter (mm) rounds were also assembled at Load Line 7. Load Line 12 was used to produce ammonium nitrate for explosives and fertilizers before becoming a renovation and demilitarization facility. In addition, RVAAP also had several areas used for burning, demolition, and testing of munitions. These burning grounds, and demolition or test areas, consisted of large parcels of open space or abandoned quarries. Potential contaminants in these load lines may include, but are not limited to, lead azide, lead styphnate, lead thiocyanate, antimony sulfide, potassium chlorate, mercury fulminate, black powder, TNT, RDX, HMX, PETN and composition B, octol, nitrocellulose, nitroguandine, and nitroglycerin.

1.2.2 Description and History of Area of Concern

LL–6, which is approximately 51 acres in size, is located in the south–central portion of RVAAP on Fuze and Booster Road (Figure 1–3). From 1941 to 1945, LL–6 operated primarily as a fuze assembly line. However, building 2F–4 was used as a fulminate mixing, building. In 1945, the load line was deactivated and the equipment was removed. In the 1950s, LL–6 was used by Firestone Defense Research, a subsidiary of Firestone Tire and Rubber Company, for defense work under contract to Picatinny Arsenal. Firestone Defense Research used the load line for research and development of various kinds of charges (i.e., shaped, fragmenting disc, etc.) for armor penetration. Frequency of firing was approximately 1–2 charges per week. The most recent activity at LL–6 occurred during the late 1970s, when it was again used for applied research and development on shaped charges for DoD by Firestone Defense Corporation. The amount of explosives involved during the operation was minimal − not more than 900 kilograms (kg) per year.

Infrastructure at LL–6 consists mainly of a gravel perimeter road around the main production area. Three experimental explosive shaped–charge chambers were used at LL–6 during the research phase of work. The chambers were located as follows:



LEGEND OF SITES:

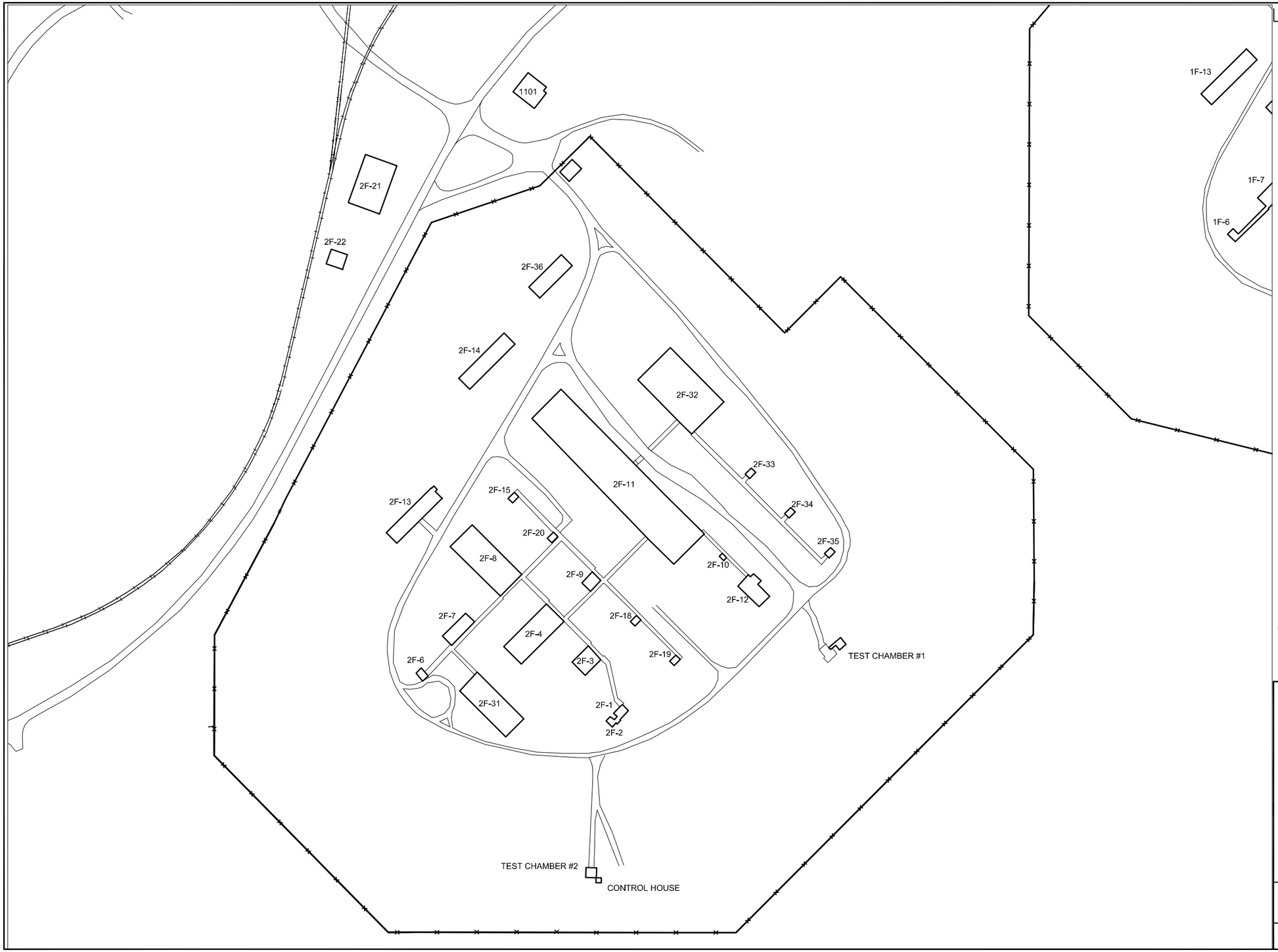
1 ..... RAMSDELL QUARRY LANDFILL
2 ..... ERIE BURNING GROUNDS
3 ..... DEMOLITIONS AREA #1
4 ..... DEMOLITIONS AREA #2
5 ..... WINKLEPECK BURNING GROUNDS
6 ..... C BLOCK QUARRY
7 ..... BLDG 1601 HAZARDOUS WASTE STORAGE
8 ..... LOAD LINE 1 AND DILUTION/SETTLING POND
9 ..... LOAD LINE 2 AND DILUTION/SETTLING POND
10 ..... LOAD LINE 3 AND DILUTION/SETTLING POND
11 ..... LOAD LINE 4 AND DILUTION/SETTLING POND
12 ..... LOAD LINE 12 AND DILUTION/SETTLING POND
13 ..... BLDG 1200 AND DILUTION/SETTLING POND
14 ..... LOAD LINE 6, EVAPORATION UNIT
15 ..... LOAD LINE 6, TREATMENT PLANT
16 ..... QUARRY LANDFILL/FORMER FUZE & BOOSTER BURNING PITS
17 ..... DEACTIVATION FURNACE
18 ..... LOAD LINE 12 PINK WASTE WATER TREATMENT
19 ..... LANDFILL NORTH OF WINKLEPECK BURNING GROUND
20 ..... SAND CREEK SEWAGE TREATMENT PLANT
21 ..... DEPOT SEWAGE TREATMENT PLANT
22 ..... GEORGE ROAD SEWAGE TREATMENT PLANT
23 ..... UNIT TRAINING SITE WASTE OIL TANK
24 RESERVE UNIT MAINTENANCE AREA WASTE OIL TANK
25 ..... BLDG 1034 MOTOR POOL WASTE OIL TANK
26 ..... FUZE BOOSTER AREA SETTLING TANKS
27 ..... BLDG 854-PCB STORAGE
28 ..... MUSTARD AGENT BURIAL SITE
29 ..... UPPER AND LOWER COBBS POND COMPLEX
30 .. TREATMENT PLANT LOAD LINE 7 PINK WASTEWATER
31 ..... ORE PILE RETENTION POND
32 ..... 40 AND 60 MM FIRING RANGE
33 ..... FIRESTONE TEST FACILITY
34 ..... SAND CREEK DISPOSAL ROAD LANDFILL
35 ..... 1037 BUILDING-LAUNDRY WASTEWATER SUMP
36 ..... PISTOL RANGE
37 ..... PESTICIDE BUILDING S-44S2
38 ..... NACA TEST AREA
39 ..... LOAD LINE 5/FUZE LINE 1
40 ..... LOAD LINE 7/BOOSTER LINE 1
41 ..... LOAD LINE 8/BOOSTER LINE 1
42 ..... LOAD LINE 9/DETONATOR LINE
43 ..... LOAD LINE 10/PERCUSSION ELEMENT
44 ..... LOAD LINE 11/ARTILLERY PRIMER
45 ..... WET STORAGE AREA
46 ..... BUILDINGS F-15 AND F-16
47 ..... BUILDING T-5301 DECONTAMINATION
48 ..... ANCHOR TEXT AREA
49 ..... CENTRAL BURN PITS
50 ..... ATLAS SCRAP YARD
51 ..... DUMP ALONG PARIS - WINDHAM ROAD
..... RAILROAD TRACKS
..... FENCELINE
..... PROPERTY BOUNDARY
..... STREAM OR CREEK
20 ..... AREAS OF CONCERN
..... IGLOO
..... BUILDING

Figure 1-2

FACILITY LOCATION MAP
LOAD LINE - 6 REMEDIAL INVESTIGATION
Ravenna Army Ammunition Plant
Ravenna, OH

Drawn By: ST Date Drawn: 06/17/2005

MKM Engineers, Inc.
4153 Bluebonnet Road
Stafford, TX 77477



LEGEND:

ROAD

BUILDING

FENCE

DT

DETONATOR LINE

N

0' 100' 200' 300'

1" = 200'

MKM Engineers
4153 Bluebonnet Drive
Stafford, TX 77477

RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

FIGURE 1-3

LOAD LINE 6 SITE MAP

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	AUG 2007	3

DRAWN BY	KP	APPR. BY	MT

- Large Test Chamber – south of 2FWP12 in open field,
- Small Test Chamber – immediately adjacent to 2FWP12, and
- Open–Range Test Chamber – southwest of 2FWP2.

Additionally, an explosive device test pond was located immediately west of the open–range test facility. This pond is close to the load line perimeter fence.

LL–6 buildings were thermally decontaminated and demolished by MKM Engineers in 2003, with the exception of four buildings (2F–3, 2F–4, 2F–7 and 2F–8). Due to high concentrations of polychlorinated biphenyl (PCBs) in the wall paint, these remaining buildings were not thermally decontaminated, but instead were thoroughly inspected and tested for explosive hazards and conventionally demolished in July 2005. Samples were collected in the vicinity of the buildings in accordance with the LL–6 sampling and work plans. Based upon the analytical results, it is not anticipated that the removal of the buildings after the sample collection had any impact on the characterization of the areas immediately surrounding the buildings. However, there has been no confirmation sampling to verify potential impacts from the demolition. Table 1–1 lists the building usage and hazard classifications for LL–6 at the RVAAP.

Table 1–1

Building Usage and Hazard Classifications for LL–6 at the RVAAP

Bldg. #	Floor	Function	Explosive	Reference	Hazard Class
2F–1	1	Fulminate Dry House	Mercury Fulminate	Property Cards and Maps	EB
2F–2	1	Heater House	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–3	1	Fulminate Mix House	Mercury Fulminate	Property Cards and Maps	EB
2F–4	1	Primer Loading	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–6	1	Powder Dry House	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–7	1	Powder Pelleting	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–8	1	Delay Loading	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–9	1	Primer Dry House	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–10	1	Detonator Service Bldg	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–11	1	Fuze Assembly	Black Powder/Mercury Fulminate	Property Cards and Maps	EB

Table 1–1 (Continued)

Building Usage and Hazard Classifications for LL–6 at the RVAAP

Bldg. #	Floor	Function	Explosive	Reference	Hazard Class
2F–12	1	Fuze Testing	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–13	1	Change House	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–14	1	Change House	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–15	1	Paint Storage	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–18	1	Primer House	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–19	1	Pellet Storage	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–20	1	Delay Storage	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–21	1	Inert Storage	n/a	Property Cards and Maps	NEB
2F–22	1	Shipping	n/a	Property Cards and Maps	NEB
2F–31	1	Delay Loading	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–32	1	Fuze Assembly	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–33	1	Pellet Storage	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–34	1	Primer Storage	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–35	1	Solvent Storage	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
2F–36	1	Change House	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
6–51	1	Gate House	Black Powder/Mercury Fulminate	Property Cards and Maps	EB
1101	1	Fire Station #3	n/a	Property Cards and Maps	NEB

EB – Explosive building (Shaded)
NEB – Non-explosive building (Un-shaded)

1.2.3 Previous Investigations

LL–6 has undergone several investigations since its closure as a production facility. The U.S Army Center for Health Promotion and Preventive Medicine (USCHPPM) conducted a Relative Risk Site Evaluation (RRSE) for previously uninvestigated sites at the RVAAP in 1996 (Hazardous and Medical Waste Study No. 37–EF–5360–97, 28 October – 1 November 1996). LL–6 was referred to as RVAAP 33 (Firestone Test Facility) in the USACHPPM RRSE. The samples were collected and analyzed for explosives and metals. Based on sampling results,

the 1996 USACHPPM Report identified surface soil to be the potential medium for contaminant migration. Hunters and recyclers were identified as potential receptors. Recyclers are personnel hired by the facility to collect or scavenge recyclable material at different sites. Therefore, the RRSE for the AOC was scored High.

In March 2002, the US Army Operations Support Command (OSC)–RVAAP in conjunction with the US Army Corps of Engineers (USACE) performed an azide screening operation at LL–6 for the purposes of health and safety as well as to provide additional information for the selection of analytes for the RI. Samples were collected from strategic locations within the load line to screen for primary (azide) and secondary (TNT and RDX) explosives. Nine surface soil samples (LL6SS–001–0001–SO through LL6SS–009–0001–SO) were collected from LL–6 during the March 2002 azide screening event. Results indicated that there was no detectable safety concern related to azide contamination at LL–6. The March 2002 sample screening results also confirmed that there is no significant contamination of secondary explosives at LL–6. However, metals were reported in excess of the RVAAP installation background criteria in three soil samples, the surface water sample, and the sediment sample submitted for laboratory analysis.

1.2.4 Regulatory Authorities

The approach to addressing environmental conditions at RVAAP is regulatory–based, following the frameworks established by the following regulatory drivers: The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); Resource Conservation and Recovery Act (RCRA), Toxic Substances Control Act (TSCA), and applicable Ohio environmental regulations. This RI was funded under the Army's Installation Restoration Program (IRP).

1.3 Report Organization

This RI Report is organized to meet Ohio EPA requirements in accordance with the U.S. Environmental Protection Agency's (USEPA's) CERCLA Superfund process, and USACE guidance. The remainder of the report discusses:

- Section 2.0 – Physical setting of the study area;
- Section 3.0 – data collection methods, and management programs to date;
- Section 4.0 – results of the RI including the nature and extent of contamination;
- Section 5.0 – fate and transport of the contaminants of concern;
- Section 6.0 – baseline human health risk assessment (BHHRA);

- Section 7.0 – screening ecological risk assessment (SERA);
- Section 8.0 – results and conclusions;
- Section 9.0 – recommendations; and
- Section 10.0 – references.

The appendices contain RI data and information including boring logs, well construction diagrams, analytical data tables, data quality assessments, a quality assurance (QA) summary, risk assessment data tables, and other detailed information used to interpret existing LL–6 conditions.

2.0 ENVIRONMENTAL SETTING AT RVAAP

This section describes the physical characteristics of the RVAAP facility – specifically, LL–6, and its adjacent environment − that are factors in interpreting the potential contaminant transport pathways, receptor populations, and exposure scenarios for the evaluation of human health and ecological risks.

2.1 Surface Features

The topography at RVAAP is characterized by contours that decrease in elevation from a topographic high in the far western portion of the facility of approximately 1,220 feet above mean sea level (ft amsl) to lows in the far eastern portion of the facility of approximately 930 ft amsl. The topography of LL–6 consists of gently undulating slopes. Elevations range from 341 meters (m) or 1,119 ft to 344 m (1,129 ft) amsl.

USACE mapped the installation topography in February 1998, using a 0.61 m (2 ft) contour interval with an accuracy of 0.204 m (0.67 ft). USACE based the topographic information on aerial photographs taken during spring 1997. The USACE survey is the basis for the topographical information illustrated in figures found in this RI report.

2.2 Meteorology and Climate

The general climate of the RVAAP area is continental − characterized by moderately warm and humid summers, reasonably cold and cloudy winters, and wide variations in precipitation from year to year. The following climatological data were obtained from the National Weather Service (NWS) Office at the Youngstown-Warren Regional Airport located in Trumbull County and are based on a 30-year average.

Total annual rainfall in the RVAAP area is approximately 37.3 in, with the highest monthly average occurring in July (4.07 in) and the lowest monthly average occurring in February (2.03 in). Average annual snowfall totals approximately 56.2 in, with the highest monthly average occurring in January (12.9 in). It should be noted that because of the influence of lake-effect snowfall events associated with Lake Erie, which is approximately 35 mi to the northwest of RVAAP, snowfall totals vary widely throughout northeastern Ohio. The average annual daily temperature in the RVAAP area is 48.3 degrees Fahrenheit (ºF), with an average daily high temperature of 57.7 ºF and an average daily low temperature of 38.7 ºF. The record high temperature of 100 ºF occurred in July 1988, and the record low temperature of (-22) ºF occurred in January 1994. The prevailing wind direction at RVAAP is from the southwest, with the highest average wind speed occurring in January (11.6 mi per hour [mph]) and the lowest

average wind speed occurring in August (7.4 mph). Thunderstorms occur on approximately 35 days per year and are most abundant from April through August. The RVAAP area is susceptible to tornadoes; minor structural damage to several buildings on the facility occurred as the result of a tornado in 1985.

2.3 Surface Water Hydrology

The entire RVAAP facility is situated within the Mahoning River Basin, with the West Branch of the Mahoning River representing the major surface stream in the area. The West Branch flows adjacent to the west end of the facility, generally in a north-to-south direction, before flowing into the Michael J. Kirwan Reservoir, which is located to the south of State Route 5. The West Branch flows out of the reservoir along the southern facility boundary before joining the Mahoning River east of RVAAP.

The western and northern portions of the RVAAP facility display low hills and a dendritic surface drainage pattern. The eastern and southern portions are characterized by an undulating to moderately level surface, with less dissection of the surface drainage. The facility has numerous marshy areas and flowing and intermittent streams whose headwaters are located in the facility's hills.

Three primary water courses drain RVAAP: (1) the South Fork of Eagle Creek, (2) Sand Creek, and (3) Hinkley Creek. Each of these water courses has many associated tributaries. Sand Creek, with a drainage area of 22.4 sq km (13.9 sq mi), flows generally in a northeast direction to its confluence with the South Fork of Eagle Creek. In turn, the South Fork of Eagle Creek then continues in a northerly direction for 4.3 km (2.7 mi) to its confluence with Eagle Creek. The drainage area of the South Fork of Eagle Creek is 42.2 sq km (26.2 sq mi), including the area drained by Sand Creek. Hinkley Creek originates just southeast of the intersection between State Routes 88 and 303 to the north of the facility. Hinkley Creek, with a drainage area of 17.7 sq km (11.0 sq mi), flows in a southerly direction through the facility to its confluence with the West Branch of the Mahoning River south of the facility.

Approximately 50 ponds are scattered throughout the facility. Many were built within natural drainage ways to function as settling ponds or basins for process effluent and runoff. Others are natural in origin, resulting from glacial action or beaver activity. Most water bodies at RVAAP support an abundance of aquatic vegetation and fish. The ponds within the installation are not currently used as a water supply source. Stormwater runoff is controlled primarily by natural drainage except in facility operations areas where an extensive storm sewer network helps to direct runoff to drainage, ditches and settling ponds. In addition, the storm sewer system was one of the primary drainage mechanisms for process effluent during the period that production facilities (i.e., LL–6) were in operation.

On-site surface water at LL–6 is limited to a small pond (used for explosive testing), and intermittent drainage ditches or gullies. The direction of the flow of surface water runoff follows the LL–6 surface contour gradient. The general gradient of the site is from the north to the south. Surface runoff flows to and follows constructed drainage ditches that feed into a natural drainage channel in the south-central portion of the site. This natural drainage channel is an unnamed tributary of the Michael J. Kirwan Reservoir. Photographs of the surface water features at LL–6 are located in Appendix A.

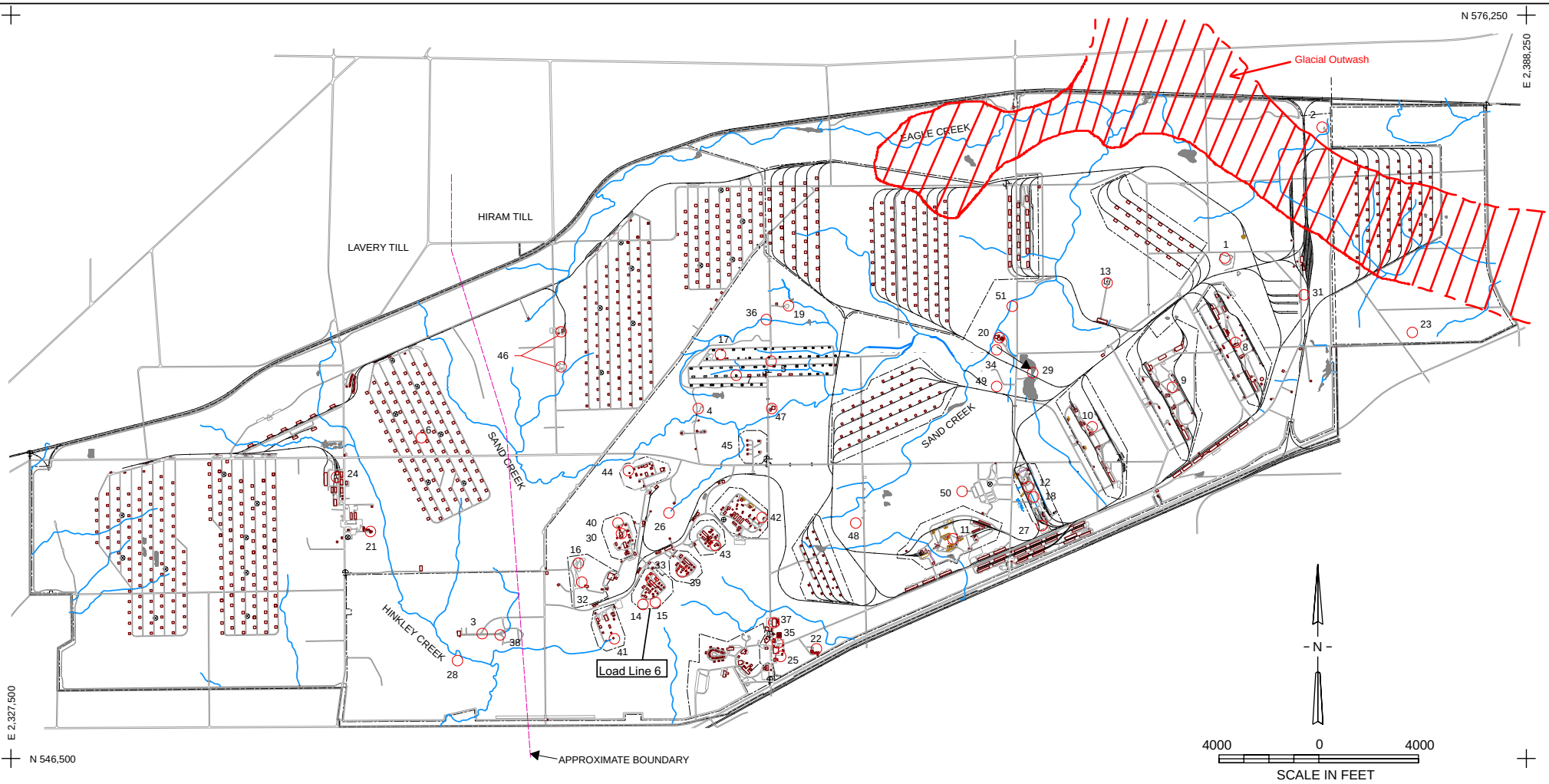
2.4 Geology

Lithologic logs from seven soil borings, which were advanced during the RI and completed as monitoring wells, were used to characterize the LL–6 surface and subsurface geology. The soils described during the advancement of the soil borings included a mixture of clay, silty clay, silt, clayey silt, sandy silt, sand, and silty sand. The lateral and vertical composition of the soils varied across the site. A consistent brown sand layer was encountered across the site ranging from 12.5 to 18.2 ft below ground surface (bgs). Bedrock was, if encountered, at a depth ranging from 20 to 23 ft bgs. The boring logs, which detail the vertical lithologic sequences, are found in Appendix B.

2.4.1 Glacial Deposits

RVAAP is located within the Glaciated Allegheny Plateau physiographic region of Ohio. Pennsylvanian bedrock is overlain by Wisconsinian Age glacial deposits. Two glacial advances during the Wisconsin Age of the Pleistocene Epoch resulted in the deposition of glacial till over the entire RVAAP installation. The Lavery Till is exposed in the western part of the installation, and the younger Hiram Till is exposed in the remaining portion of RVAAP, including LL–6, which is located in the south-central portion of RVAAP (White, 1982) (Figure 2–1). Glacial outwash deposits are found in the north eastern part of RVAAP in the Eagle creek drainage area and the area described as Erie Burning Grounds (White, 1982).

The first glacial advance deposited the Lavery Till over the facility. The Lavery Till consists mostly of clay and silt with a few cobbles and sporadic boulders. In general, the Lavery Till consists of 28% sand 42% silt, and 30% clay. The second glacial advance deposited the Hiram Till over the eastern two-thirds of the facility only. The Hiram Till has the highest clay content of tills in northeastern Ohio (White, 1982). The Hiram Till typically consists of 12% sand, 41% silt, and 47% illite and chlorite clay minerals, and ranges in depth from 1.5 to 4.6 m (5 – 15 ft) bgs. Unweathered Hiram Till is dark gray and turns a dark brown when exposed to the atmosphere. Soil associated with the Hiram Till at RVAAP includes the Mahoning silt loam complex. The specific soils developed at LL–6 are detailed in Section 2.5.



LEGEND OF SITES:

1 ..... RAMSDELL QUARRY LANDFILL
2 ..... ERIE BURNING GROUNDS
3 ..... DEMOLITIONS AREA #1
4 ..... DEMOLITIONS AREA #2
5 ..... WINKLEPECK BURNING GROUNDS
6 ..... C BLOCK QUARRY
7 ..... BLDG 1601 HAZARDOUS WASTE STORAGE
8 ..... LOAD LINE 1 AND DILUTION/SETTLING POND
9 ..... LOAD LINE 2 AND DILUTION/SETTLING POND
10 ..... LOAD LINE 3 AND DILUTION/SETTLING POND
11 ..... LOAD LINE 4 AND DILUTION/SETTLING POND
12 ..... LOAD LINE 12 AND DILUTION/SETTLING POND
13 ..... BLDG 1200 AND DILUTION/SETTLING POND
14 ..... LOAD LINE 6, EVAPORATION UNIT
15 ..... LOAD LINE 6, TREATMENT PLANT
16 ..... QUARRY LANDFILL/FORMER FUZE & BOOSTER BURNING PITS
17 ..... DEACTIVATION FURNACE
18 ..... LOAD LINE 12 PINK WASTE WATER TREATMENT
19 ..... LANDFILL NORTH OF WINKLEPECK BURNING GROUND
20 ..... SAND CREEK SEWAGE TREATMENT PLANT
21 ..... DEPOT SEWAGE TREATMENT PLANT
22 ..... GEORGE ROAD SEWAGE TREATMENT PLANT
23 ..... UNIT TRAINING SITE WASTE OIL TANK
24 RESERVE UNIT MAINTENANCE AREA WASTE OIL TANK
25 ..... BLDG 1034 MOTOR POOL WASTE OIL TANK
26 ..... FUZE BOOSTER AREA SETTLING TANKS
27 ..... BLDG 854-PCB STORAGE
28 ..... MUSTARD AGENT BURIAL SITE
29 ..... UPPER AND LOWER COBBS POND COMPLEX
30 .. TREATMENT PLANT LOAD LINE 7 PINK WASTEWATER
31 ..... ORE PILE RETENTION POND
32 ..... 40 AND 60 MM FIRING RANGE
33 ..... LOAD LINE 6/FIRESTONE TEST FACILITY
34 ..... SAND CREEK DISPOSAL ROAD LANDFILL
35 ..... 1037 BUILDING-LAUNDRY WASTEWATER SUMP
36 ..... PISTOL RANGE
37 ..... PESTICIDE BUILDING S-44S2
38 ..... NACA TEST AREA
39 ..... LOAD LINE 5/FUZE LINE 1
40 ..... LOAD LINE 7/BOOSTER LINE 1
41 ..... LOAD LINE 8/BOOSTER LINE 1
42 ..... LOAD LINE 9/DETONATOR LINE
43 ..... LOAD LINE 10/PERCUSSION ELEMENT
44 ..... LOAD LINE 11/ARTILLERY PRIMER
45 ..... WET STORAGE AREA
46 ..... BUILDINGS F-15 AND F-16
47 ..... BUILDING T-5301 DECONTAMINATION
48 ..... ANCHOR TEXT AREA
49 ..... CENTRAL BURN PITS
50 ..... ATLAS SCRAP YARD
51 ..... DUMP ALONG PARIS - WINDHAM ROAD
..... RAILROAD TRACKS
..... FENCELINE
..... PROPERTY BOUNDARY
..... STREAM OR CREEK
20 ..... AREAS OF CONCERN
..... IGLOO
..... BUILDING

Figure 2-1
Load Line 6 Remedial Investigation
Glacial Till Map
Ravenna Army Ammunition Plant
Ravenna, OH

Drawn By: ST Date Drawn: 06/17/2005

MKM Engineers, Inc.
4153 Bluebonnet Road
Stafford, TX 77477

Glacial data from - White, George, Glacial Geology of Northeast Ohio. Bulletin, 1982

The geotechnical laboratory results have been used to provide a range of grain size encountered in the soil borings. The geotechnical analysis at LL–6 indicated a grain size range of 8.4% to 26% sand, 35.7% to 53.3% silt, and 17.8% to 51.6% clay. The thickness of the glacial deposits varies across the installation. The till/soil thickness encountered at LL–6 during installation of the soil borings varied from 18 ft to 23 ft. The till/soils encountered at the site consisted of silt, silty clay, and sand. A medium to coarse sand interval was described in several monitoring well borings between 3.8 and 5.5 m (12.5 and 18.1 ft) bgs.

Subsurface lithology at LL–6 consists mostly of clay to sand-rich silt tills with interbedded sands scattered throughout. These deposits are generally firm, low to moderately plastic, and tend to hold water where encountered. Deposits with higher concentrations of sand and gravel generally control the elevation of the shallow water table zone. Cross-sections of the subsurface at LL–6 illustrate the lateral distribution and variation of these discontinuous glaciated sediments (Figures 2–2 to 2–5).

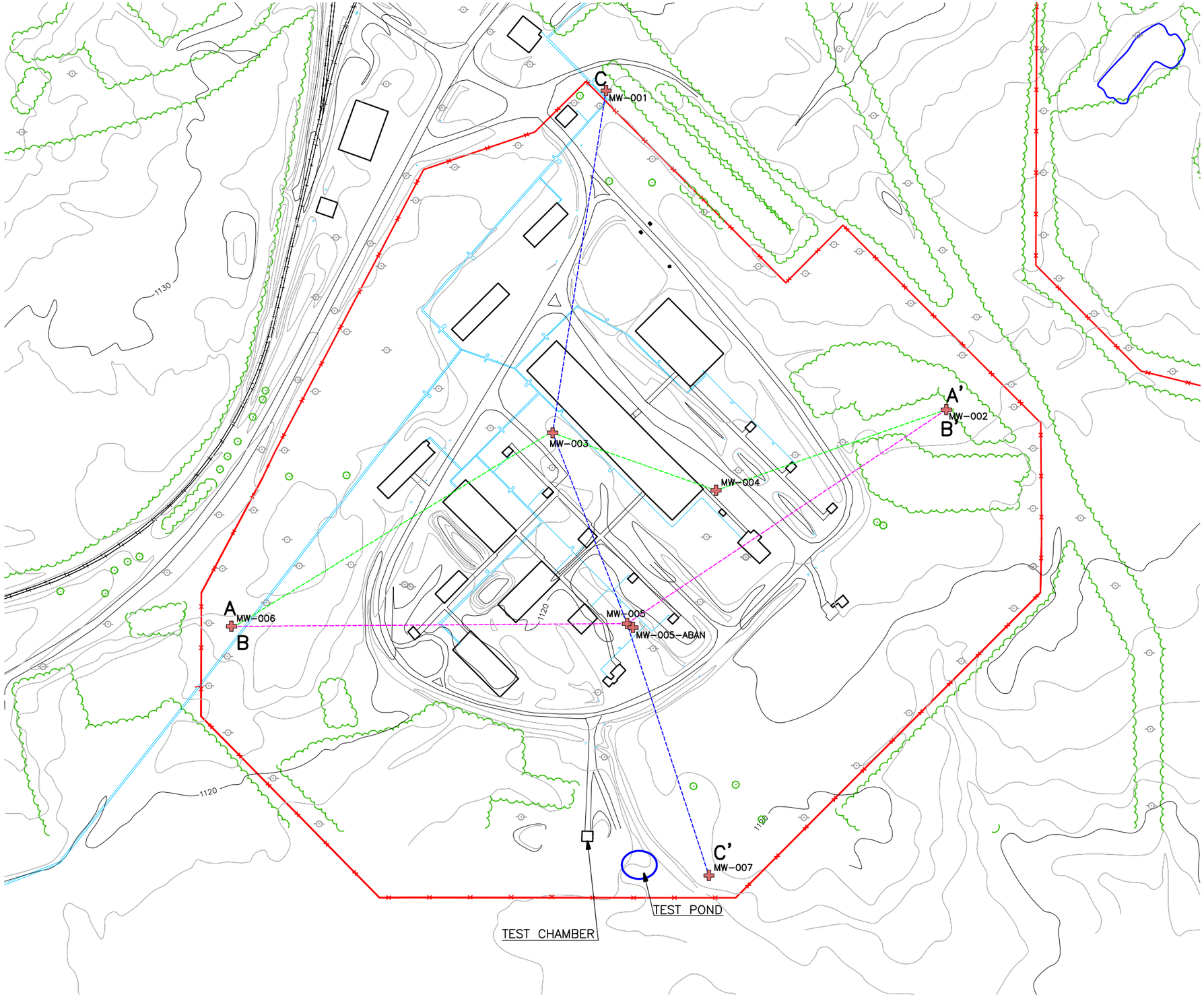
2.4.2 Sedimentary Rocks

Bedrock outcrops at several areas across RVAAP. According to general geological documents published by the State of Ohio, both Mississippian and Pennsylvanian Age bedrock is believed to underly RVAAP (USACE, 2001). The bedrock geology of Portage County is shown on Figure 2-6.

2.4.2.1 RVAAP Sedimentary Rocks

The bedrock geology of RVAAP consists of Carboniferous Age sedimentary rocks that lie stratigraphically beneath the glacial deposits of the Lavery and Hiram Tills. The oldest outcropping of bedrock at the surface within the facility is the Cuyahoga Group of the Mississippian Age. Three Members comprise this formation: (1) the Orangeville Shale, (2) the Sharpsville Sandstone, and (3) the Meadville Shale. The Cuyahoga outcrops in the far northeastern corner of the facility and generally consists of blue-gray silty shale with interbedded sandstone. The regional dip of the Cuyahoga strata is between 1.5 and 3.0 m (5 and 11.5 ft) per mile to the south. The remainder of the facility is underlain by bedrock associated with the Pottsville Formation of Pennsylvanian Age. The Pottsville Formation, which lies unconformably on an erosional surface of the Cuyahoga Group, is divided into four Members: (1) the Sharon, (2) the Connoquenessing, (3) the Mercer, and (4) the Homewood Sandstone. The Sharon Member consists of two individual units: the Sharon Conglomerate and the Sharon Shale.

The Sharon Conglomerate is porous, coarse-grained, gray-white sandstone that often exhibits thin layers of milky white quartzite pebbles. The Sharon Conglomerate also has locally occurring thin shale lenses in the upper portion of the unit.



LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- MONITORING WELL SAMPLE LOCATION
- BUILDING
- FENCE
- TRANVERSE A–A'
- TRANSVERSE B–B'
- TRANSVERSE C–C'

0' 100' 200' 300'
1" = 200'

N

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RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

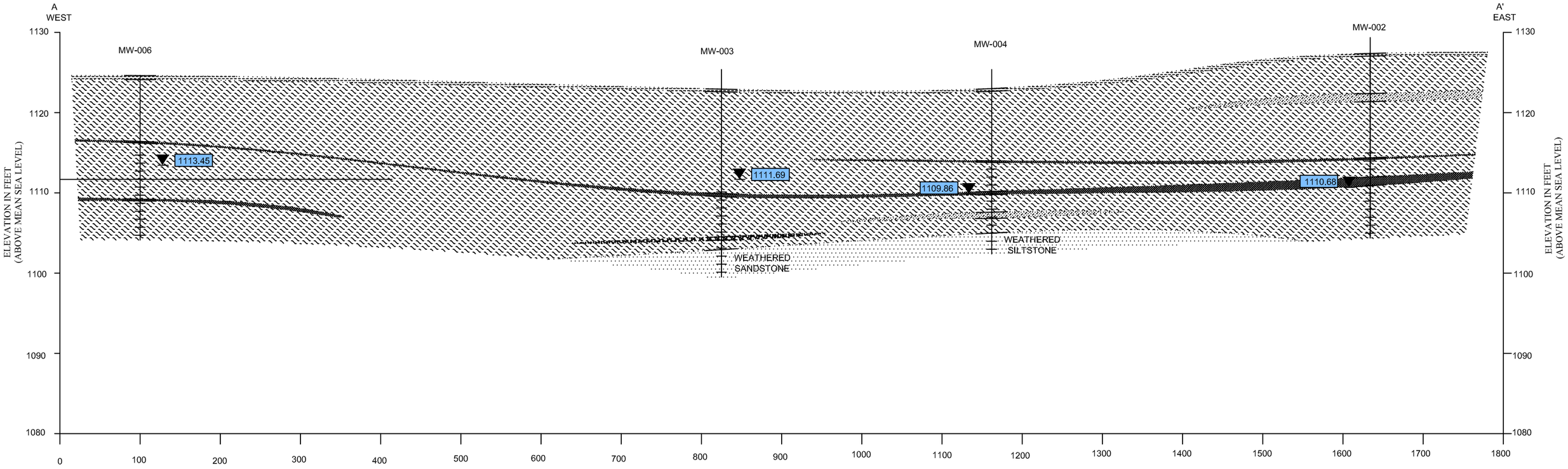
FIGURE 2–2

LOCATION OF GEOLOGIC CROSS SECTIONS MAP

LL 6 REMEDIAL INVESTIGATION

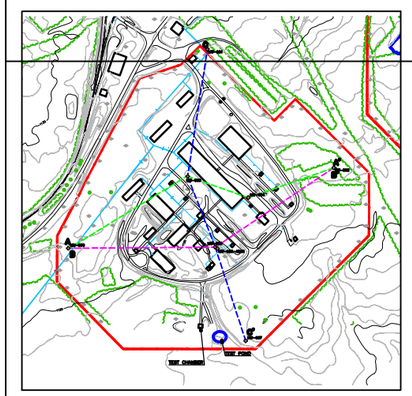
SIZE	PROJECT NO.	DATE:	REV
B	02–02–0085	MAY 2007	2

DRAWN BY	R. BOWMAN	APPR. BY	SL



DISTANCE IN FEET
CROSS SECTION A

HORIZONTAL 1"=120'
VERTICAL 1"=12'



VERTICAL EXAGGERATION = 10X

LEGEND

- TOP SOIL
- SANDY SILT
- ROCK FRAGMENTS
- KNOWN SUBSURFACE SOIL CONDITIONS
- SILTY SAND
- CLAYEY SILT
- 1140.64 GROUNDWATER ELEVATION (ft) - June 2004
- EXPECTED SUBSURFACE SOIL CONDITIONS
- HOMEWOOD MEMBER
- DEPTH GROUNDWATER ENCOUNTERED
- SCREEN INTERVAL

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED
	1		10/06	SAB
	2		05/07	SL
	3		08/07	MT

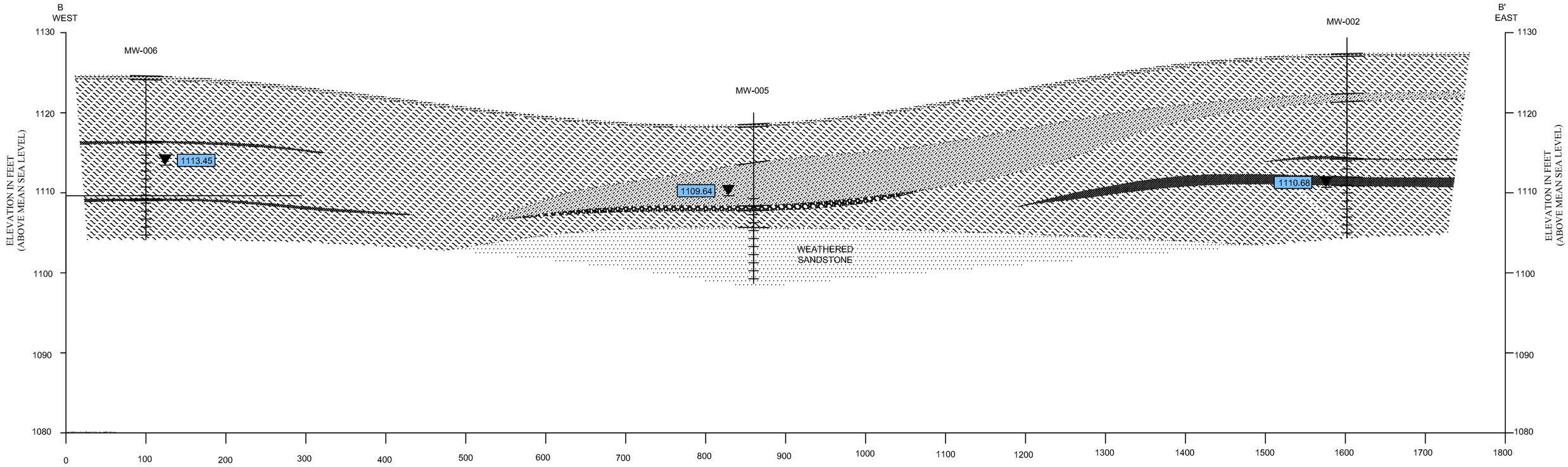
MKM ENGINEERS, INC.

DATE DRAWN 08/16/07

FIGURE 2–3
LOAD LINE 6 REMEDIAL INVESTIGATION
GEOLOGIC CROSS SECTION A–A'
RAVENNA ARMY AMMUNITION PLANT, RAVENNA OHIO

SIZE	PROJECT NO.	DWG NO.	REV
B	02–02–0047	2–3	3

DRAWN BY	ST/RB/KP	APPR. BY	MT



DISTANCE IN FEET
CROSS SECTION B

HORIZONTAL 1"=120'
VERTICAL 1"=12'

VERTICAL EXAGGERATION = 10X

LEGEND

- TOP SOIL
- SANDY SILT
- ROCK FRAGMENTS
- KNOWN SUBSURFACE SOIL CONDITIONS
- SILTY SAND
- CLAYEY SILT
- 1140.64 GROUNDWATER ELEVATION (ft) - June 2004
- EXPECTED SUBSURFACE SOIL CONDITIONS
- SANDSTONE HOMEWOOD MEMBER
- DEPTH GROUNDWATER ENCOUNTERED
- SCREEN INTERVAL

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED
	1		10/06	SAB
	2		05/07	SL
	3		08/07	MT

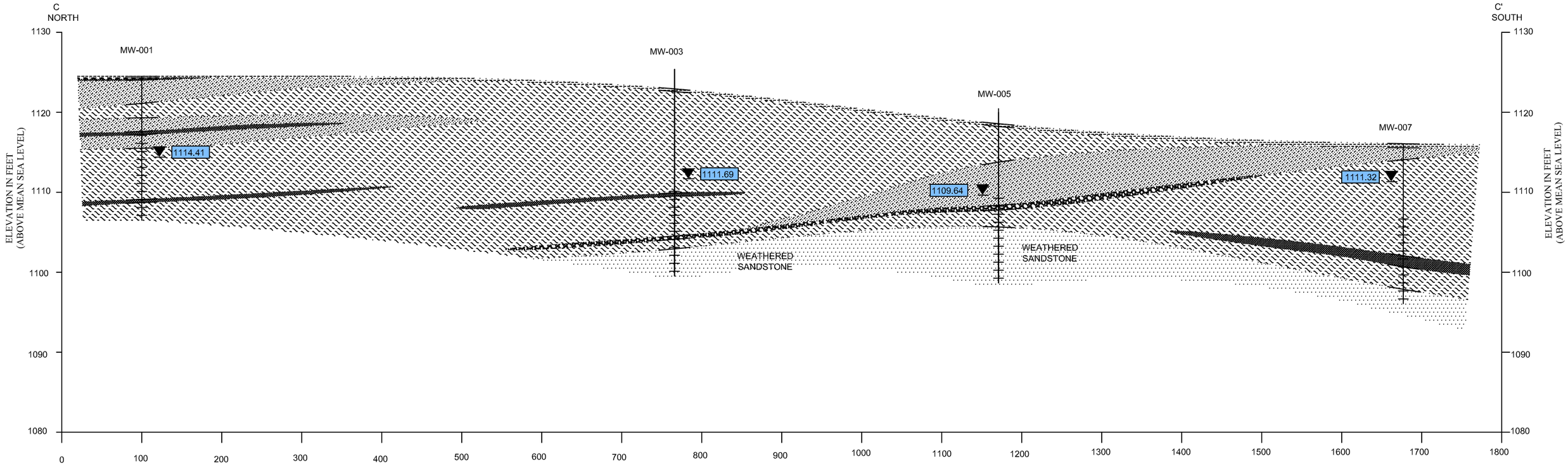
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DATE DRAWN 08/16/07

FIGURE 2–4
LOAD LINE 6 – REMEDIAL INVESTIGATION
GEOLOGIC CROSS SECTION B–B'
RAVENNA ARMY AMMUNITION PLANT, RAVENNA OHIO

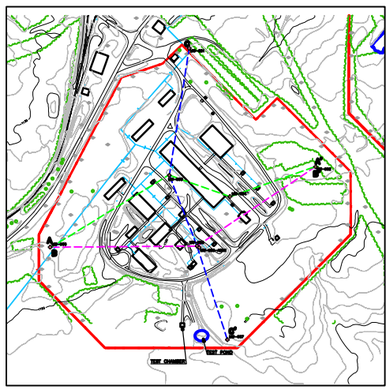
SIZE	PROJECT NO.	DWG NO.	REV
B	02–02–0047	2–4	3

DRAWN BY	ST/RB/KP	APPR. BY	MT



DISTANCE IN FEET
CROSS SECTION C

HORIZONTAL 1"=120'
VERTICAL 1"=12'



VERTICAL EXAGGERATION = 10X

LEGEND

- TOP SOIL
- SANDY SILT
- ROCK FRAGMENTS
- KNOWN SUBSURFACE SOIL CONDITIONS
- SILTY SAND
- CLAYEY SILT
- 1140.64 GROUNDWATER ELEVATION (ft) - June 2004
- EXPECTED SUBSURFACE SOIL CONDITIONS
- SANDSTONE HOMEWOOD MEMBER
- DEPTH GROUNDWATER ENCOUNTERED
- SCREEN INTERVAL

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED
	1		10/06	SAB
	2		05/07	SL
	3		08/07	MT

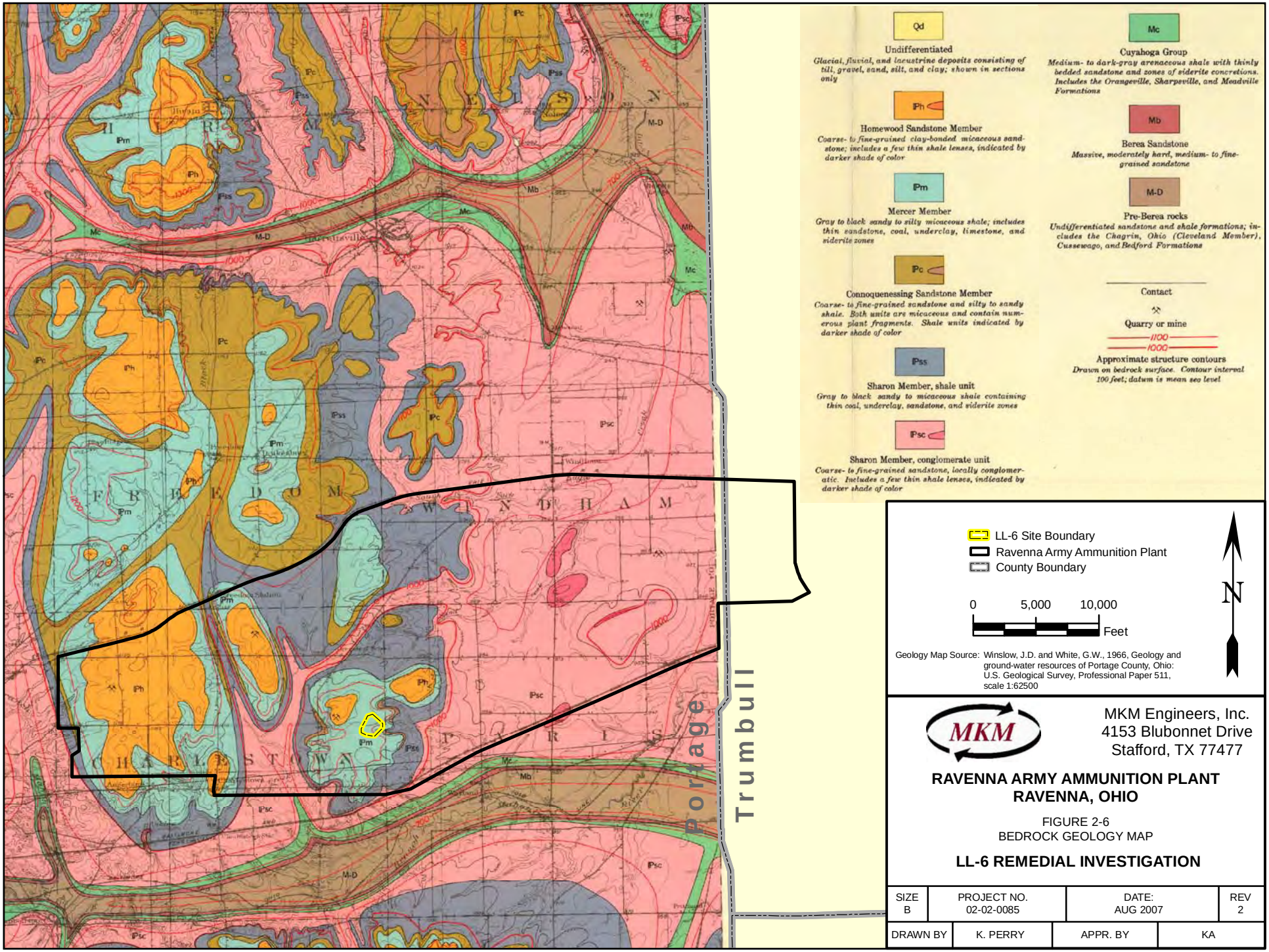
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DATE DRAWN 08/16/07

FIGURE 2–5
LOAD LINE 6 – REMEDIAL INVESTIGATION
GEOLOGIC CROSS SECTION C–C'
RAVENNA ARMY AMMUNITION PLANT, RAVENNA OHIO

SIZE	PROJECT NO.	DWG NO.	REV
D	02–02–0047	2–5	3

DRAWN BY	ST/RB/KP	APPR. BY	MT



Geology Map Source: Winslow, J.D. and White, G.W., 1966, Geology and ground-water resources of Portage County, Ohio: U.S. Geological Survey, Professional Paper 511, scale 1:62500

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Stafford, TX 77477

RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

FIGURE 2-6
BEDROCK GEOLOGY MAP

LL-6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	AUG 2007	2
DRAWN BY	K. PERRY	APPR. BY	KA

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Owing to the differences in lithology between the Sharon Conglomerate and the underlying shales of the Cuyahoga Group, the contact between the Pottsville Formation and Cuyahoga Group is usually distinct. The Sharon Shale overlies the Sharon Conglomerate and consists of sandy, gray-black, fissile shale with some plant fragments and thin flagstone beds. Sharon sandstones are exposed on the ground surface at Load Line 1 and the former Ramsdell Quarry. The Connoquenessing Sandstone Member of the Pottsville Formation unconformably overlies the Sharon Member and is a medium to coarse-grained, gray-white sandstone with more feldspar and clay than the Sharon Conglomerate. Thin interbeds and partings of sandy shale also are common in the Connoquenessing. The Mercer Member of the Pottsville Formation overlies the Connoquenessing and consists of silty to carbonaceous shale with abundant thin, discontinuous sandstone lenses in the upper portion. Regionally, the Mercer also has been noted to contain interbeds of coal. The Homewood Member of the Pottsville Formation unconformably overlies the Mercer Member and consists of coarse-grained cross-bedded sandstones that contain discontinuous shale lenses.

The Connoquenessing, Mercer, and Homewood Members are present only in the western half of the RVAAP facility (LL–6). The Sharon Conglomerate unit is the upper bedrock surface and is present in the rest of the facility including LL-6. The regional dip of the Pottsville Formation strata is between 1.5 and 3.5 m per 1.6 km (5 and 11.5 ft per mi.) to the south.

2.4.2.2 LL–6 Sedimentary Bedrock

The Homewood Member of the Pottsville Formation is the upper bedrock surface present beneath the glacial deposits/soils cover at LL–6. At LL–6 weathered bedrock (Homewood Member Sandstone) was encountered in three locations, at depths from 13 ft bgs to 20 ft bgs, during the advancement of soil borings for monitoring well construction at LL–6. The weathered bedrock encountered in the three borings was not cored since the monitoring wells were set above competent bedrock. The weathered bedrock fragments encountered in the borings consisted of fine to medium grained sandstones and some siltstones.

2.5 Soils

According to the *Soil Survey of Portage County, Ohio* (USDASCS, 1978) and *Soil Survey of Trumbull County, Ohio* (USDASCS, 1982), RVAAP soils, which formed in glacial tills, are described as being nearly level to gently sloping and range from poorly drained to moderately-well drained. One soil type is found at LL–6: Mahoning silt loam, 0–2% slopes and 2–6% slopes. Mahoning silt loam soils formed in silty clay loam or clay loam glacial till. Mahoning silt loam, 0–2% slope, is associated with upland areas between drainage ways. Runoff is slow to ponded, and seasonal wetness and slow permeability are characteristic of this soil. Mahoning

silt loam, 2–6% slope, is gently sloping, in slightly convex upland areas. Runoff is medium to rapid, and severe seasonal wetness and slow permeability are characteristic of this soil.

The tills/soils encountered during the RI at LL–6 included silts, silty clay, and sand. The sand facies was encountered in the seven monitoring well borings at depths ranging from 12.5 ft bgs to 18.2 ft bgs. The geotechnical laboratory results have been used to provide a range of grain size encountered in the soil borings. The geotechnical analysis at LL–6 indicated a grain size range of 8.4% to 26% sand, 35.7% to 53.3% silt, and 17.8% to 51.6% clay.

2.6 Hydrogeology

This section describes the unconsolidated sediments, bedrock, and groundwater utilization found at RVAAP and LL–6.

2.6.1 Unconsolidated Sediments

Limited subsurface information indicates that a buried bedrock valley may be present to the west and north of the area known as “Fuze and Booster Hill”. However, the glacial deposits that fill this valley have not been utilized for groundwater production at RVAAP. The water-bearing characteristics for the sand and gravel aquifers in the vicinity of the RVAAP installation are poorly documented. Wells that penetrate these aquifers can yield up to 6,080 liters per minute (LPM) [1,600 gallons per minute (GPM)]. However, yields from wells penetrating silty or clay till materials are significantly lower. In general, the Lavery and Hiram Tills are too thin and impermeable to produce useful quantities of water.

2.6.2 Bedrock

The Sharon Conglomerate and Connoquenessing Sandstone bedrock were the primary sources of potable groundwater at RVAAP during its active phase. Many facility production wells were completed in either the Sharon Conglomerate or the Connoquenessing Sandstone. Some wells were completed so that water was produced from both the Sharon Conglomerate and the Connoquenessing Sandstone, as well as the intervening Sharon Shale (to the extent that the Sharon Shale could produce water). The highest yields were determined to come from the quartzite-pebble conglomerate facies and from jointed and fractured zones. Weathered bedrock (Homewood Sandstone) was encountered in four locations, at depths from 13 to 20 ft, during the advancement of soil borings at LL–6.

The most important bedrock sources of groundwater in the vicinity of the RVAAP facility are the sandstone/conglomerate Members of the Pottsville Formation. These aquifers, together with two other deeper Mississippian/Devonian sandstone aquifers, represent the most important bedrock sources of groundwater in northeastern Ohio. The Sharon Conglomerate, as the

primary source of groundwater at RVAAP, maintains the most significant well yields of the Pottsville Formation Members with hydraulic conductivity values from 19 to 7,600 liters per day per meter (LPD/m) [from 5 to 2,000 gallons per day per foot (GPD/ft)]. Past studies of the Sharon Conglomerate indicate that the highest yields are associated with the true conglomerate phase (coarse-grained sandstone with abundant quartzite pebbles) and with joints and fractures in the bedrock; however, there is no facility-specific information available regarding variations in aquifer properties resulting from these factors. Where present, the overlying Sharon Shale acts as a relatively impermeable confining layer for the Sharon Conglomerate. Several flowing artesian production wells have been noted at the facility.

The Connoquenessing Sandstone and the Homewood Sandstone are the remaining aquifers of the Pottsville Formation and exhibit hydraulic conductivities from 19 to 1,140 LPD/m (from 5 to 300 GPD/ft) and from 19 to 760 LPD/m (from 5 to 200 GPD/ft), respectively. Well yields in the Connoquenessing and Homewood sandstones, although lower than the Sharon Conglomerate, are high enough to provide significant quantities of water. Several wells at the RVAAP facility have penetrated both the Sharon Conglomerate and the Connoquenessing Sandstone and reportedly produced water from both units. In general, hydraulic conductivities in the shales of the Sharon and Mercer Members of the Pottsville Formation are low and produce insignificant groundwater yields. The primary porosity of the shales is likely secondary, owing to joints and fractures in the bedrock; however, there is no facility-specific information available regarding the occurrence of joints and fractures in these units.

There are no records documenting the use of groundwater from LL–6. However, because the underlying Sharon Conglomerate was extensively pumped as a source of groundwater in the vicinity (Kammer, 1982), consideration should be given to the potential for historical contaminant migration from the AOC via groundwater draw down through the Homewood Sandstone. This phenomenon (downward migration between sandstone units), while possible, would only occur if the Homewood Sandstone were affected by LL–6 operations and sufficient downward permeability were present.

2.6.3 Groundwater Utilization

Production wells scattered throughout the facility provided necessary sanitary and process water for RVAAP operations. Remaining process production wells were permanently abandoned in 1992. Currently, three groundwater production wells remain in operation. Two of these wells, located in the central portion of the facility, provide sanitary water to on-site personnel. The production well at Building T5301 has not been abandoned and is not currently utilized. The well may be used as a source of non-potable water in the future. Residential groundwater use in the surrounding area is similar to that for RVAAP, with the Sharon Sandstone acting as the major producing aquifer in the area. The Connoquenessing Sandstone and the Homewood Sandstone also provide limited groundwater resources, primarily near the

western half of the RVAAP facility. Many of the local residential wells surrounding RVAAP are completed in the unconsolidated glacial material.

2.7 Demography and Land Use

As of February 2006, a total of 20,403 acres of the former 21,683-acre RVAAP have been transferred to the United States Property and Fiscal Officer (USP&FO) for Ohio for use as an OHARNG training site. Currently, RVAAP consists of 1,280 acres in several distinct parcels scattered throughout the confines of the OHARNG's Ravenna Training and Logistics Site (RTLS). RVAAP's remaining parcels of land are located completely within the RTLS, and are completely enclosed by the RTLS perimeter fence.

The RTLS is located in northeastern Ohio within Portage and Trumbull counties, approximately 4.8 kilometers (km) (3 mi) east/northeast of the City of Ravenna and approximately 1.6 km (1 mi) northwest of the Village of Newton Falls. The RVAAP portions of the property are completely located within Portage County. The RTLS (inclusive of RVAAP) is a parcel of property approximately 17.7 km (11 mi) long and 5.6 km (3.5 mi) wide. The facility is bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad on the south; Garrett, McCormick, and Berry Roads on the west; the Norfolk Southern Corporation railroad on the north; and State Route 534 on the east.

The RTLS is surrounded by several communities: Windham on the north, Garrettsville 9.6 km (6 mi) to the northwest; Village of Newton Falls 1.6 km (1 mi to the southeast; Charlestown to the southwest, and Wayland 4.8 km (3 mi) to the south. RTLS did not exist when the RVAAP was operational, and the entire 21,683–acre parcel was a government-owned, contractor-operated (GOCO) industrial facility.

The RVAAP facility is located in a rural area, not close to any major industrial or other developed areas. Based on data from the United States Census Bureau (1992) and the *Portage County Soil and Water Conservation District Resources Inventory* (1985), approximately 55% of Portage County, in which a majority of installation acreage is located, consists of either woodland or farmland acreage. The Michael J. Kirwan Reservoir (also known as the West Branch Reservoir) is the closest major recreational area and is located adjacent to the western half of RVAAP south of State Route 5. The vegetation at LL–6 consists of grass, shrubs, and small trees.

2.8 Ecology

Before the government acquired the property in the 1940s, much of the land at RVAAP was cleared for agricultural use. Over 80% of RVAAP is now forest. The limited field cover growth in the remaining 20% of RVAAP is the result of earlier agricultural practices that left these sites

with poor topsoil that still limits forest growth. Several thousand acres of agricultural fields were planted with trees during the 1950s and 1960s, but these plantings did not take well in areas with poor topsoil. Some fields, leased for cattle grazing during the same period, were subsequently delayed in their reversion to forest. A few fields have undergone periodic brush removal to maintain them as open fields. Portions of the RVAAP facility satisfy the regulatory definition of a jurisdictional wetland. Wetland areas at RVAAP include seasonally saturated wetlands, wet fields, and forested wetlands. Some wetland areas are associated with anthropogenic settling ponds and drainage areas. Some of the wetland areas are the result of natural drainage or beaver (*Castor canadensis*) activity. Some wetland areas may have been impacted by former operations due to effluent discharged to settling ponds and the natural drainage of the area in the past. However, many wetlands on the facility are of high quality.

The flora and fauna present at RVAAP are varied and widespread. The following 12 plant species listed as Ohio State Potentially Threatened have been identified at RVAAP:

1. Gray birch (*Betula populifolia*),
2. Butternut (*Juglans cinera*),
3. Northern rose azalea (*Rhododendron nudiflorum* var. *roseum*),
4. Hobblebush (*Viburnum alnifolium*),
5. Long beech fern (*Phegopteris connectilius*),
6. Straw sedge (*Carex straminea*),
7. Water avens (*Geum rivale*),
8. Tall St. John's wort (*Hypercium majus*),
9. Swamp oats (*Sphenopholis pensylvanica*),
10. Shining ladies'-tresses (*Spiranthes lucida*),
11. Arbor vitae (*Thuja occidentalis*), and
12. American chestnut (*Castanea dentate*).

In addition to being a State Potentially Threatened Plant species, butternut also is listed as a Federal Candidate (Category 2) species. A complete list of rare species (plant and animal) found at RVAAP is provided in Appendix B.

The following nine plant and animal species listed as Ohio State Threatened have been identified at RVAAP:

1. Barn owl (*Tyto alba*),
2. Dark-eyed junco (*Junco hyemlais*)(migrant),
3. Hermit thrush (*Catharus guttatus*)(migrant),
4. Least bittern (*Ixobrychus exilis*),
5. Least flycatcher (*Empidonax minimus*),
6. *Psilotreta indecisa* (caddis fly),
7. Simple willow-herb (*Epilobium strictum*),
8. Woodland horsetail (*Equisetum sylvaticum*), and
9. Pale sedge (*Carex pallescens*).

Animals and plants listed as Ohio State Endangered include the sandhill crane (*Grus canadensis*), American bittern (*Botaurus lentiginosus)*, northern harrier (C*ircus cyaneus*), yellow-bellied sapsucker (*Sphyrapicus varius)*, golden-winged warbler (*Vermivora chrysoptera*), osprey (*Pandion haliaetus*), trumpeter swan (*Cygnus buccinator*), mountain brook lamprey (Ichthyomyzon greeleyi), graceful underwing (Catocala gracilis), ovate spikerush (*Eleocharis ovata*), tufted moisture-loving moss (*Philonotis fontana* var. *caespitosa*), narrow-necked Pohl's moss (*Pohlia elongata* var. *elongata*) and bobcat (*Lynx rufus*). Twenty-one animal species present at RVAAP are also listed as Ohio State Species of Concern:

1. Pygmy shrew (*Sorex hovi*),
2. Star-nosed mole (*Condylura cristata*),
3. Woodland jumping mouse (*Napaeozapus insignis*),
4. Sharp-shinned hawk (*Accipiter striatus*),
5. Marsh wren (*Cistothorus palustris*),
6. Henslow's sparrow (*Ammodramus henslowii*),
7. Cerulean warbler (*Dendroica cerulean*),
8. Prothonotary warbler (*Protonotaria citrea*),

9. Bobolink (*Dolichonyx oryzivorus*),
10. Northern bobwhite (*Colinus virginianus*),
11. Common moorhen (*Gallinula chloropus*),
12. Great egret (*Casmerodius albus*),
13. Sora (*Porzana Carolina*),
14. Virginia rail (*Rallus limicola*),
15. Creek heelsplitter (*Lasmigona compressa*),
16. Sedge wren (*Cistothorus platensis*)
17. Eastern box turtle (*Terrapene carolina*),
18. Four-toed salamander (*Hemidactylium scutatum*),
19. Mayfly (*Stenonema ithica),*
20. Moth (*Apamea mixta)*, and
21. Moth (*Brachylomia algens)*.

The OHARNG currently manages the Integrated Natural Resource Management Plan all of RVAAP. Restricted land use and forest management practices have preserved and enabled large forest tracts to mature. Habitat conversion (function of lands being changed back to natural conditions) at RVAAP has focused on restoration of the forests that covered the area before its being cleared for agriculture. The reversion of these agricultural fields to mature forest provides a diversity of habitats from old field through several successional stages. Overall, the increasing forest cover enhances the area for use by both plant and animal forest species.

Future IRP activities will require consideration of these species to ensure no detrimental effects on threatened or endangered RVAAP flora and fauna occur. This will be discussed in the Ecological Risk Assessment presented in Section 7.0. There are currently no Federally listed species or critical habitat on the RTLS property. There are a few species currently under federal observation for listing but none listed.

2.9 Post–RI Decontamination/Demolition Activities

Buildings 2F–3, 2F–7, 2F–8, and 2F–9 were demolished after the RI effort at LL–6. The work conducted included conventional demolition of the buildings followed by building slab removal. The potential impact on the RI sampling locations was reviewed by the Ohio EPA because the building demolition occurred after the Load Line 6 RI. Shallow soil sample locations potentially affected by the demolition operations included LL6SS–016–0001–SO, LL6SS–013–0001–SO, LL6–018–0001–SO, and LL6–006–0001–SO. Subsurface soil sample locations potentially affected by the demolition operations included LL6SB–016–0001–SO, LL6SB–039–0001–SO, LL6SB–013–0001–SO, and LL6SB–006–0001–SO. Proper protocols were followed during the demolition operations. However, impacts on the RI soil sampling locations and their validity will be determined during Phase II activities.

3.0 LOAD LINE 6 INVESTIGATIONS

This section describes the field activities, sampling activities, and sample analyses performed during the investigation of LL–6. All activities were conducted in accordance with the *Facility-Wide Sampling Analysis Plan* (*FWSAP*; USACE, 2001) and the *SAP Addendum* for LL–6 (MKM, 2003b). Investigation objectives, rationale for sampling locations, sampling methods, and sampling locations are discussed in this section. Deviations from the *FWSAP* or the *SAP Addendum* are also documented in this section.

3.1 Field Activities

Azide screening activities conducted in March 2002 and RI activities conducted from October through December 2003 are summarized as follows:

- Mowing/clearing sampling areas and access routes;
- Conducting an avoidance screen for munitions and explosives of concern (MEC);
- Staking sampling locations;
- Excavating test trenches;
- Establishing work zones;
- Establishing temporary decontamination area;
- Collecting surface soil samples;
- Collecting subsurface soil samples;
- Conducting monitoring well installation and development;
- Collecting groundwater samples from monitoring wells;
- Conducting in-situ permeability testing (slug tests);
- Collecting water level measurements;
- Collecting surface water samples;
- Collecting sediment samples;
- Collecting sewer manhole water samples;
- Collecting sub-floor samples;
- Collecting geotechnical samples;
- Conducting a sample location and monitoring well survey; and
- Packing and shipping samples.

The following sections summarize the field sampling activities conducted during the LL–6 azide screening and RI. A photographic log of the RI activities and aerial map are provided in Appendix C.

3.1.1 Mowing/Clearing of Sample Locations

Ground-level vegetation was mowed using a hydroaxe, brushog, and/or hand clearing with chainsaw, machete, and weed eater. The vegetation was cut or cleared to allow personnel and equipment to safely access the designated sampling locations.

3.1.2 MEC Avoidance

Before initiating any field activities, a MEC survey was conducted at LL–6 to ensure worker safety during the RI. A qualified unexploded ordnance (UXO) technician surveyed areas where personnel or equipment might traverse. Anomalies were noted, and safe pathways were established. Appendix D contains the UXO Avoidance Report.

3.1.3 Staking Sampling Locations

Stakes were placed at the approximate soil sampling locations and at the groundwater monitoring well locations. A UXO-qualified technician used a Schonstedt magnetometer to determine whether any anomalies were present. If any anomaly was identified during pre-sampling clearance activity, the sampling location was moved.

3.1.4 Trenching

The trenching activities provided information about the soil stratification profile, depth to groundwater, and depth to bedrock. Trenching was conducted in accordance with Section 4.4.2.4.2 of the *FWSAP*, although no samples were collected during the trenching operations.

Using an excavator, soil was removed at depths ranging from 14.5 ft to 15.5 ft bgs. Soil was removed in 2 ft to 3 ft lifts and placed adjacent to the excavation. A geologist noted the stratigraphic profile of the soils in the trench. Once the trench reached a depth that inhibited profiling from the surface, the excavator brought soil to the top of the trench where the geologist assessed the stratigraphic characteristics. When the required information (depth to bedrock or groundwater, if either was encountered, and the stratigraphic profile) had been obtained, soil was immediately returned to the excavated trench. After soil was replaced in the trench, the soil was graded and compacted. No contaminated soil was visually identified and no MEC was found or removed from the trenches at LL–6.

3.1.5 Work Zones

During drilling and trenching operations, MKM established work zones, delineated by yellow caution tape and road cones. A sign-in log that tracked the whereabouts of field personnel and visitors was maintained at Bldg 1038.

3.1.6 Temporary Decontamination Area

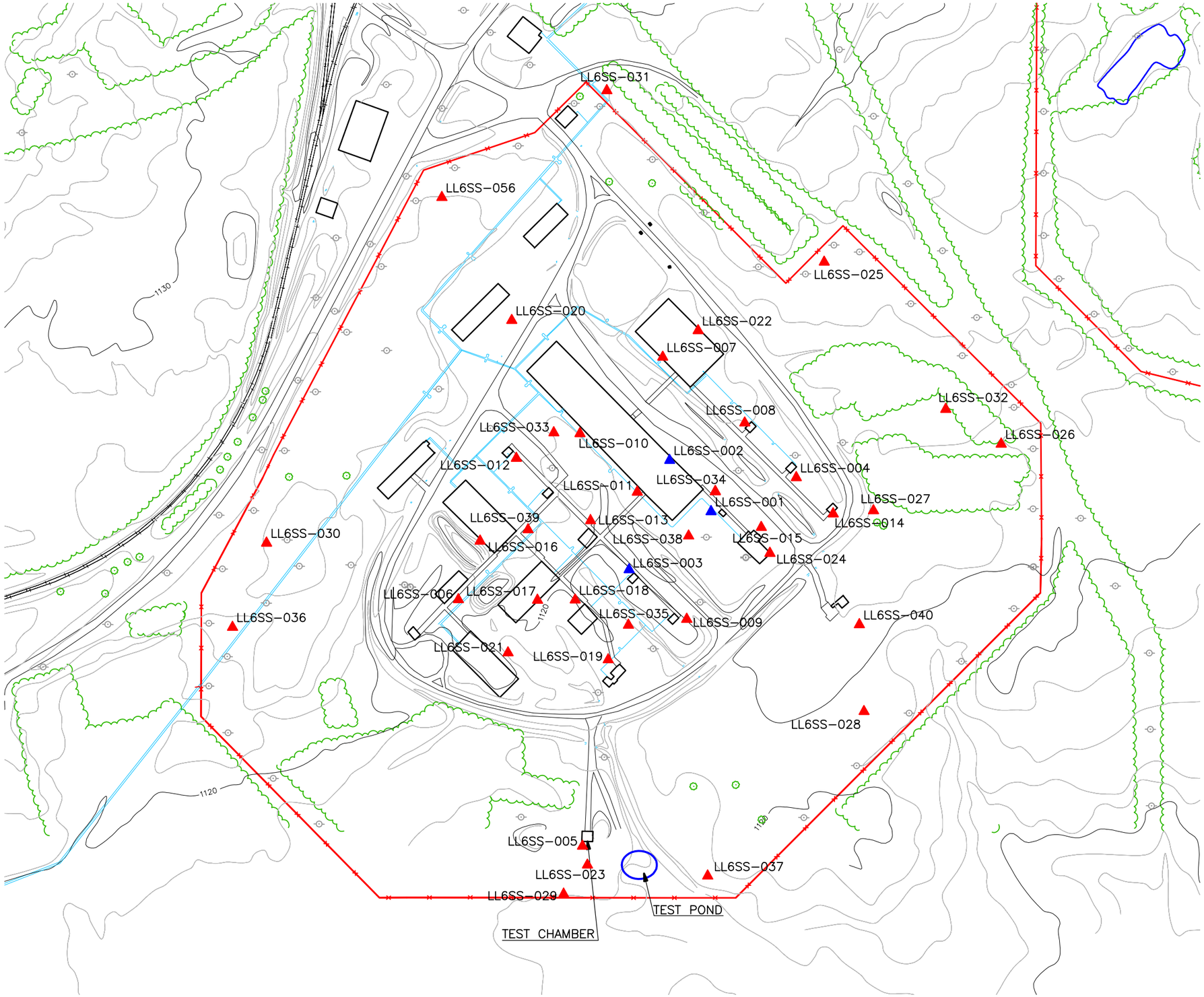
A temporary field decontamination area was constructed to facilitate decontamination of the drilling rig, augers, rods and other associated equipment and personnel. The field decontamination area was located outside the main gate of LL–6 in the parking area. A lined decontamination pad was constructed to capture decon fluids. In addition, several investigation-derived waste (IDW) water and clean water above-ground storage tanks (ASTs) were staged at this location. Sampling and drilling equipment was decontaminated in accordance with the procedures outlined in Sections 4.4.2.8 and 4.3.8 of the *FWSAP*.

3.1.7 Soil Samples

The following sections describe the soil sampling activities that occurred during the performance of the LL–6 azide screening and RI.

3.1.7.1 Azide Screening Soil Samples

Nine surface soil samples (LL6SS–001–0001–SO through LL6SS–009–0001–SO) were collected from LL–6 during the March 2002 azide screening event. Four of the soil samples were screened for lead azide, and nine samples were field screened for TNT and RDX using the Jenkins Method. Additionally, three of the soil samples (LL6SS–001–0001–SO through LL6SS–003–0001–SO) were submitted to Severn Trent Laboratories, Inc. (STL) for explosives and metals analysis. These samples were also sent to General Physics Laboratories (GPL) Laboratory in Gaithersburg, Maryland to substantiate the accuracy of the new GPL screening method for explosives (modified 8330 single column). In addition, one split sample was collected and submitted for analysis. Soil samples collected during the azide screening were collected using a bucket hand auger (stainless steel) method. Soil samples were collected from 0-1 ft interval. The surface soil samples were collected in and around bulk handling and process buildings and from locations within the load line. Figure 3–1 shows the location of the surface soil samples. Analytical and laboratory results of the surface soil samples that were sent to STL are presented in Appendix E. Additional information on azide screening is presented in Appendix F of this report.



LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SURFACE SOIL SAMPLE LOCATION
- SURFACE SOIL SAMPLING LOCATION TAKEN DURING AZIDE SCREENING
- BUILDING
- FENCE

N

0' 100' 200' 300'

1" = 200'

MKM Engineers
4153 Bluebonnet Drive
Stafford, TX 77477

RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

FIGURE 3-1

SURFACE SOIL SAMPLE LOCATION MAP

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2

DRAWN BY	R. BOWMAN	APPR. BY	SL

3.1.7.2 RI Soil Samples

Soil sampling during the LL–6 RI was conducted using the hollow-stem auger/split-spoon, direct push (Geoprobe), and hand auger methods. Soil samples were collected from the surface (0-1 ft interval) and subsurface (1-3 ft interval and deeper). The types of soil samples collected, the sampling intervals (if applicable), and the rationale for the depth of sample collection are listed in Table 3–1.

Table 3–1
Rationale for Selection of Soil Sampling Intervals

Sample Type	Sampling Intervals	Rationale for Actual Depth
Surface Soil	0-1 ft	Predetermined depths specified in the work plan
Subsurface Soil	1-3 ft	Predetermined depths specified in the work plan
Monitoring Well Boreholes	1st interval: 0-1 ft 2nd interval: Varied	Visual observation and/or headspace reading Immediately above saturated zone or headspace reading
Sub-floor	NA	Floor/soil interface in four LL–6 buildings
Sump/Test Chamber	0-1 ft 2nd interval: Varied	Visual observations Depth of the bottom of the sump/test chamber or immediately above saturated zone
Sewer	0-1 ft Below total manhole depth	Visual observations Depth of the bottom of the sewer manholes
VOC Grid	Varied	Immediately above saturated zone or highest headspace reading

After a soil sample was collected, it was immediately placed into a cooler containing ice. Each cooler shipped to the laboratory was accompanied by a completed chain-of-custody form.

3.1.7.2.1 Surface Soils

Surface soil samples were collected to:

- Assess the potential impact of LL–6 activities on surrounding soil,
- Evaluate condition of soil outside the production area,
- Determine the nature and extent of contamination, and
- Determine whether releases had occurred from LL–6 infrastructure.

Table 3–2 lists the sample numbers and the method used to collect each sample. Thirty-seven surface soil samples were collected within the LL–6 AOC. All samples were analyzed for metals. In addition, five samples (exceeding the required minimum of 10%) were analyzed for the full suite of analytes including explosives, metals, VOCs, SVOCs, and PCBs.

Table 3−2
Summary of Surface Soil Samples and Analysis

Sample Type	Collection Method	Sample Numbers[1]	Sample Depth	Activity	Date of Field Work	Laboratory Parameters
Surface Soil						
Surface Soil	Hand Auger	SS001-SS003	0-1 ft	Azide Screening	March 2002	TAL Metals and Explosives [4]
Surface Soil	Hand Auger	SS004-SS030	0-1 ft	R.I	Nov - Dec 2003	TAL Metals and 10% Explosives [2,3]
Monitoring Well	Hand Auger	SS031-SS037	0-1 ft	R.I	Nov - Dec 2003	TAL Metals and 10% Explosives [2,3]
Sewer	Geoprobe	SS038-SS039	0-1 ft	R.I	Nov - Dec 2003	TAL Metals and 10% Explosives [2,3]
Test Chamber	Geoprobe	SS040-SS041	0-1 ft	R.I	Nov - Dec 2003	TAL Metals and 10% Explosives [2,3]
Subsurface Soil						
Subsurface Soil	Hand Auger	SB001-SB030	1-3 ft	R.I	Nov - Dec 2003	TAL Metals and 10% Explosives [2,3]
Monitoring Well	Drill Rig / Split Spoon	SB031-SB037	> 1 ft	R.I	Nov - Dec 2003	TAL Metals and 10% Explosives [2,3]
Sewer	Geoprobe	SB038-SB039	> 1 ft	R.I	Nov - Dec 2003	TAL Metals and 10% Explosives [2,3]
Test Chamber / Sump	Geoprobe / Trowel	SB040-SB041	> 1 ft	R.I	Nov - Dec 2003	TAL Metals and 10% Explosives [2,3]
Sub-floor	Hand Auger	SB042-SB045	1-3 ft	R.I	Nov - Dec 2003	TAL Metals and 10% Explosives [2,3]
VOC Grid	Geoprobe	SB046-SB055	> 1 ft	R.I	Nov - Dec 2003	VOCs, SVOCs, TPH (GRO & DRO)
Groundwater						
Groundwater	Bailer / Low Flow	MW001-MW007	Varied	R.I	Nov - Dec 2003	TAL Metals, Explosives, VOCs, SVOCs, PCBs, Pesticides, Cyanide and Propellants
Surface Water						
Surface Water	Submersion	SW001	not applicable	Azide Screening	March 2002	TAL Metals and Explosives
Surface Water	Submersion	SW002-SW005	not applicable	R.I	Nov - Dec 2003	TAL Metals, Explosives and Cyanide [2]
Sump / Sewer Water	Scoop	SW006-SW009	> 1 ft	R.I	Nov - Dec 2003	TAL Metals, Explosives and Cyanide [2]
Sediment						
Sediment	Hand Core	SD001	> 1 ft	Azide Screening	March 2002	TAL Metals and Explosives
Ditch Sediment	Scoop / Hand Auger	SD002-SD005 and SD010-SD015	0-0.5 ft	R.I	Nov - Dec 2003	TAL Metals, 10% Explosives, TOC and Grain Size [2,3]
Sump / Sewer Sediment	Scoop	SD006-SD009	> 1 ft	R.I	Nov - Dec 2003	TAL Metals, 10% Explosives, TOC and Grain Size [2]
Contingency						
Surface Soil	Hand Auger	SS056	0-1 ft	R.I	Nov - Dec 2003	TAL Metals
Subsurface Soil	Hand Auger	SB056	1-3 ft	R.I	Nov - Dec 2003	TAL Metals

Notes:
1. The following samples were not collected:
SS041, SB022, SB029, SW007, SW009, SD006, SD007, SD008 and SD009. Refer to Section 3.3 for details.
The following samples were not sent to lab:
SB043, SB046, SB047, SB048, SB052, SB053, and SB054
2. Approximately 10% of these samples were analyzed for VOCs, SVOCs, explosives, pesticides, PCBs, cyanide and propellants.
3. 50% of soil samples were sent to GPL for explosive screening using the new modified 8330 method.
4. Samples were sent to GPL laboratory for explosive screening using the new modified 8330 method.

These samples included 27 hand auger surface soil samples (LL6SS–004–0001–SO through LL6SS–030–0001–SO); seven monitoring well locations (LL6SS–031–0001–SO through LL6SS–037–0001–SO); two surface soil samples adjacent to sewers (LL6SS–038–0001–SO and LL6SS–039–0001–SO); and one surface soil sample adjacent to Test Chamber 1 (LL6SS–040–0001–SO).

In addition, four split samples were collected and submitted for analysis. Surface soil samples are documented on the field sampling forms presented in Appendix G. Surface soil sampling results are presented in Appendix E.

3.1.7.2.2 Subsurface Soils

Figure 3–2 shows the location of the subsurface soil samples. Forty-nine subsurface soil samples were collected within the LL–6 AOC. Samples were analyzed for metals. In addition, 5 samples (approximately 10%) of the samples were analyzed for the full suite of analytes including explosives, metals, VOCs, SVOCs, and PCBs. Six split samples were collected and submitted for analysis as part of the QA/QC procedure. These samples included 28 hand auger subsurface soil samples (LL6SB–001–0001–SO through LL6SB–021–0001–SO, LL6SB–023–0001–SO through LL6SB–028–0001–SO, and LL6SB–030–0001–SO); seven monitoring well locations (LL6SB–031–0001–SO through LL6SB–037–0001–SO); at depth equivalent to the bottom of two sewer manholes (LL6SB–038–0001–SO and LL6SB–039–0001–SO); at depth equivalent to the bottom of two sump/test chamber (LL6SB–040–0001–SO and LL6SB–041–0001–SO); and at 10 locations near the former solvent storage building (LL6SB–046–0001–SO through LL6SB–055–0001–SO). Subsurface soil samples were collected to:

- Assess the potential impact of LL–6 activities on the surrounding soil;
- Determine horizontal and vertical nature and extent of contamination;
- Evaluate the geotechnical characteristics of the LL–6 soils; and
- Determine whether releases had occurred from LL–6 infrastructure.

A hollow-stem auger (HSA) rig was used to collect soil borings LL6SB–031–0001–SO through LL6SB–037–0001–SO − the seven monitoring well locations. The HSA soil borings were collected using a standard 2 in outside diameter (OD) by 24 in long split-spoon sampler. The samplers were equipped with sand catchers to minimize loss of soil as the split-spoon sampler was withdrawn.

Two subsurface soil samples (LL6SB–038–0001–SO and LL6SB–039–0001–SO) were collected at LL–6 sewer thrust points or manholes. The samples were located at manholes and stress points where sewer integrity was potentially suspect (see Figure 3–2).

LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SUBSURFACE SOIL SAMPLE LOCATION
- BUILDING
- FENCE

LL6SB–031
LL6SB–056
LL6SB–025
LL6SB–020
LL6SB–022
LL6SB–045
LL6SB–007
LL6SB–042
LL6SB–010
LL6SB–008
LL6SB–032
LL6SB–026
LL6SB–033
LL6SB–012
LL6SB–043
LL6SB–002
LL6SB–004
LL6SB–047
LL6SB–039
LL6SB–034
LL6SB–011
LL6SB–027
LL6SB–046
LL6SB–001
LL6SB–014
LL6SB–050
LL6SB–030
LL6SB–013
LL6SB–015
LL6SB–051
LL6SB–016
LL6SB–028
LL6SB–024
LL6SB–052
LL6SB–003
LL6SB–053
LL6SB–006
LL6SB–044
LL6SB–048
LL6SB–055
LL6SB–018
LL6SB–049
LL6SB–009
LL6SB–036
LL6SB–017
LL6SB–054
LL6SB–035
LL6SB–040
LL6SB–041
LL6SB–021
LL6SB–019
LL6SB–028
LL6SB–005
LL6SB–023
LL6SB–037
LL6SB–029
TEST POND
TEST CHAMBER
1130
1120

N

0' 100' 200' 300'
1" = 200'

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FIGURE 3–2

SUBSURFACE SOIL SAMPLE LOCATION MAP

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02–02–0085	MAY 2007	2

DRAWN BY	R. BOWMAN	APPR. BY	SL

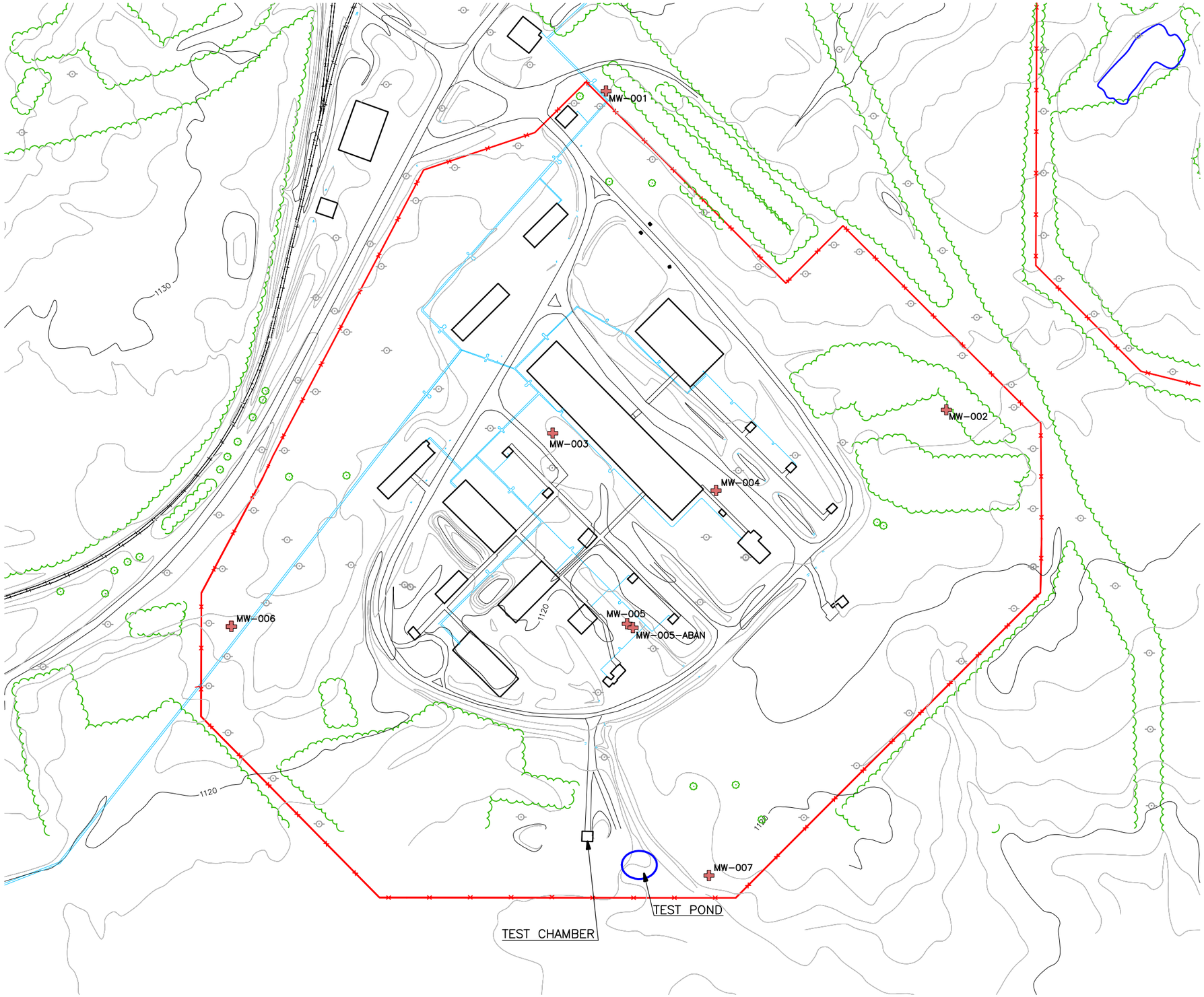
From each boring, two discrete surface soil samples were collected from the 0-1 ft bgs interval and at a second interval starting at the elevation equal to the total manhole depth and extending to 2 ft below the total manhole depth. Before collecting the sample, the samples were field screened for VOCs using a hand-held photo ionization detector (PID). One direct-push soil boring was advanced beside each of the sump and Test Chamber 1 locations. Two soil samples were collected from each boring at Test Chamber 1. The first sample was collected from the 0-1 ft interval. The second sample (LL6SB–040–0001–SO) was collected from the 4 to 6 ft interval. Only one soil sample (LL6SB–041–0001–SO) was collected from approximately 7 ft under the sump, which straddled the bottom elevation of the sump. The sump was excavated during the demolition operations conducted before the RI activities began.

A VOC grid was established at LL–6 in response to the findings of a spent VOC disposal pit at LL–11. The grid was located in the area most likely to be used for local load line disposal purposes. The 50 ft grid was placed in close proximity to the solvent building, downgradient from the load line operations, and in an area that was not used for any load line function (i.e., open field). Then the screening points were established on the grid. Each location was field screened using head space techniques. Screening samples were collected at 10 direct-push soil borings (LL6SB–046–0001–SO through LL6SB–055–0001–SO) from a VOC grid established east of the solvent building at LL–6 (Bldg 2F–35). Four of the 10 soil samples (LL6SB–049–0001–SO, LL6SB–050–0001–SO, LL6SB–051–0001–SO, and LL6SB–055–0001–SO) were sent to STL for confirmation analysis. Samples selected for analysis were collected from the borings exhibiting the highest head space readings.

Soil boring logs are documented in Appendix A, and the monitoring well soil boring logs are documented in Appendix H. Subsurface soil samples are documented on the field sampling forms presented in Appendix I. These subsurface soil sampling results are presented in Appendix J. Samples were placed into a cooler containing ice and submitted to the laboratory accompanied by completed chain-of-custody forms.

3.1.8 Groundwater Activities

- During the RI, seven monitoring wells were installed in the shallow unconsolidated water table zone at LL–6 (Figure 3–3), slug tests were conducted, and groundwater samples were collected. Monitoring Well 5 (MW–005) was plugged because of an installation issue (straightness). The well was abandoned, and a new well was drilled upgradient (north) of the abandoned well with Ohio EPA approval of the technical field change order. Well abandonment forms are included in Appendix B. The new MW–005 was installed after a groundwater sample was collected from the abandoned well. Because of the close proximity (25 ft to the northwest) of the new MW–005 to the abandoned well, no sample was collected from the new MW–005 with Ohio EPA approval of the technical field change order. In addition, one split sample was collected and submitted for analysis.



LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- MONITORING WELL SAMPLE LOCATION
- BUILDING
- FENCE

N

0' 100' 200' 300'
1" = 200'

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FIGURE 3–3

GROUNDWATER MONITORING WELL LOCATION MAP

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02–02–0085	MAY 2007	2

DRAWN BY	R. BOWMAN	APPR. BY	SL

These groundwater activities were conducted to:

- Determine whether the production activities had adversely affected shallow groundwater quality downgradient from the process buildings,
- Evaluate the quality of shallow groundwater upgradient of LL–6, and

Collect data about the LL–6 groundwater flow regime.Monitoring wells were located in the suspected downgradient direction from the areas believed most likely affected by activities at this AOC to evaluate potential subsurface contamination. One well (MW–001) was located in the anticipated upgradient direction from LL–6.

3.1.8.1 Monitoring Well Installation

The installation, development, and sampling of monitoring wells were conducted in accordance with Section 4.3.2 of the *FWSAP* (USACE, 2001) and the *SAP Addendum* (MKM, 2003b). The monitoring wells were installed using HSA drilling methods under the direct supervision of a qualified geologist. A 15.9 cm (6.26 in) inside diameter, hollow-stem auger was used to advance the borehole through unconsolidated material to an average depth of 21.04 ft bgs.

Subsurface soil samples were collected continuously from each of the HSA boreholes using split-spoon samplers. Soils from each split-spoon interval were divided into two portions: part of the soil was placed into pre-cleaned jars with Teflon-lined lids provided by the laboratory; and part of the soil was placed into a new, disposable and resealable bag. After a minimum of 20 minutes, the tip of a PID was inserted into the bag to screen the headspace for the presence of organic vapors. If elevated PID readings were recorded, the soil sample from the interval that exhibited the highest PID reading was sent to the laboratory for analysis. If no elevated PID readings were recorded, the sample from the interval immediately above the saturated zone was analyzed.

Monitoring wells were constructed in each borehole, following termination of drilling at the appropriate depth. A 3.05 m (10 ft) section of new, pre–cleaned 5.0 cm (2.0 in) schedule 40 polyvinyl chloride (PVC) 0.010 slot screen was set to straddle the static water level determined during drilling activities. The well was completed to the surface using new, schedule 40 PVC riser. The screen and riser were placed into the borehole through the drill stem augers during well construction. Clean Global No. 7 sand filter pack was tremied in place from the bottom of the boring to approximately 0.6 m (2 ft) above the top of the well screen. The filter pack was sealed with 0.6 m (2 ft) of bentonite pellets. Type 1 Portland cement with 7% bentonite grout was tremied to complete the remainder of annular space to the surface. At most locations, the wells were finished at the surface with a protective steel surface casing (pro-casing). The only exceptions were locations where shallow saturated subsurface conditions required that the wells be finished using flush or surface mounts. The Ohio EPA approved this change in a memorandum dated 12 November 2003. Field technical change memorandums can be found

in Appendix K. Three steel posts were installed around each well. Monitoring well installation procedures are provided in Section 4.3.2 of the *FWSAP* (USACE, 2001). Well construction diagrams are provided as part of Appendix H.

At least 48 hours after completion (and no longer than 7 days), static water level and total well depth were recorded, and each monitoring well was developed so that a representative groundwater sample could be collected. A minimum of five borehole volumes were removed from each well using a submersible pump. Sediment volume in some of the monitoring wells necessitated the use of alternative development methods to remove the sediment. These methods included tubing and check valve surging. Well development and purging records are provided in Appendix H.

3.1.8.2 In-Situ Permeability Testing

Slug tests were performed at LL–6 wells to estimate the hydraulic conductivity of the unconsolidated material surrounding each well screen. Test results were field checked for validity before to leaving the site. However data files for MW–001, MW–002, and MW–006 were corrupted after field collection. Slug tests were repeated on November 3, 2006 for MW–002 and MW–006 (MW–001 does not contain a sufficient water column to conduct a slug test). The revised data are included in Appendix L. Slug test data records for the remaining four wells (MW–003, MW–004, MW–005 and MW–007) are also provided in Appendix L.

A transducer was used to collect the falling and rising head data. First, the rising head was conducted by inserting a stainless steel slug into the well and recording water levels until the groundwater returned to static levels. After it was determined that the groundwater elevations had stabilized, the falling head test was conducted by removing the slug and collecting data until static conditions were achieved. The slug testing of monitoring wells was conducted in accordance with the *FWSAP* (USACE, 2001) and the *SAP Addendum* (MKM, 2003b).

3.1.8.3 Groundwater Sampling

Before collecting groundwater samples, each well's condition was evaluated and noted. This evaluation occurred at least 48 hours after development was complete. Casing headspace was field screened at each well using a hand-held PID. The depth to water and depth to the bottom of the well casing were measured and recorded. Each well was purged using micropurge technology. Purging continued until water quality indicators such as pH, temperature, dissolved oxygen, and conductivity were stabilized (three consecutive readings within 10% of each other). Samples were collected within 24 hours of purging each monitoring well and placed into pre-cleaned bottles provided by STL. Low-flow sampling technology was used to collect groundwater samples at LL–6, with the exception of the VOC samples, which were collected with a two-inch bailer. This collection method was used so that any potential VOCs were not volatilized or missed if they were light non-aqueous phase liquids.

Groundwater samples were collected between December 15–18, 2003. Either a two-inch bailer or low-flow technology (a purge rate of less than 500 milliters [ml] per minute) was used to collect groundwater samples. If low-flow technology was appropriate, a QED Sample Pro bladder pump with an associated pump controller and flow cell was used. Groundwater samples were collected as specified in Section 4.3.4 of the *FWSAP* (USACE, 2001). Groundwater samples that were to be analyzed for target analyte list (TAL) dissolved metals were field-filtered as per Section 4.3.5 of the *FWSAP*. Samples were placed into a cooler containing ice and submitted to the lab accompanied by completed chain-of-custody forms.

Characteristics of the unconsolidated materials in which the wells are set include abundant mobile fines. Historically, prevalent turbidity readings are >5 nephelometric turbidity (NTU). Only bedrock wells have shown turbidity <5 NTU. Wells were surged for a maximum of 48 hours or until seven borehole volumes were removed with surge blocks, tubing, pumps, check valves, and bailers to remove sediment from screen. For several wells a turbidity of ≤5 nephelometric turbidity units (NTUs) could not be reached given the nature of the unconsolidated water bearing zone. Low-yield wells with turbidity >5 NTUs were stopped after 7 borehole volumes were removed or after 48 hours of development. Each well was allowed 48 hours to recover before resampling. These issues and procedures were discussed with the Ohio EPA during the field investigations. Well purging and sampling forms are provided in Appendix H. Groundwater analytical and laboratory results are provided in Appendix M.

3.1.8.4 Water Level Measurements

Static water level and total depth measurements were taken and recorded at each monitoring well on two separate occasions to provide data on the groundwater flow regime underlying LL–6. These data were collected during December 2003 and June 2004 and are shown in Table 3–3. Groundwater elevation data are included in Appendix H.

Table 3–3
LL–6 Groundwater Elevations

Easting	Northing	Well ID	TOC	Depth to water, ft		GW Elevation, ft MSL	
				Dec–03	Jun–04	Dec–03	Jun–04
2353153.23	554214.84	LL6mw–001	1,124.16	10.97	9.75	1,113.19	1,114.41
2353820.09	553589.88	LL6mw–002	1,129.36	17.32	18.68	1,112.04	1,110.68
2353048.68	553544.34	LL6mw–003	1,125.38	13.11	13.69	1,112.27	1,111.69
2353368.79	553431.82	LL6mw–004	1,125.39	14.91	15.53	1,110.48	1,109.86
2353194.52	553170.76	LL6mw–005	1,120.47	8.62	10.83	1,111.85	1,109.64
2352419.15	553165.28	LL6mw–006	1,124.37	12.26	10.92	1,112.11	1,113.45
2353354.89	552677.17	LL6mw–007	1,115.62	3.40	4.30	1,112.22	1,111.32

NOTE: Groundwater samples measured during 9 days of MW development.

3.1.9 Surface Water

The following sections describe the surface water sampling activities that occurred during the performance of the LL–6 azide screening and RI.

3.1.9.1 Azide Screening Surface Water Sample

One surface water sample (LL6SW–001–0001–SW) was collected from LL–6 during the March 2002 azide screening event. In addition, one split sample was collected and submitted for analysis. The surface water sample was collected from a pond that was used for under-water explosive testing. The surface water sample was collected using direct fill of a hand-held bottle. The surface water sample was submitted to STL for explosives and metals analysis. Figure 3–4 shows the location of the surface water samples. Analytical and laboratory results of the surface water samples that were sent to STL are presented in Appendix N. Additional information on Azide Screening is presented in Appendix F of this report.

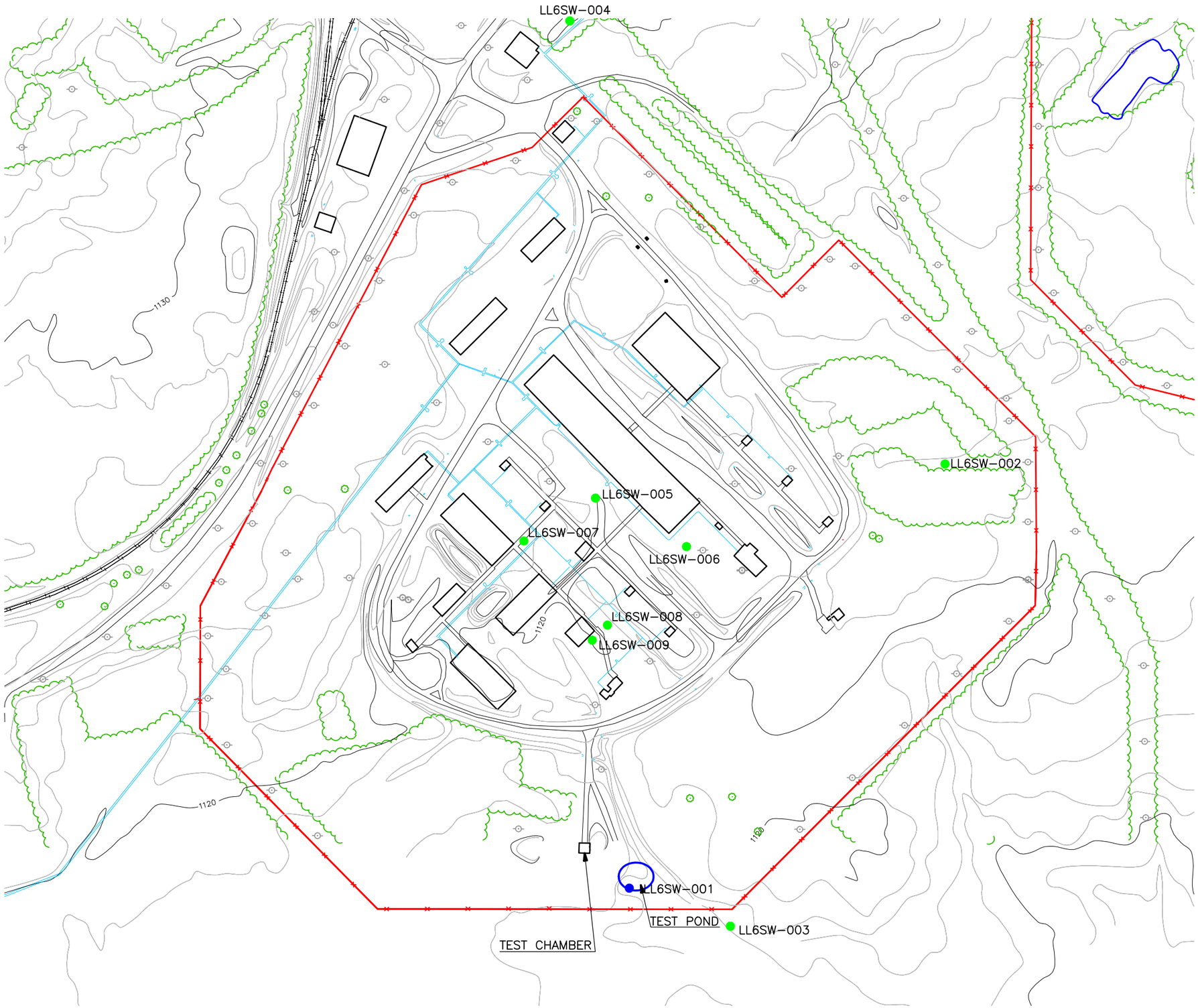
3.1.9.2 RI Surface Water Samples

Surface water samples were collected from the main flow ways at the LL–6 to:

- Evaluate whether surface water is being affected by runoff from the former production area,
- Identify the migration pathways for potentially contaminated runoff (if any) from the process area, and
- Evaluate whether contaminants migrate beyond the site boundary via LL–6 drainage ditches.

Five locations (LL6SW–001–0001–SW through LL6SW–005–0001–SW) were selected to evaluate whether contaminants could be affecting surface water within the AOC boundary (Figure 3–4). In addition, one split sample was collected and submitted for analysis. Sewer sample locations LL6SW–006–0001–SW through LL6SW-009-0001-SW also are shown on Figure 3-4 and discussed in Section 3.1.11.1.

At each location, surface water sample collection began at the furthest downstream point and moved upstream, thus minimizing disturbance of the sediment and the turbidity of the collected sample. The surface water was collected as described in Section 4.6.2.1.1 of the *FWSAP* (USACE, 2001) and the *SAP Addendum* (MKM, 2003b). Direct fill of hand-held bottles was used to sample water in the drainage ditches. Each container was submerged into the water with the cap in place. The cap was removed, and the container was allowed to fill slowly and continuously. Water quality measurements (pH, conductivity, dissolved oxygen content, and temperature) were recorded just before sample collection. Table 3–2 lists the analyses run on each surface water sample.



LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SURFACE WATER SAMPLING LOCATION
- SURFACE WATER SAMPLING LOCATION TAKEN DURING AZIDE SCREENING
- BUILDING
- FENCE

N

0' 100' 200' 300'

1" = 200'

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FIGURE 3-4

SURFACE WATER SAMPLE LOCATION MAP

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
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DRAWN BY	R. BOWMAN	APPR. BY	SL

Samples were immediately placed into a cooler containing ice, and the cooler was submitted to the laboratory accompanied by completed chain-of-custody forms. Surface water field sampling forms are provided in Appendix O, and analytical and laboratory results from the samples are presented in Appendix N.

3.1.10 Sediment

The following sections describe the sediment sampling activities that occurred during the performance of the LL–6 azide screening and RI.

3.1.10.1 Azide Screening Sediment Sample

One sediment sample (LL6SD–001–0001–SD) was collected from LL–6 during the March 2002 azide screening event. The sediment sample was co–located with the surface water sample and was collected from the pond that was used for under-water explosive testing. The sediment sample was collected using a 0.61 m (2 ft) hand core sampler. The sediment sample was submitted to STL for explosives and metals analysis. Figure 3–5 shows the location of the sediment sample. Analytical and laboratory results of the sediment sample that was sent to STL are presented in Appendix P. Additional information on azide screening is presented in Appendix F of this report.

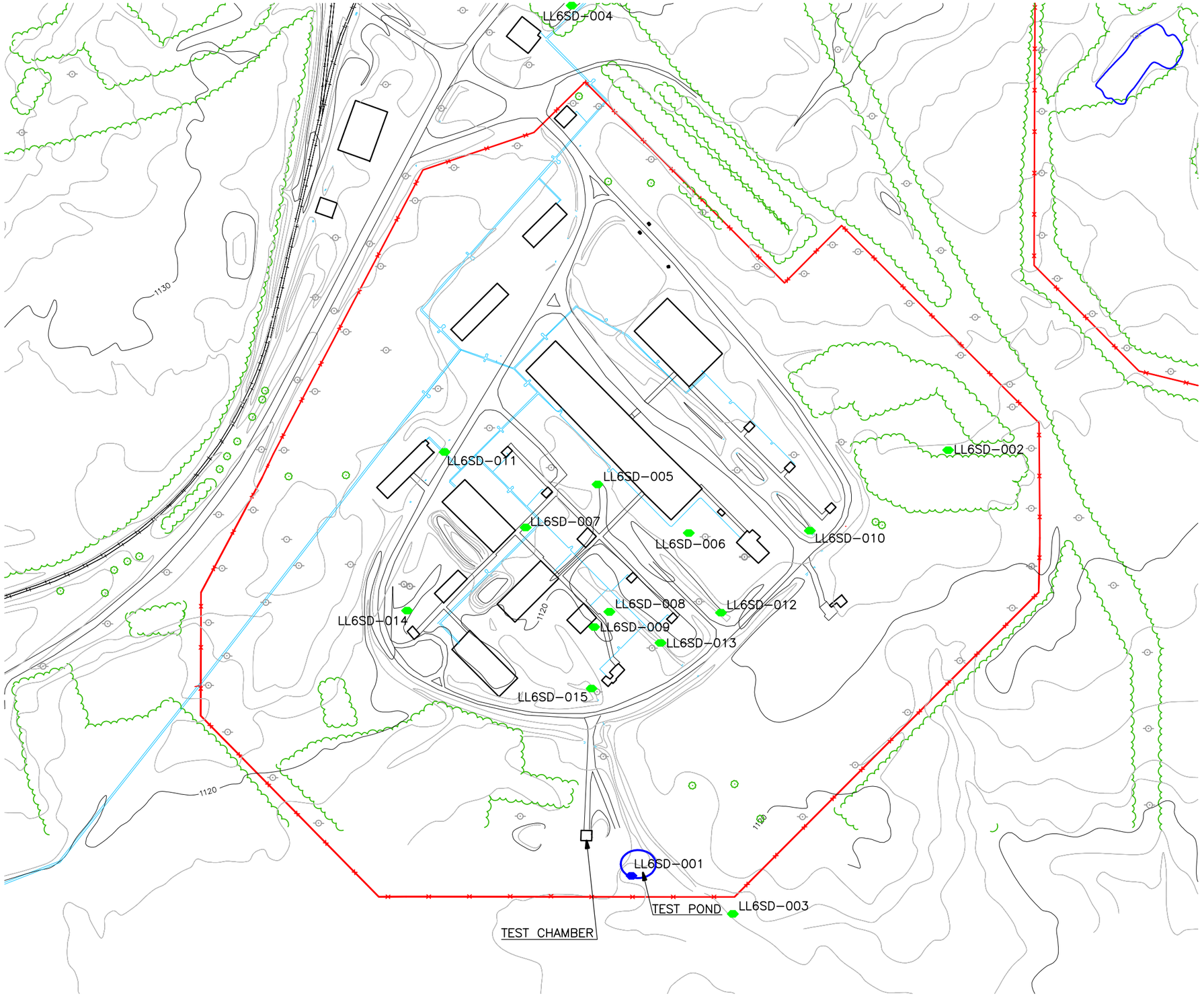
3.1.10.2 RI Sediment Samples

Sediment samples were collected from the main flow ways at the LL–6 to:

- Evaluate whether sediments are being impacted via surface water runoff at the LL–6,
- Identify the migration pathway for potential contaminants that may have been suspended in surface water runoff, and
- Evaluate whether contaminants may have migrated beyond the AOC boundaries.

Ten locations (LL6SD–002–0001–SD through LL6SD–005–0001–SD and LL6SD–010–0001–SD through LL6SD–015–0001–SD) were selected to evaluate whether the drainage system at LL–6 allowed contaminants to migrate beyond the site boundary (Figure 3–5). Four of the sediment samples (LL6SD–002–0001–SD through LL6SD–005–0001–SD) were co-located with the surface water sample locations.

Sediment samples were collected from 0 to 0.15 m (0 to 0.5 ft) below the sediment-water interface along the drainage ditches. Sediment samples were collected using a scoop or trowel. Three of the ten sediment samples (LL6SD–010–0001–SD, LL6SD–011–0001–SD and LL6SD–012–0001–SD) were collected using a stainless steel hand auger. Two sediment samples (LL6SD–011–0001–SD, and LL6SD–012–0001–SD) were collected as soil samples because water was not present during sampling. Sampling procedures are described in Section 4.5.2.1 of the *FWSAP* (USACE, 2001) and the *SAP Addendum* for LL–6 (MKM, 2003b).



LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SEDIMENT SAMPLING LOCATION
- SEDIMENT SAMPLING LOCATION TAKED DURING AZIDE SCREENING
- BUILDING
- FENCE

N

0' 100' 200' 300'

1" = 200'

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RAVENNA, OHIO

FIGURE 3-5

SEDIMENT SAMPLE LOCATION MAP

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2

DRAWN BY	R. BOWMAN	APPR. BY	SL

Sediment samples from LL–6 were homogenized and placed into sample containers. Samples were immediately placed into a cooler containing ice and submitted to the laboratory accompanied by a completed chain-of-custody forms. Two split samples were also collected and submitted for analysis. Table 3–2 lists the analyses completed on the sediment/soil samples. Sediment field sampling forms are presented in Appendix Q, and analytical and laboratory results from the samples are presented in Appendix P.

3.1.11 Other RI Samples

Additional environmental samples were collected from sewers at LL–6. No water or sediment sample was collected from the sump at LL–6 during the RI because the sump was excavated during the demolition operations conducted before RI activities began. However, a water sample was collected from the sump during the demolition operations for waste disposal characterization. The laboratory results for the sump water are presented in Appendix N. Samples were collected from standing water in LL–6 sewer manholes. No sediment samples (LL6SD–006–0001–SD through LL6SD–008–0001–SD) were collected from the sewer manholes owing to the lack of recoverable quantities of sediment. If a sample was not obtained, it was noted on a field sampling report. The samples were collected to evaluate whether process operations had affected the sewer manholes. When sewer manhole samples were collected, no personnel entered the structures. A scoop was lowered into the manhole to collect the water sample.

3.1.11.1 Sewer Manhole Water Samples

Water samples LL6SW–006–0001–SW and LL6SW–008–0001–SW were collected from sewers located near Buildings 2F–11 and 2F–3 (Figure 3–4). Water sample LL6SW–007–0001–SW from the sewer located near Building 2F–8 was not collected because not enough water was present or recoverable. Table 3–2 lists the sewer samples that were collected and the associated analyses.

Water samples were immediately placed into a cooler containing ice and submitted to the laboratory accompanied by a completed chain-of-custody forms. The field sampling forms for the sewer water and sediment samples are provided in Appendices O and Q, respectively. The analytical and laboratory results for the sewer water are presented in Appendix N.

3.1.11.2 Subfloor Samples

Subfloor samples LL6SB–042–0001–SO through LL6SB–045–0001–SO at Buildings 2F–11, 2F–4, and 2F–3 were collected at the soil/sub-base interface to assess potential impact on the underlying soils from historic activities at LL–6. Two samples were collected from Building 2F–11 and one each from Buildings 2F–4 and 2F–3 (Figure 3–2). The subfloor samples were collected from the areas shown in the approved *SAP* Addendum for the Remedial Investigation of Load Line 6 (MKM, 2003b). These samples were originally scoped to be collected by boring

through the concrete slabs into the undisturbed soil in the 0–1 ft interval. Demolition activities were conducted at LL–6 before the RI sampling began. The heavy equipment (excavators, bulldozers and loaders) tracked within the footprint of the buildings, and the subfloor soil was disturbed to depths sometimes greater than 1 ft below the subfloor base. The subfloor soil in the 0–1 ft interval did not appear to be representative of the predemolition conditions. Therefore, samples were collected from the 1–3 ft interval below the disturbed soil.

The soil/floor interface samples were collected after the buildings were demolished. Work was conducted in accordance with the LL–6 work plan and SAP. The sample location was determined by establishing the four corners of the former building and placing the sample location in an area of the building with a function most likely to release compounds used at the load line. The samples were collected using a hand auger from 1-3 ft bgs. One discreet soil sample was then collected from each boring location using a clean, decontaminated, stainless steel hand auger. Samples were immediately placed into a cooler containing ice and submitted to the laboratory accompanied by a completed chain-of-custody forms. Subfloor (surface soil) field sampling forms are provided in Appendix G, and analytical and laboratory results from the samples are presented in Appendix E.

3.1.11.3 Geotechnical Samples

Geotechnical samples were collected from three of the ten monitoring well borehole locations, as agreed with Ohio EPA and USACE. Sample locations were selected in the field by the geologist, based upon site knowledge and field conditions encountered during the boring installation. The intervals sampled were selected based upon recognition of the different lithologies encountered and the saturated/unsaturated conditions. Geotechnical analysis included grain size distribution, moisture content, total organic carbon (TOC), hydraulic conductivity, and Atterberg limits. The analytical results match the typical distributions and qualities anticipated for the till/soils types at LL–6. The samples were collected using direct-push Shelby tubes and submitted to a geotechnical laboratory for analysis. Samples were collected from:

- LL6SB–031–0001–SO from the 8 to 10 ft interval,
- LL6SB–033–0001–SO from the 2 to 4 ft interval, and
- LL6SB–036–0001–SO from the 4 to 6 ft interval.

Geotechnical results are presented in Appendix R.

3.1.11.4 Contingency Samples

Two contingency samples (LL6SS–056–0001–SO and LL6SB–056–0001–SO) were collected at LL–6. The number of unbiased samples required depended upon the number of soil samples taken at the end of the field effort. The two soil samples were collected from the same location

at 0–1 ft and 1–3 ft bgs (Figures 3–1 and 3–2). Field sampling forms for surface soil and subsurface soil are provided in Appendices G and I, respectively; and analytical results from the samples are presented in Appendices E and J, respectively.

3.1.12 Sampling Location Survey

Each newly installed monitoring well, soil, surface water and sediment sampling location was surveyed as specified in Section 4.3.2.3.12 of the *FWSAP* (USACE, 2001). Monitoring well, soil, surface water, and sediment sampling location survey data can be found in Appendix S.

3.1.13 Investigation-Derived Waste

During the field activities, IDW was generated. The accumulated soil and water wastes were characterized and disposed. Representative composite samples of the waste materials were collected and analyzed per the requirements of the disposal facility. The following summarizes the LL–6 waste management disposition operations:

- Excess soil cuttings generated from soil sampling, drilling operations, and sediment sampling were containerized in a 20 yard roll-off and stored until disposition. Based on the composite sampling and analyses, the soil was determined to be non-hazardous. These materials were profiled and disposed at the county-wide Regional Disposal Facility (RDF) landfill in East Sparta, Ohio.
- Monitoring well development/purging and equipment decontamination generated IDW wastewater. Based on laboratory analytical results, the wastewater was determined to be non-hazardous. The wastewater was profiled and transported to the biosolids treatment facility in Cleveland, Ohio, for disposal.

IDW was collected, stored, sampled/analyzed, and disposed in accordance with applicable federal, state, and/or local rules, laws, and regulations. Appendix T contains copies of chain-of-custody forms for IDW samples, IDW field sampling forms, laboratory reports, and manifests used to track the IDW.

3.1.14 Sample Packaging and Shipping

Samples were packaged and shipped per Section 6.0 of the *FWSAP* (USACE, 2001) and Section 7.0 of the *SAP Addendum* (MKM, 2003b). Samples were properly packaged for shipment and dispatched to STL and GPL for analysis accompanied by completed chain-of-custody forms. When transferring the possession of samples, the individuals relinquishing custody and the individual receiving the samples signed their names and noted the date and time of transfer on the record. Shipments complied with applicable Department of Transportation regulations for environmental samples.

3.2 Data Analysis and Quality

This section briefly describes the data quality procedures that were followed, and then discusses the quality of the data collected.

3.2.1 Field Laboratory Program

As previously mentioned, surface soil samples collected during the azide screening were field analyzed for TNT and RDX using the Jenkins method. QA procedures were completed in accordance with manufacturer requirements, including calibration of the instrument to achieve proper wave length readings and analysis of a control sample.

Samples collected during the RI (October 2003 – December 2003) were also sent to GPL for explosive screening analysis, instead of screening for explosives by the Jenkins method as outlined in the *SAP Addendum* (MKM, 2003b). These GPL data were not validated nor used in the quantitative risk assessment; however, these data are mentioned in the uncertainty discussion (section 7.0) of this report. Analytical results for the GPL data are presented in Appendices E, J, and P for surface soil, subsurface soil, and sediments, respectively. Furthermore, the STL air-dried split duplicate samples (D–12S, D–13S, and D–14S) collected during the azide screening were not used in the quantitative risk assessment. However, analytical results for these samples are presented in Appendix F.

3.2.2 Laboratory Analysis

Analytical laboratory procedures were completed in accordance with applicable professional standards, USEPA requirements, government regulations and guidelines, and specific project goals and requirements. Samples collected during the investigation were analyzed by STL, a USACE Center of Excellence validated laboratory under contract for the investigation. With the exception of nitroguanidine and nitrocellulose analyses, chemical analyses were performed at STL's Chicago laboratory. The two aforementioned propellants were analyzed at STL's Sacramento laboratory. Geotechnical parameters were performed by Prime Engineering, Inc., located in Akron, Ohio. Explosive screening (modified 8330) samples were submitted to GPL in Gathersburg, MD, for analysis. Laboratories supporting this work have statements of qualifications, including organizational structures, QA manuals, and standard operating procedures, which are available upon request.

Samples were analyzed in accordance with the FWSAP (USACE, 2001) and the SAP Addendum (MKM, 2003b). The data quality objectives (DQOs) established for the LL–6 RI complies with USEPA Region V guidance. The requirements for sample collection, handling, analysis criteria, target analytes, laboratory criteria, and data validation criteria at LL–6 are consistent with USEPA requirements for National Priority List (NPL) sites. DQOs for this project included analytical precision, accuracy, representativeness, completeness, comparability, and sensitivity of the measurement data.

The analytical laboratories were required to adhere strictly to the Quality Assurance Project Plan (QAPP) to ensure good quality data would be provided. The laboratory was required to perform analyses in compliance with USEPA SW–846 (USEPA, 1990), Test Methods for Evaluating Solid Waste, Physical/Chemical Methods and Analytical Protocols. USEPA SW–846 chemical analytical procedures were followed for the analyses of metals, VOCs, SVOCs, pesticides, PCBs, explosives, and cyanide. Laboratories were required to comply with methods as written; recommended procedures suggested in the methods were considered to be requirements.

Geotechnical samples were collected and tested for the following parameters:

- Atterberg limits,
- Specific gravity,
- Moisture content,
- Grain size,
- pH, and
- Total organic content.

The requisite number of QA/Quality Control (QC) samples was obtained during the LL–6 RI. QC samples for this project included equipment blanks (10%), trip blanks (VOC coolers as required), field blanks (10%), field duplicates (10%), laboratory method blanks (5%), laboratory control samples, laboratory duplicates, and matrix spike/matrix spike duplicates (MS/MSD) (5%). The QA/QC sample results (equipment rinseate samples, trip blanks, and field duplicates) are discussed in Appendix U.

These samples were collected to meet the following requirements:

- Laboratory method blanks and laboratory control samples were employed to determine the accuracy and precision of the analytical method as implemented by the laboratory;
- Matrix spike samples provided information about the effect of the sample matrix on the measurement method;
- Laboratory sample duplicates and MS/MSDs assisted in determining the analytical reproducibility and precision of the analysis for the samples of interest;
- Field blanks, consisting of potable water used in the decontamination process, equipment rinseate blanks, and trip blanks were submitted for analysis along with field duplicate (co-located) samples to assess the quality of the data resulting from the field sampling program;
- Field blank samples were analyzed to determine procedural contamination at the site that may contribute to sample contamination;

- Equipment rinseate blanks were used to assess the adequacy of equipment decontamination processes for groundwater sample collection;
- Trip blanks were used to assess the potential for VOC contamination of samples owing to contaminant migration during sample shipment and storage; and
- Field duplicate samples were analyzed to determine sample heterogeneity and sampling method reproducibility.

3.2.3 Data Review, Validation, and Quality Assessment

MKM will maintain the LL–6 RI project files, including relevant records, reports, logs, field notebooks, pictures, subcontractor reports, correspondence, and chain-of-custody forms. These files will remain in the custody of the MKM Project Manager until they are transferred to BRACD, OHARNG RTLS, and RVAAP.

Samples were properly packaged for shipment and dispatched to STL and GPL for analysis accompanied by completed chain-of-custody forms. When transferring the possession of samples, the individual relinquishing custody and the individual receiving the samples signed their names and noted the date and time of transfer on the record. Shipments complied with applicable Department of Transportation regulations for environmental samples.

Analytical data were produced, reviewed, and reported by the laboratory in accordance with specifications outlined in the SAP Addendum (MKM, 2003b) and the laboratory's QA manual. Laboratory reports included documentation verifying compliance with sample log-in procedures, analytical holding times, and QC procedures for analyses. The laboratory reports also provide information pertaining to percent recovery attained in laboratory spike samples, calibration curves (initial and continuing), dilutions, and detection limits. The laboratory flagged suspect data if results warranted.

STL performed in-house analytical data reduction under the direction of the Laboratory Project Manager and QA Officer. These individuals were responsible for assessing data quality and informing MKM of any data that were considered "unacceptable" or required caution on the part of the data user in terms of its reliability. This notification allowed MKM to determine the need for recollection or reanalysis of any samples to achieve DQOs. Data reduction, review, and reporting by the laboratory were conducted as follows:

- Raw data produced by the analyst were given to the analyst's supervisor;
- The supervisor reviewed the data to determine whether it met the QC criteria as outlined in the established methods and for overall reasonableness;
- Upon acceptance of the raw data by the supervisor, a report was generated and sent to the laboratory's Project Manager;

- The laboratory's Project Manager reviewed the reports and, based on that review, generated final reports; and
- The final data were delivered to MKM personnel, who forwarded the packages to Purves Environmental, an independent third party validator, for QA review, comparison, and validation. The QC results were evaluated and summarized in the LL–6 Quality Control Summary Report (QCSR), which is provided in Appendix U.

STL prepared and retained full analytical and QC documentation for the project in both hard (paper) copy and electronic storage media (i.e., magnetic tape) as directed by the analytical methods employed. STL provided the following information to MKM in each analytical data package submitted:

- Cover sheets listing the samples included in the report and narrative comments describing problems encountered (if any) during analysis;
- Tabulated results of inorganic and organic compounds identified and quantified; and
- Analytical results for QC sample spikes, sample duplicates, initial and continuing calibration verifications of standards and blanks, method blanks, and laboratory control sample information.

Upon receipt of each package, MKM compared the data packages to the chain-of-custody forms to ensure analyses had been conducted and results were provided. Only STL data were forwarded to Purves Environmental for data validation. The samples that were sent to GPL for explosive screening were not sent to Purves Environmental for data validation. The GPL samples were used only to provide data and information to assess the accuracy and validity of the GPL test method for potential use instead of field screening kits for explosives. Purves Environmental systematically verified and validated the data to ensure that the precision and accuracy of the analytical data were adequate for their intended use. This validation process minimized the potential of using false or negative results in the decision-making process and ensured that detected and non-detected compounds were accurately identified. This approach was consistent with the DQOs for the project and with the analytical methods, and appropriate for determining contaminants of concern and calculating risk.

The data validation determined that the data were 100% complete and usable, and that they satisfied the DQOs for this project. The data validation reports are presented in Appendix U.

3.3 Deviations from the Work Plan

Every effort was made to complete the field activities in accordance with the approved work plan. However, in some instances, circumstances or field conditions necessitated a modification. Ohio EPA was involved in deviation decisions either while an Ohio EPA representative was present at the site or via e-mail or other correspondence. Those changes are noted below:

- The *SAP Addendum (MKM, 2003b)* mandated that 50% of the soil samples be field screened by the Jenkins method; however, it was agreed upon by the parties to send 50% of the soil samples to GPL for explosive screening (modified 8330) analysis.
- Sample LL6SS–010–0001–SO was recollected after the original sample was lost by the lab.
- Sample LL6SS–041–0001–SO was not collected during the RI because the sump was excavated during the demolition operations that were conducted before the RI began.
- Sample LL6SB–009–0001–SO second interval (1–3 ft) was collected 1 ft NW of the original location because of refusal at 18 in at the original location.
- Sample LL6SB–022–0001–SO was not collected because of refusal at 18 in at the original location. A second attempt was made to collect the sample 1 ft NW of the original location, but the sample was again refused at 18 in.
- Sample LL6SB–029–0001–SO was not collected because of refusal at two different locations.
- Sample LL6SB–043–0001–SO was collected but not sent to the lab. Sample LL6SB–043–0001–SO was planned as a contingency sample if needed as per the SAP/WP. Field crews collected the sample as a precaution in case the sample was needed to meet QA/QC requirements. The sample was not needed to fulfill QA/QC requirements and was therefore discarded as IDW.
- Sample LL6SW–007–0001–SW was not collected because sewer water was not present at the time of sampling.
- Sample LL6SW–009–0001–SW was not collected during the RI because the sump was excavated during the demolition operations that were conducted before the RI began. However, the sump water was sampled for characterization for disposal during the demolition activities.
- At some ditch locations, no water was present. In those cases, a soil sample was collected from the 0-1 ft range. The following samples that had been planned as sediment samples were “converted” to soil samples owing to field conditions: LL6SD–011–0001–SD and LL6SD–012–0001–SD.
- Sample LL6SD–009–0001–SD was not collected during the RI because the sump was excavated during the demolition operations that were conducted before the RI began.
- Samples LL6SD–006–0001–SD, LL6SD–007–0001–SD, and LL6SD–008–0001–SD were not collected because sewer sediment was not present at the time of sampling.
- Monitoring well MW–005 was plugged because the casing was not installed perpendicular to the ground surface. Therefore, the original MW–005 was abandoned and the well was redrilled upgradient (25 ft to the northwest) upon Ohio EPA approval. Required documents were filed with the Ohio Department of Natural Resources (ODNR) in accordance with the regulations.

- Slug tests were performed for MW–001, MW–002, and MW–006. However, data files for these tests were corrupted after field collection. The tests were re–run after the submission of the Preliminary Draft RI Report with the exception of MW–001, which has not had a sufficient water column to conduct slug testing.
- The MS/MSD frequency required by the SAP was achieved for Method 8330 analyses; however, the laboratory did not select project samples for MS/MSD analyses for all other methods. Therefore, the overall MS/MSD frequency did not meet the SAP requirements.

Although deviations occurred, the objectives of the RI were still achieved.

4.0 NATURE AND EXTENT OF CONTAMINATION

This section summarizes the soil (surface and subsurface), groundwater, surface water, sediment, and other analytical results. The results are organized by media or type of sample: soil (surface and subsurface), groundwater, surface water, and sediment, including samples such as standing water and residue found in the sumps, and geotechnical data results. Tables provided at the end of this section list the analytical results that exceeded either the RVAAP installation background criteria (USACE, 2001b) criteria or Region 9 residential soil or tap water PRGs, which were used to screen the initial results.

The RVAAP installation background concentrations were calculated from data obtained in the Winklepeck Burning Ground (WBG) Phase II RI (USACE, 2001b). The background criteria are based on concentrations of selected naturally occurring metals in soil, sediment, surface water, and groundwater. Background values were not established for explosives, propellants, VOCs, SVOCs, and TOC; therefore, the background value assigned to these compounds, for the purpose of this RI, is zero. For metals that were "non-detect" in the background study, the background value was established as zero (USACE, 2001b). Some metals (including cyanide and cadmium) are reported as greater than installation background criteria (USACE, 2001b) exceedances even though the reported concentrations are extremely low, when compared to their respective PRGs. Region 9 residential PRGs were obtained from the USEPA website. Region 9 PRGs for non-carcinogenic (nc) concentrations are reported as one-tenth of the published Region 9 PRG value for soil and sediment media (also referred to as Cal-modified PRG values). Cal-modified refers to the State of California modified toxicity criteria that are presented on the USEPA Region 9 PRG table, 1998 (USEPA, 2004c). This procedure takes into account the additive issues with multiple COPCs. The data tables found at the end of Section 4.0, include a column that lists the installation background criteria (USACE, 2001b) concentrations that were established for each analyte/medium. No background criteria were established for RVAAP soils that exceed 3 ft in depth. Therefore, results for samples collected at depths greater than 3 ft were compared to the background values established for metals found in the 1–3 ft interval. The significance of the contaminants detected in LL–6 media is discussed in the human health and ecological risk assessment discussions (Sections 8.1.3 and 8.1.4) of this document.

4.1 Soils

This section summarizes the physical and chemical data collected from soil sample locations at LL–6.

4.1.1 Surface Soils Exceedances

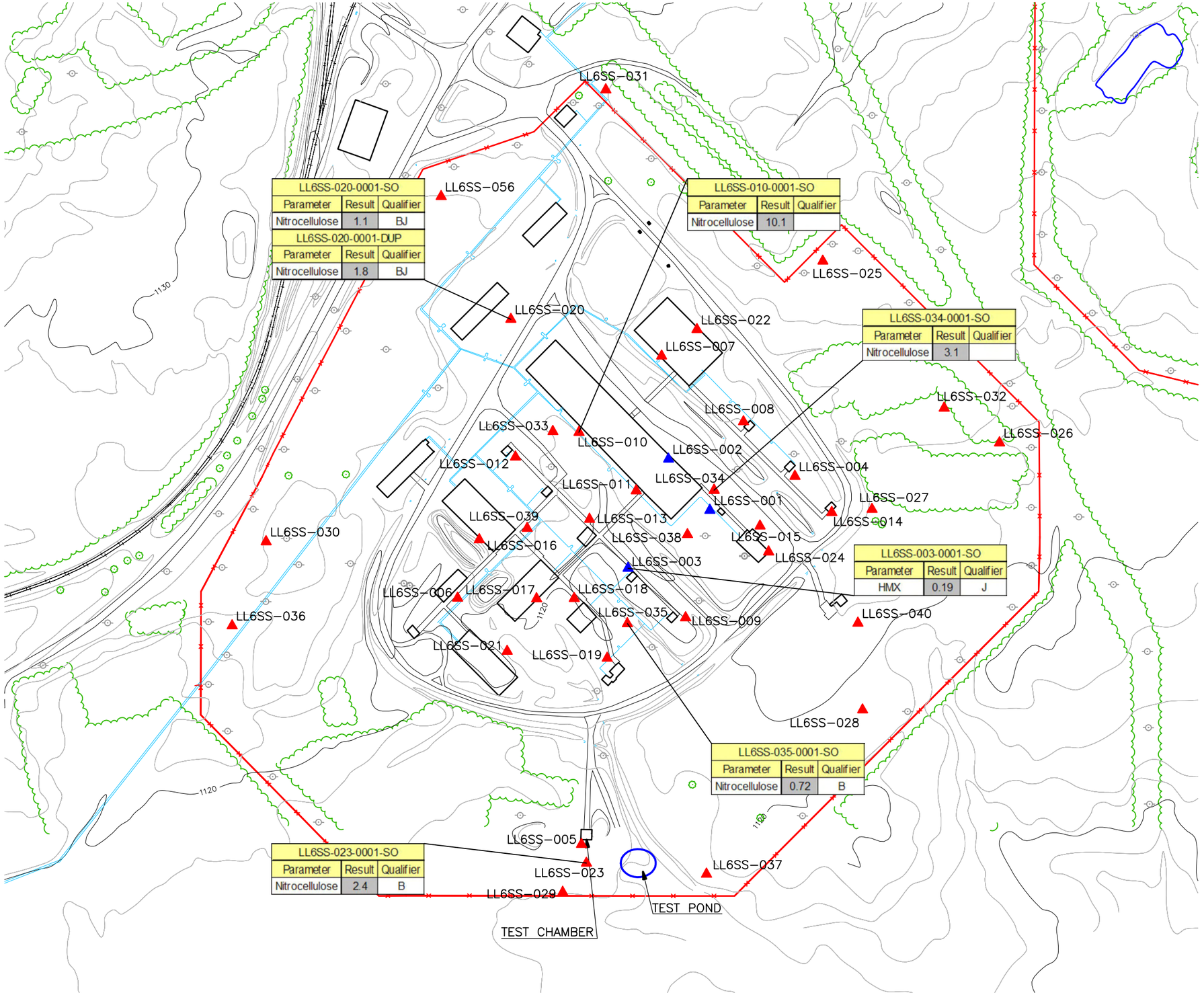
Surface soil samples were collected from 40 locations at LL–6 during the azide screening and RI sampling activities. Each sample was collected from the surface to a depth of 1 ft (0–1 ft) bgs. Thirty-seven samples and four duplicate samples were collected during the RI. Samples collected during the RI were submitted for analysis of TAL metals. In addition, five RI samples were also analyzed for the RVAAP full analytical suite of TAL metals, explosives, cyanides, VOCs, SVOCs, PCBs, pesticides, and propellants. Samples collected during the azide screening were submitted for analysis of TAL metals and explosives. A total of six USACE split samples were collected (for purposes of the azide screening study) from three of the RI sample locations. Wet (designated by a W) and dry (designated by a D) USACE split samples were collected from RI samples LL6SS–001–0001–SO (W–12S and D–12S), LL6SS–002–0001–SO (W–13S and D–13S), and LL6SS–003–0001–SO (W–14S and D–14S). Analytical results were compared to RVAAP installation background criteria and Region 9 residential soil PRGs.

One explosive (HMX), one propellant (nitrocellulose) and one PCB (aroclor 1254), several SVOCs and metals including aluminum, arsenic, cadmium, chromium, copper, lead, manganese, mercury, and zinc were detected at concentrations greater than the RVAAP installation background criteria, Region 9 residential soil PRGs or both. Therefore, the lateral and vertical extent of exceedances for explosives, propellants, SVOCs, PCBs, and TAL metals, were not fully delineated in surface soil during this Phase I RI. The lateral extent of surface soil contamination at LL–6 (as determined by this Phase I RI) is shown in Figures 4–1, 4–2, 4–3 and 4–4. The distribution of selected site-related contaminants (cadmium, chromium, copper, lead, magnesium, mercury, and zinc) identified as COPCs in Section 6.2.3 of this document, are shown in Figures 4–5 through 4–11. The distribution and exposure pathways for site related chemicals (SRCs) are further discussed in the conceptual site model included in Section 5.4. The concentration ranges listed in the figures were developed using a statistical distribution of minimum, maximum, and median background values.

Analytical results for the surface soil samples are summarized in Table 4–1, a summary of surface soil results during azide screening are listed in Table 4–2, and surface soil exceedances are summarized in Table 4–3. Surface soil analytical results and laboratory results are also located in Appendix E. Azide screening results for surface soil are located in Appendix F.

4.1.1.1 Explosives and Propellants

HMX was detected above the RVAAP installation background criterion (WBG Phase II RI, 2001) in 3 samples, 1 of which was a duplicate, with a maximum concentration of 0.2 mg/kg (J) detected in sample D–14S (a dry split sample collected from RI sample LL6SS–003–0001–SO). However, the maximum result was qualified as estimated (J) because the concentration of HMX was detected above the method detection limit but below the reporting limit.



LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SURFACE SOIL SAMPLE LOCATION
- SURFACE SOIL SAMPLING LOCATION TAKEN DURING AZIDE SCREENING
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN mg/kg
IF RESULT ≥ BACKGROUND, THEN THE VALUE IS SHADED
IF RESULT ≥ THE PRG THEN THE VALUE IS LISTED IN BOLD TEXT
IF RESULT ≥ BACKGROUND AND THE PRG THE VALUE IS BOLD + SHADED
IF RESULT < BACKGROUND AND PRG THEN THE VALUE IS LISTED IN NORMAL TEXT

ORGANIC QUALIFIERS
J – RESULT IS AN ESTIMATED VALUE BELOW THE RL

ORGANIC FLAGS
B – METHOD BLANK: BATCH QC IS GREATER THAN RL
H – ALTERNATE PEAK SELECTION UPON ANALYTICAL REVIEW

N

0' 100' 200' 300'
1" = 200'

MKM Engineers
4153 Bluebonnet Drive
Stafford, TX 77477

RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

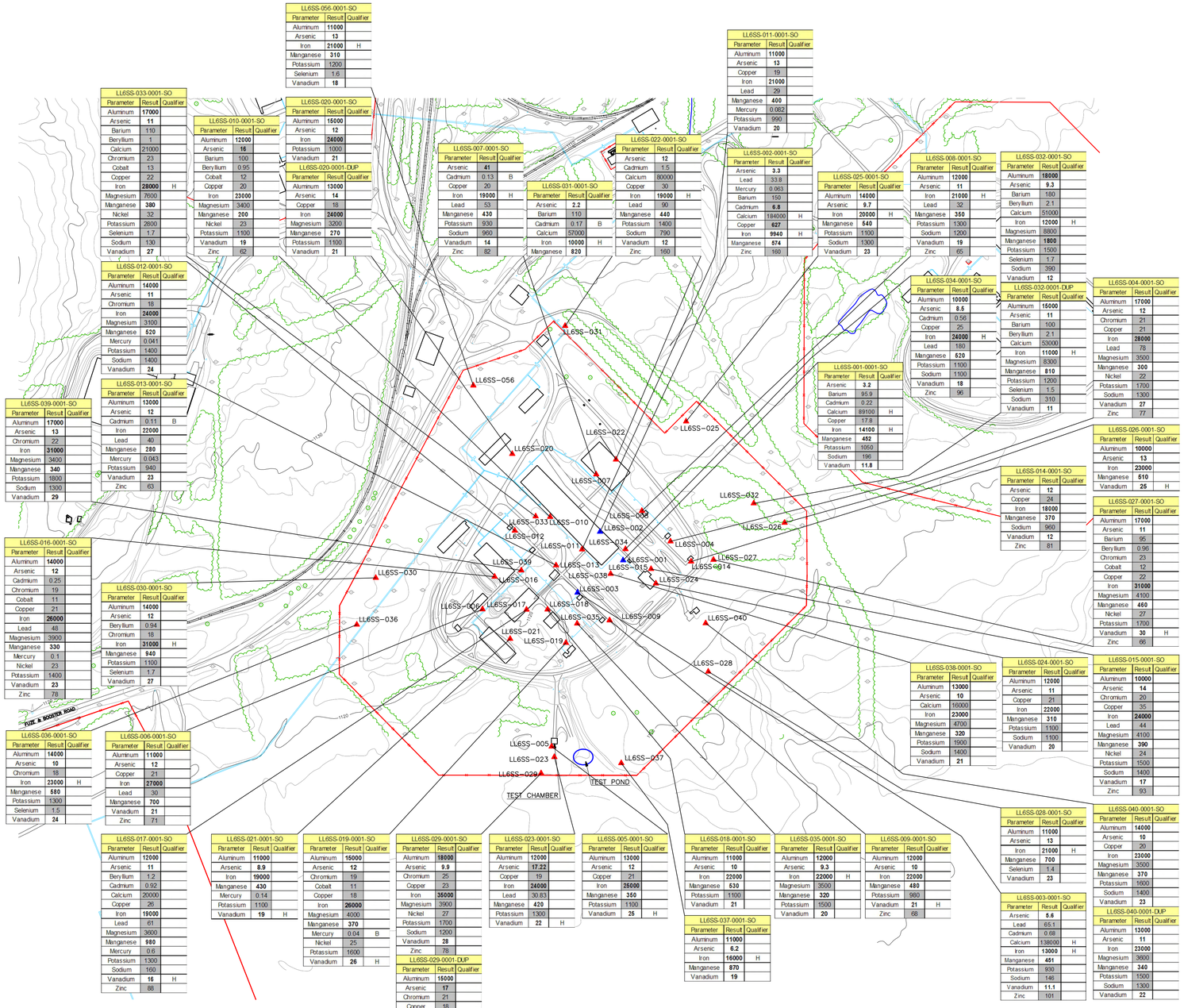
FIGURE 4-1

SURFACE SOIL SAMPLE (0-1Ft)
EXCEEDANCES EXPLOSIVES/PROPELLANTS

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	AUG 2007	3

DRAWN BY	RB/KP	APPR. BY	MT



LL6SS-056-0001-SO

Parameter	Result	Qualifier
Aluminum	11000	
Arsenic	13	
Iron	21000	H
Manganese	310	
Potassium	1200	
Selenium	1.8	
Vanadium	18	

LL6SS-033-0001-SO

Parameter	Result	Qualifier
Aluminum	17000	
Arsenic	11	
Barium	110	
Beryllium	1	
Calcium	21000	
Chromium	23	
Cobalt	13	
Copper	22	
Iron	28000	H
Magnesium	7600	
Manganese	380	
Nickel	32	
Potassium	2800	
Selenium	1.7	
Sodium	130	
Vanadium	27	

LL6SS-010-0001-SO

Parameter	Result	Qualifier
Aluminum	12000	
Arsenic	16	
Barium	100	
Beryllium	0.95	
Cobalt	12	
Copper	20	
Iron	23000	
Magnesium	3400	
Manganese	200	
Nickel	23	
Potassium	1100	
Vanadium	19	
Zinc	62	

LL6SS-020-0001-SO

Parameter	Result	Qualifier
Aluminum	15000	
Arsenic	12	
Iron	24000	
Potassium	1000	
Vanadium	21	

LL6SS-020-0001-DUP

Parameter	Result	Qualifier
Aluminum	13000	
Arsenic	14	
Copper	18	
Iron	24000	
Magnesium	3200	
Manganese	270	
Potassium	1100	
Vanadium	21	

LL6SS-007-0001-SO

Parameter	Result	Qualifier
Arsenic	41	
Cadmium	0.13	B
Copper	20	
Iron	19000	H
Lead	53	
Manganese	430	
Potassium	930	
Sodium	960	
Vanadium	14	
Zinc	82	

LL6SS-031-0001-SO

Parameter	Result	Qualifier
Arsenic	2.2	
Barium	110	
Cadmium	0.17	B
Calcium	57000	
Iron	10000	H
Manganese	820	

LL6SS-022-0001-SO

Parameter	Result	Qualifier
Arsenic	12	
Cadmium	1.5	
Calcium	80000	
Copper	30	
Iron	19000	H
Lead	90	
Manganese	440	
Potassium	1400	
Sodium	790	
Vanadium	12	
Zinc	160	

LL6SS-011-0001-SO

Parameter	Result	Qualifier
Aluminum	11000	
Arsenic	13	
Copper	19	
Iron	21000	
Lead	29	
Manganese	400	
Mercury	0.082	
Potassium	990	
Vanadium	20	

LL6SS-002-0001-SO

Parameter	Result	Qualifier
Arsenic	3.3	
Lead	33.8	
Mercury	0.063	
Barium	150	
Cadmium	6.8	
Calcium	184000	H
Copper	627	
Iron	9940	H
Manganese	574	
Zinc	160	

LL6SS-025-0001-SO

Parameter	Result	Qualifier
Aluminum	14000	
Arsenic	9.7	
Iron	20000	H
Manganese	540	
Potassium	1100	
Sodium	1300	
Vanadium	23	

LL6SS-008-0001-SO

Parameter	Result	Qualifier
Aluminum	12000	
Arsenic	11	
Iron	21000	H
Lead	32	
Manganese	350	
Potassium	1300	
Sodium	1200	
Vanadium	19	
Zinc	65	

LL6SS-032-0001-SO

Parameter	Result	Qualifier
Aluminum	18000	
Arsenic	9.3	
Barium	180	
Beryllium	2.1	
Calcium	51000	
Iron	12000	H
Magnesium	8800	
Manganese	1800	
Potassium	1500	
Selenium	1.7	
Sodium	390	
Vanadium	12	

LL6SS-034-0001-SO

Parameter	Result	Qualifier
Aluminum	10000	
Arsenic	8.5	
Cadmium	0.56	
Copper	25	
Iron	24000	H
Lead	180	
Manganese	520	
Potassium	1100	
Sodium	1100	
Vanadium	18	
Zinc	96	

LL6SS-032-0001-DUP

Parameter	Result	Qualifier
Aluminum	15000	
Arsenic	11	
Barium	100	
Beryllium	2.1	
Calcium	53000	
Iron	11000	H
Magnesium	8300	
Manganese	810	
Potassium	1200	
Selenium	1.5	
Sodium	310	
Vanadium	11	

LL6SS-004-0001-SO

Parameter	Result	Qualifier
Aluminum	17000	
Arsenic	12	
Chromium	21	
Copper	21	
Iron	28000	
Lead	78	
Magnesium	3500	
Manganese	300	
Nickel	22	
Potassium	1700	
Sodium	1300	
Vanadium	27	
Zinc	77	

LL6SS-001-0001-SO

Parameter	Result	Qualifier
Arsenic	3.2	
Barium	95.9	
Cadmium	0.22	
Calcium	89100	H
Copper	17.8	
Iron	14100	H
Manganese	452	
Potassium	1050	
Sodium	196	
Vanadium	11.8	

LL6SS-026-0001-SO

Parameter	Result	Qualifier
Aluminum	10000	
Arsenic	13	
Iron	23000	
Manganese	510	
Vanadium	25	H

LL6SS-014-0001-SO

Parameter	Result	Qualifier
Arsenic	12	
Copper	24	
Iron	18000	
Manganese	370	
Sodium	960	
Vanadium	12	
Zinc	81	

LL6SS-027-0001-SO

Parameter	Result	Qualifier
Aluminum	17000	
Arsenic	11	
Barium	95	
Beryllium	0.96	
Chromium	23	
Cobalt	12	
Copper	22	
Iron	31000	
Magnesium	4100	
Manganese	440	
Nickel	27	
Potassium	1700	
Vanadium	30	H
Zinc	66	

LL6SS-039-0001-SO

Parameter	Result	Qualifier
Aluminum	17000	
Arsenic	13	
Chromium	22	
Iron	31000	
Magnesium	3400	
Manganese	340	
Potassium	1800	
Sodium	1300	
Vanadium	29	

LL6SS-013-0001-SO

Parameter	Result	Qualifier
Aluminum	13000	
Arsenic	12	
Cadmium	0.11	B
Iron	22000	
Lead	40	
Manganese	280	
Mercury	0.043	
Potassium	940	
Vanadium	23	
Zinc	63	

LL6SS-016-0001-SO

Parameter	Result	Qualifier
Aluminum	14000	
Arsenic	12	
Cadmium	0.25	
Chromium	19	
Cobalt	11	
Copper	21	
Iron	26000	
Lead	48	
Magnesium	3900	
Manganese	330	
Mercury	0.1	
Nickel	23	
Potassium	1400	
Vanadium	23	
Zinc	78	

LL6SS-030-0001-SO

Parameter	Result	Qualifier
Aluminum	14000	
Arsenic	12	
Beryllium	0.94	
Chromium	18	
Iron	31000	H
Manganese	940	
Potassium	1100	
Selenium	1.7	
Vanadium	27	

LL6SS-038-0001-SO

Parameter	Result	Qualifier
Aluminum	13000	
Arsenic	10	
Iron	23000	
Magnesium	4700	
Manganese	320	
Potassium	1900	
Sodium	1400	
Vanadium	21	

LL6SS-024-0001-SO

Parameter	Result	Qualifier
Aluminum	12000	
Arsenic	11	
Copper	21	
Iron	22000	
Manganese	310	
Potassium	1100	
Sodium	1100	
Vanadium	20	

LL6SS-015-0001-SO

Parameter	Result	Qualifier
Aluminum	10000	
Arsenic	14	
Chromium	20	
Copper	35	
Iron	24000	
Lead	44	
Magnesium	4100	
Manganese	390	
Nickel	24	
Potassium	1500	
Sodium	1400	
Vanadium	17	
Zinc	93	

LL6SS-036-0001-SO

Parameter	Result	Qualifier
Aluminum	14000	
Arsenic	10	
Chromium	18	
Iron	23000	H
Manganese	580	
Potassium	1300	
Selenium	1.5	
Vanadium	24	

LL6SS-006-0001-SO

Parameter	Result	Qualifier
Aluminum	11000	
Arsenic	12	
Copper	21	
Iron	27000	
Lead	30	
Manganese	700	
Vanadium	21	
Zinc	71	

LL6SS-028-0001-SO

Parameter	Result	Qualifier
Aluminum	11000	
Arsenic	13	
Iron	21000	H
Manganese	700	
Selenium	1.4	
Vanadium	23	

LL6SS-040-0001-SO

Parameter	Result	Qualifier
Aluminum	14000	
Arsenic	10	
Copper	20	
Iron	23000	
Magnesium	3500	
Manganese	370	
Potassium	1600	
Sodium	1400	
Vanadium	23	

LL6SS-003-0001-SO

Parameter	Result	Qualifier
Arsenic	5.6	
Lead	65.1	
Cadmium	0.68	
Calcium	138000	H
Iron	13000	H
Manganese	451	
Potassium	930	
Sodium	146	
Vanadium	11.1	
Zinc	101	

LL6SS-040-0001-DUP

Parameter	Result	Qualifier
Aluminum	13000	
Arsenic	11	
Iron	23000	
Magnesium	3600	
Manganese	340	
Potassium	1500	
Sodium	1300	
Vanadium	22	

LL6SS-017-0001-SO

Parameter	Result	Qualifier
Aluminum	12000	
Arsenic	11	
Beryllium	1.2	
Cadmium	0.92	
Calcium	20000	
Copper	26	
Iron	19000	
Lead	61	
Magnesium	3600	
Manganese	980	
Mercury	0.6	
Potassium	1300	
Sodium	160	
Vanadium	16	H
Zinc	88	

LL6SS-021-0001-SO

Parameter	Result	Qualifier
Aluminum	11000	
Arsenic	8.9	
Iron	19000	
Manganese	430	
Mercury	0.14	
Potassium	1100	
Vanadium	19	H

LL6SS-019-0001-SO

Parameter	Result	Qualifier
Aluminum	15000	
Arsenic	12	
Chromium	19	
Cobalt	11	
Copper	18	
Iron	26000	
Magnesium	4000	
Manganese	370	
Mercury	0.04	B
Nickel	25	
Potassium	1600	
Vanadium	26	H

LL6SS-029-0001-SO

Parameter	Result	Qualifier
Aluminum	18000	
Arsenic	9.9	
Chromium	25	
Copper	23	
Iron	35000	
Magnesium	3900	
Nickel	27	
Potassium	1700	
Sodium	1200	
Vanadium	28	
Zinc	78	

LL6SS-029-0001-DUP

Parameter	Result	Qualifier
Aluminum	15000	
Arsenic	17	
Chromium	21	
Copper	18	
Iron	27000	
Manganese	200	
Potassium	1400	
Sodium	1100	
Vanadium	26	

LL6SS-023-0001-SO

Parameter	Result	Qualifier
Aluminum	12000	
Arsenic	17.22	
Copper	19	
Iron	24000	
Lead	30.83	
Manganese	420	
Potassium	1300	
Vanadium	22	H

LL6SS-005-0001-SO

Parameter	Result	Qualifier
Aluminum	13000	
Arsenic	12	
Copper	21	
Iron	25000	
Manganese	350	
Potassium	1100	
Vanadium	25	H

LL6SS-018-0001-SO

Parameter	Result	Qualifier
Aluminum	11000	
Arsenic	10	
Iron	22000	
Manganese	530	
Potassium	1100	
Vanadium	21	

LL6SS-037-0001-SO

Parameter	Result	Qualifier
Aluminum	11000	
Arsenic	6.2	
Iron	16000	H
Manganese	870	
Vanadium	19	

LL6SS-035-0001-SO

Parameter	Result	Qualifier
Aluminum	12000	
Arsenic	9.3	
Iron	22000	H
Magnesium	3500	
Manganese	320	
Potassium	1500	
Vanadium	20	

LL6SS-009-0001-SO

Parameter	Result	Qualifier
Aluminum	12000	
Arsenic	10	
Iron	22000	
Manganese	480	
Potassium	980	
Vanadium	21	H
Zinc	68	

LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SURFACE SOIL SAMPLE LOCATION
- SURFACE SOIL SAMPLING LOCATION TAKEN DURING AZIDE SCREENING
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN mk/kg

IF RESULT ≥ BACKGROUND, THEN THE VALUE IS SHADED
IF RESULT ≥ THE PRG THEN THE VALUE IS LISTED IN BOLD TEXT
IF RESULT ≥ BACKGROUND AND THE PRG THE VALUE IS BOLD + SHADED
IF RESULT < BACKGROUND AND PRG THEN THE VALUE IS LISTED IN NORMAL TEXT

INORGANIC QUALIFIERS
J – RESULT IS LESS THAN THE RL, BUT GREATER THAN OR EQUAL TO THE MDL
B – RESULT IS LESS THAN THE CRDL/RL, BUT GREATER THAN OR EQUAL TO THE IDL/MDL

INORGANIC FLAGS
H – BATCH QC IS GREATER THAN RL

N

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1" = 200'

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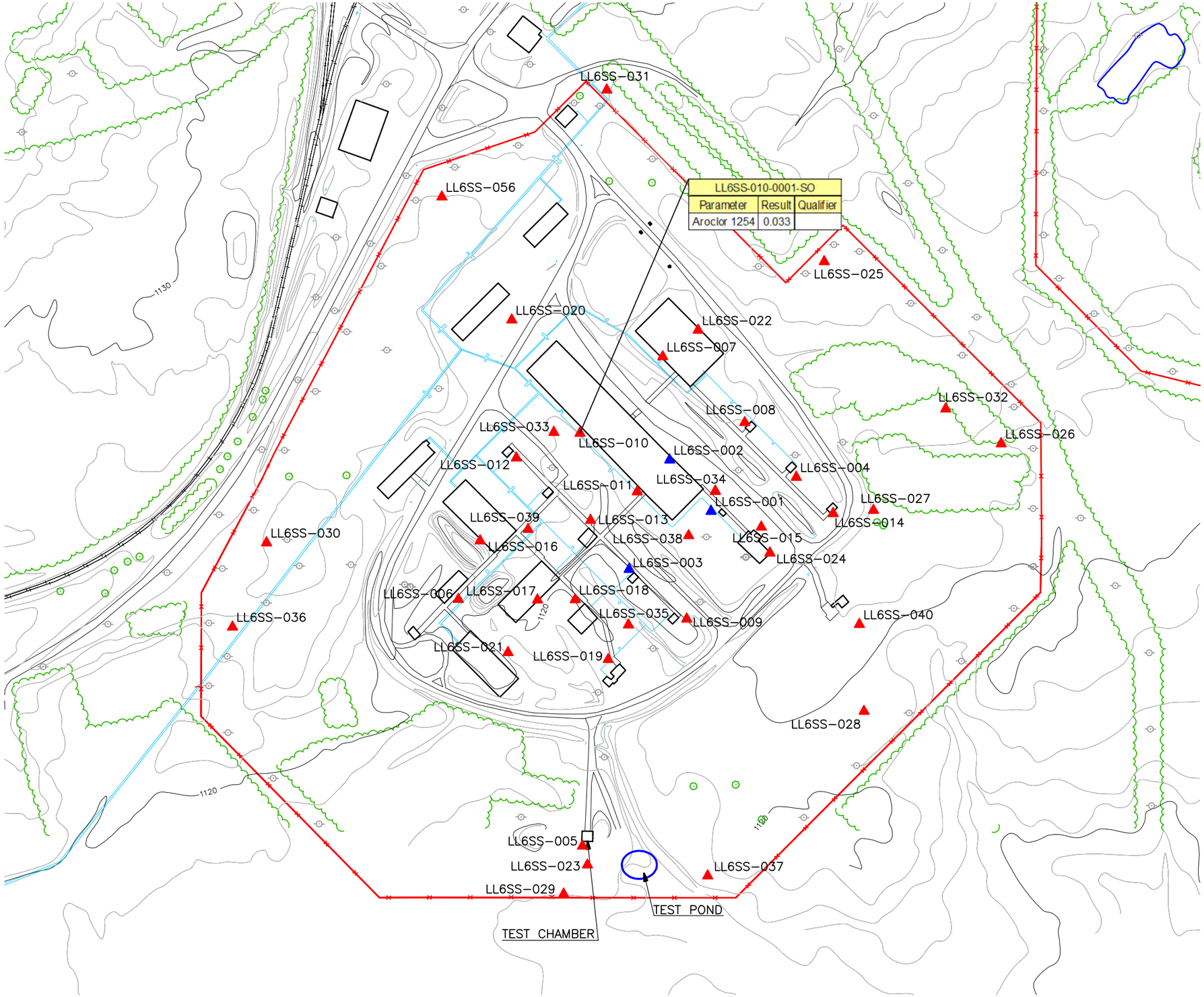
FIGURE 4-2

SURFACE SOIL SAMPLE (0-1Ft)
EXCEEDANCES TAL METALS/CYANIDE

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
D	02-02-0085	MAY 2007	2

DRAWN BY	APPR. BY
R. BOWMAN	SL



LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SURFACE SOIL SAMPLE LOCATION
- SURFACE SOIL SAMPLING LOCATION TAKEN DURING AZIDE SCREENING
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN mg/kg

IF RESULT ≥ BACKGROUND, THEN THE VALUE IS SHADED
IF RESULT ≥ THE PRG THEN THE VALUE IS LISTED IN BOLD TEXT
IF RESULT ≥ BACKGROUND AND THE PRG THE VALUE IS BOLD + SHADED
IF RESULT < BACKGROUND AND PRG THEN THE VALUE IS LISTED IN NORMAL TEXT

ORGANIC QUALIFIERS
J – RESULT IS AN ESTIMATED VALUE BELOW THE RL

ORGANIC FLAGS
B – METHOD BLANK: BATCH QC IS GREATER THAN RL

N

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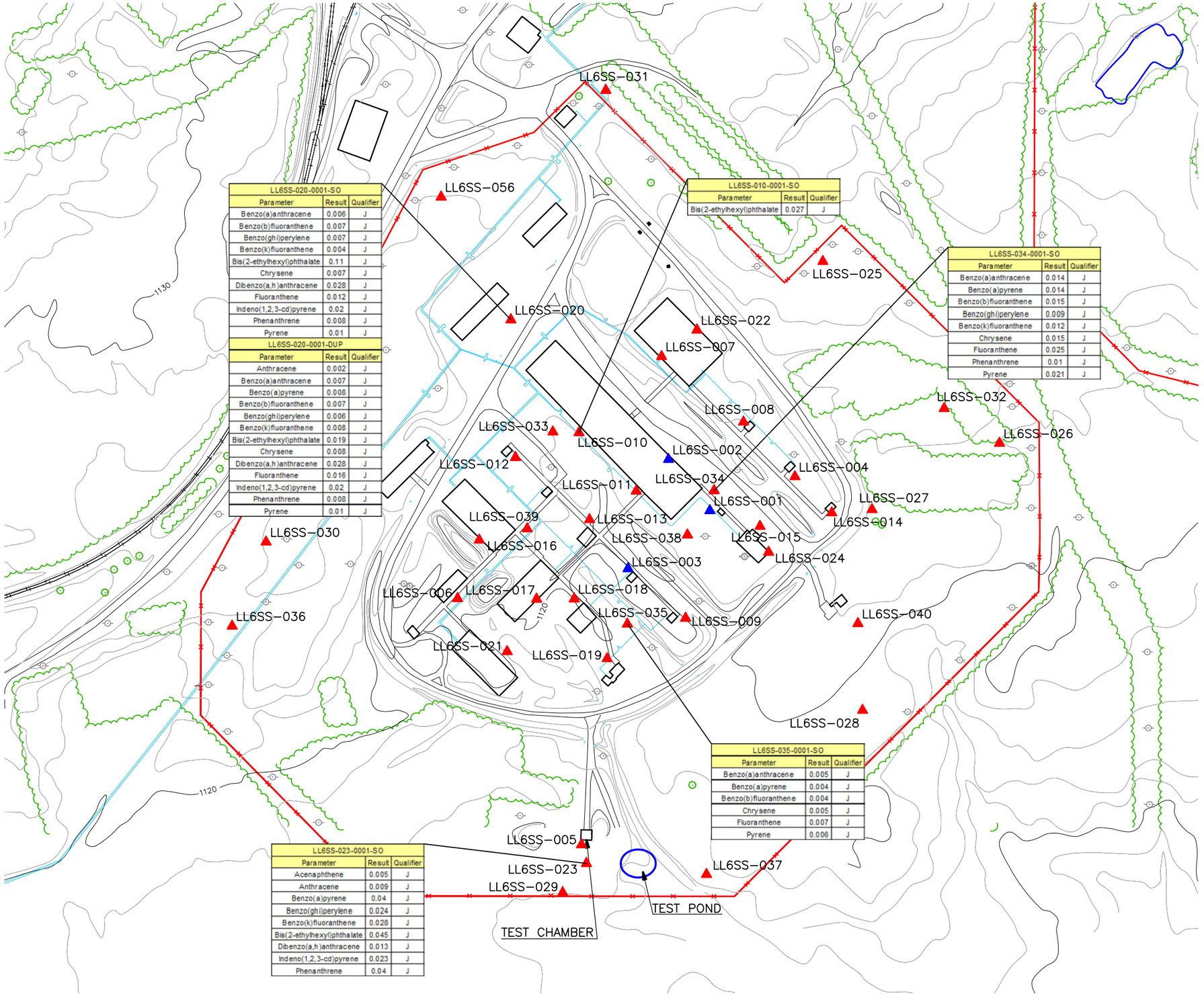
FIGURE 4-3

SURFACE SOIL SAMPLE (0-1Ft)
EXCEEDANCES PCBs

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2

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LL6SS-020-0001-SO		
Parameter	Result	Qualifier
Benzo(a)anthracene	0.006	J
Benzo(b)fluoranthene	0.007	J
Benzo(ghi)perylene	0.007	J
Benzo(k)fluoranthene	0.004	J
Bis(2-ethylhexyl)phthalate	0.11	J
Chrysene	0.007	J
Dibenzo(a,h)anthracene	0.028	J
Fluoranthene	0.012	J
Indeno(1,2,3-cd)pyrene	0.02	J
Phenanthrene	0.008	J
Pyrene	0.01	J

LL6SS-020-0001-DUP		
Parameter	Result	Qualifier
Anthracene	0.002	J
Benzo(a)anthracene	0.007	J
Benzo(a)pyrene	0.008	J
Benzo(b)fluoranthene	0.007	J
Benzo(ghi)perylene	0.006	J
Benzo(k)fluoranthene	0.008	J
Bis(2-ethylhexyl)phthalate	0.019	J
Chrysene	0.008	J
Dibenzo(a,h)anthracene	0.028	J
Fluoranthene	0.016	J
Indeno(1,2,3-cd)pyrene	0.02	J
Phenanthrene	0.008	J
Pyrene	0.01	J

LL6SS-010-0001-SO		
Parameter	Result	Qualifier
Bis(2-ethylhexyl)phthalate	0.027	J

LL6SS-034-0001-SO		
Parameter	Result	Qualifier
Benzo(a)anthracene	0.014	J
Benzo(a)pyrene	0.014	J
Benzo(b)fluoranthene	0.015	J
Benzo(ghi)perylene	0.009	J
Benzo(k)fluoranthene	0.012	J
Chrysene	0.015	J
Fluoranthene	0.025	J
Phenanthrene	0.01	J
Pyrene	0.021	J

LL6SS-035-0001-SO		
Parameter	Result	Qualifier
Benzo(a)anthracene	0.005	J
Benzo(a)pyrene	0.004	J
Benzo(b)fluoranthene	0.004	J
Chrysene	0.005	J
Fluoranthene	0.007	J
Pyrene	0.006	J

LL6SS-023-0001-SO		
Parameter	Result	Qualifier
Acenaphthene	0.005	J
Anthracene	0.009	J
Benzo(a)pyrene	0.04	J
Benzo(ghi)perylene	0.024	J
Benzo(k)fluoranthene	0.028	J
Bis(2-ethylhexyl)phthalate	0.045	J
Dibenzo(a,h)anthracene	0.013	J
Indeno(1,2,3-cd)pyrene	0.023	J
Phenanthrene	0.04	J

LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SURFACE SOIL SAMPLE LOCATION
- SURFACE SOIL SAMPLING LOCATION TAKEN DURING AZIDE SCREENING
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN mg/kg
IF RESULT ≥ BACKGROUND, THEN THE VALUE IS SHADED
IF RESULT ≥ THE PRG THEN THE VALUE IS LISTED IN BOLD TEXT
IF RESULT ≥ BACKGROUND AND THE PRG THE VALUE IS BOLD + SHADED
IF RESULT < BACKGROUND AND PRG THEN THE VALUE IS LISTED IN NORMAL TEXT

ORGANIC QUALIFIERS
J – RESULT IS AN ESTIMATED VALUE BELOW THE RL

ORGANIC FLAGS
B – METHOD BLANK: BATCH QC IS GREATER THAN RL

N

0' 100' 200' 300'
1" = 200'

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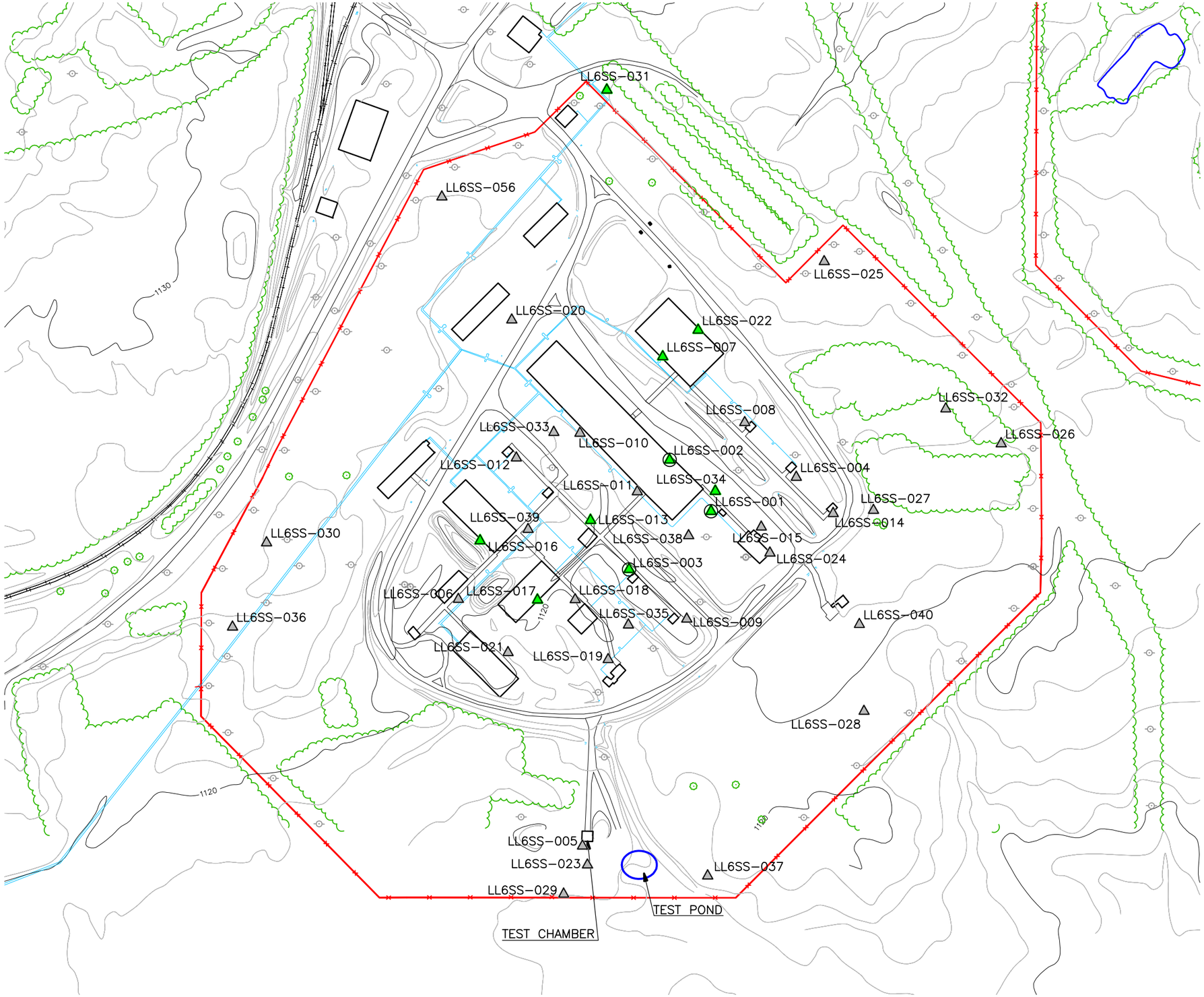
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RAVENNA, OHIO

FIGURE 4-4

SURFACE SOIL SAMPLE (0-1Ft)
EXCEEDANCES VOCs/SVOCs

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2
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LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- BUILDING
- FENCE
- SURFACE SOIL SAMPLE LOCATION
- SURFACE SOIL SAMPLING LOCATION TAKEN DURING AZIDE SCREENING

SURFACE BACKGROUND VALUE FOR CADMIUM = 0.00 mg/Kg

CONCENTRATION

- **NON-DETECT**
- **DETECT**

N

0' 100' 200' 300'

1" = 200'

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Stafford, TX 77477

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RAVENNA, OHIO

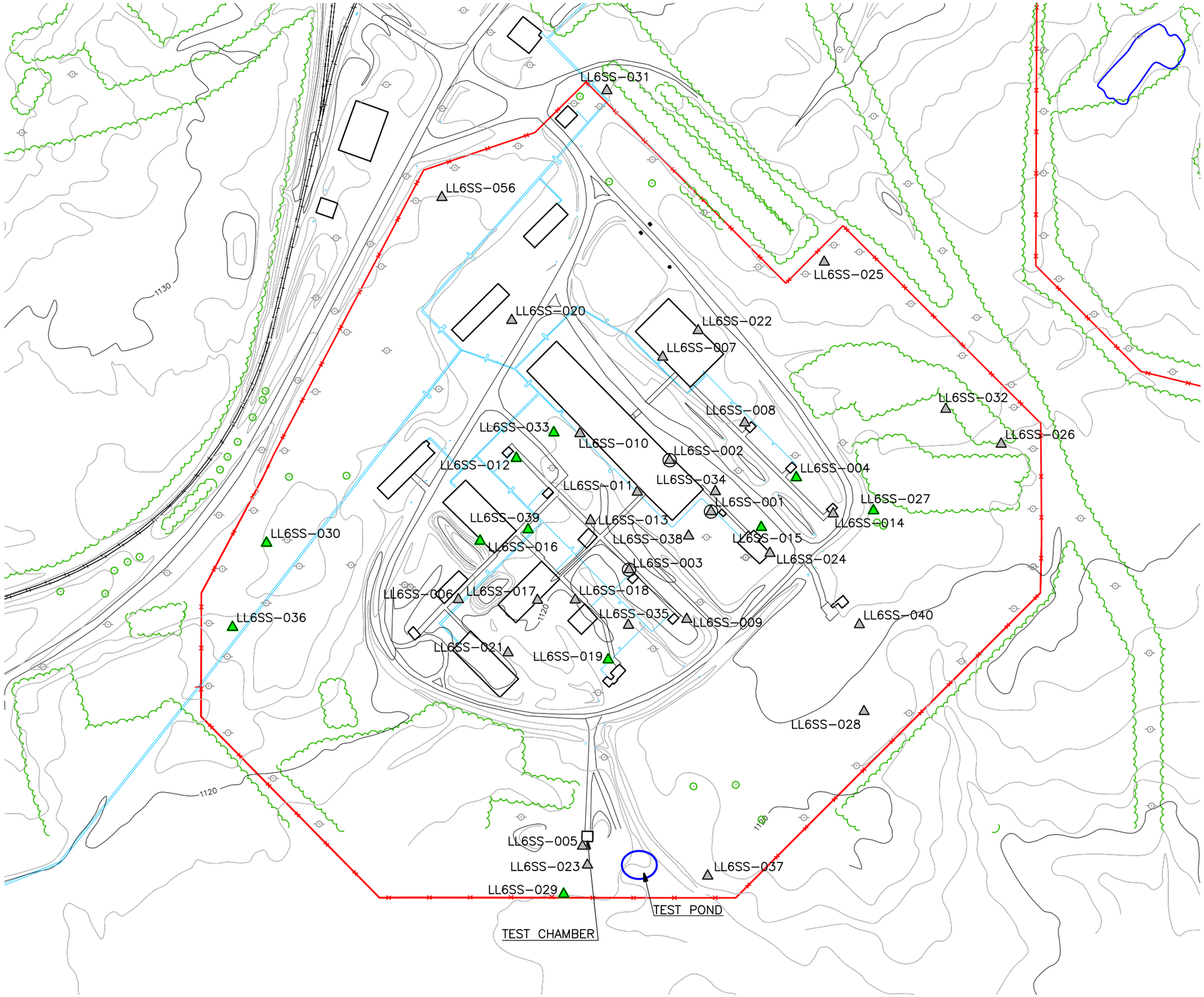
FIGURE 4-5

SURFACE SOIL SAMPLE (0-1Ft)
CADMIUM

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2

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LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- BUILDING
- FENCE
- SURFACE SOIL SAMPLE LOCATION
- SURFACE SOIL SAMPLING LOCATION TAKEN DURING AZIDE SCREENING

SURFACE BACKGROUND VALUE FOR CHROMIUM = 17.4 mg/Kg

CONCENTRATION

- **NON-DETECT OR ≤ BACKGROUND**
- **> 1 TO 2 TIMES BACKGROUND**
- **> 2 TO 5 TIMES BACKGROUND**
- **> 5 TO 20 TIMES BACKGROUND**
- **> 20 TIMES BACKGROUND**

N

0' 100' 200' 300'

1" = 200'

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RAVENNA, OHIO

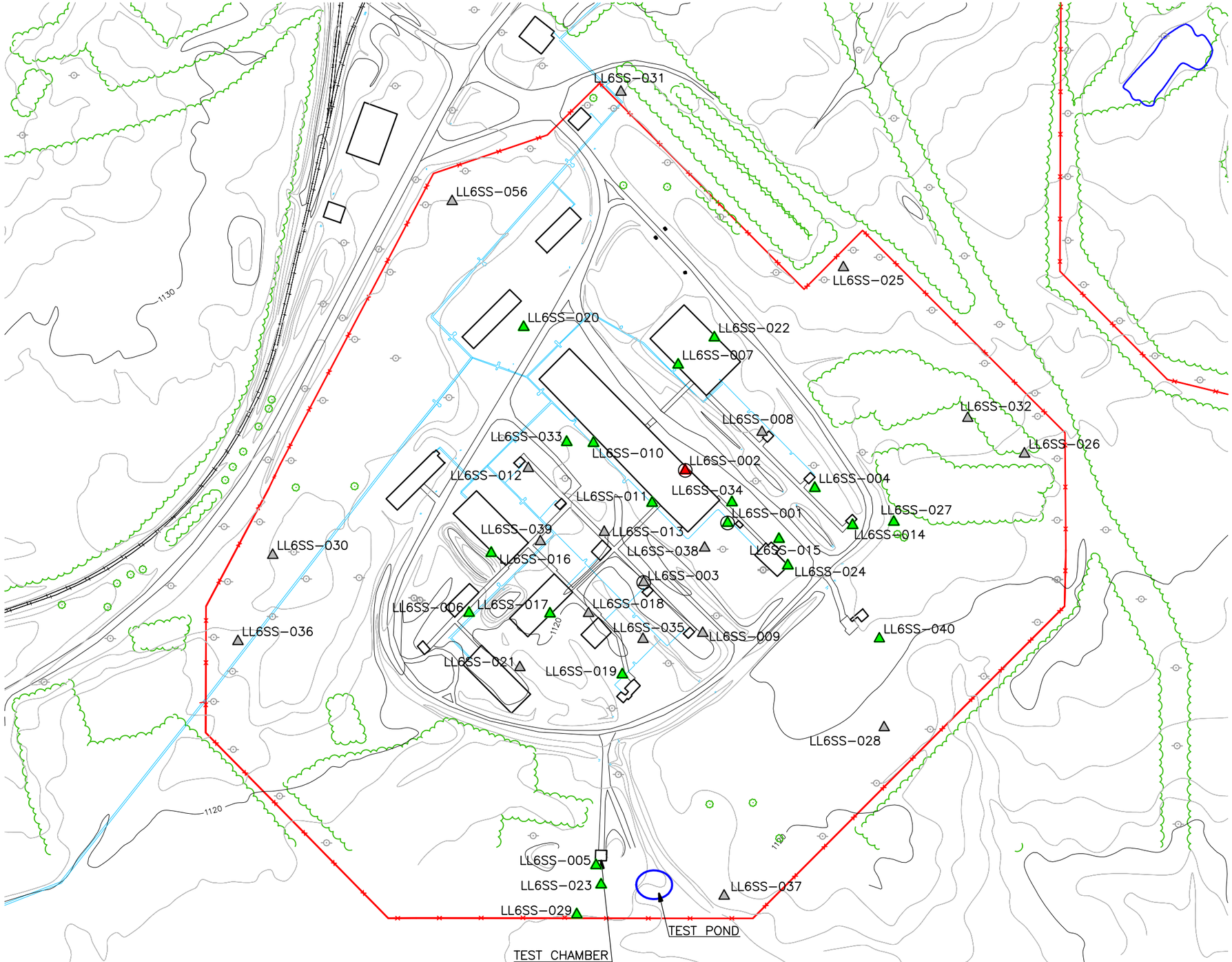
FIGURE 4-6

SURFACE SOIL SAMPLE (0-1Ft)
CHROMIUM

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2

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LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- BUILDING
- FENCE
- SURFACE SOIL SAMPLE LOCATION
- SURFACE SOIL SAMPLING LOCATION TAKEN DURING AZIDE SCREENING

SURFACE BACKGROUND VALUE FOR COPPER = 17.7 mg/Kg

CONCENTRATION

- **NON-DETECT OR ≤ BACKGROUND**
- **> 1 TO 2 TIMES BACKGROUND**
- **> 2 TO 5 TIMES BACKGROUND**
- **> 5 TO 20 TIMES BACKGROUND**
- **> 20 TIMES BACKGROUND**

N

0' 100' 200' 300'

1" = 200'

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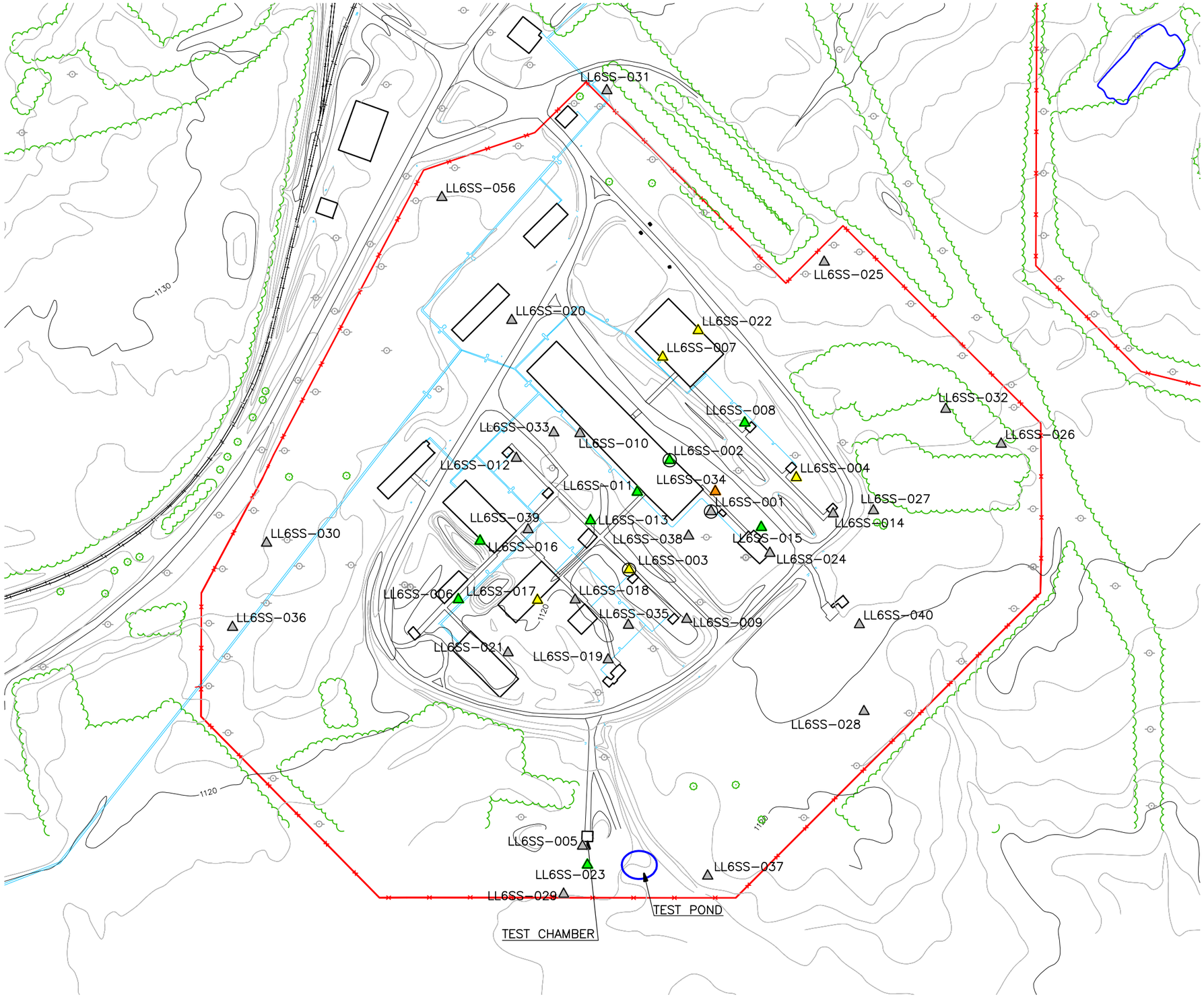
FIGURE 4-7

SURFACE SOIL SAMPLE (0-1Ft)
COPPER

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
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LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- BUILDING
- FENCE
- SURFACE SOIL SAMPLE LOCATION
- SURFACE SOIL SAMPLING LOCATION TAKEN DURING AZIDE SCREENING

SURFACE BACKGROUND VALUE FOR LEAD = 28.1 mg/Kg

CONCENTRATION

- **NON-DETECT OR ≤ BACKGROUND**
- **> 1 TO 2 TIMES BACKGROUND**
- **> 2 TO 5 TIMES BACKGROUND**
- **> 5 TO 20 TIMES BACKGROUND**
- **> 20 TIMES BACKGROUND**

N

0' 100' 200' 300'

1" = 200'

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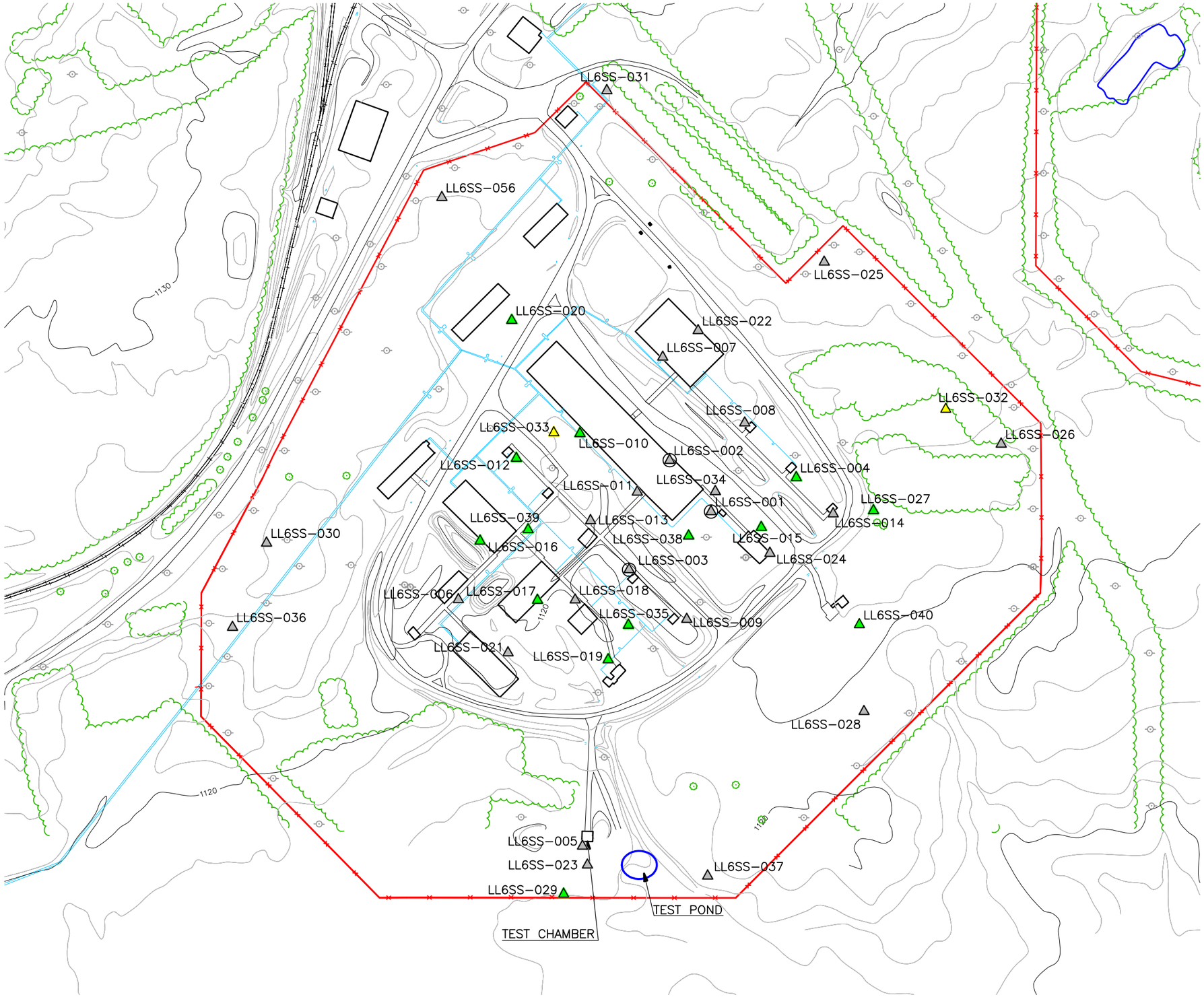
FIGURE 4-8

SURFACE SOIL SAMPLE (0-1Ft)
LEAD

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2

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LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- BUILDING
- FENCE
- SURFACE SOIL SAMPLE LOCATION
- SURFACE SOIL SAMPLING LOCATION TAKEN DURING AZIDE SCREENING

SURFACE BACKGROUND VALUE FOR MAGNESIUM = 3030 mg/Kg

CONCENTRATION

- **NON-DETECT OR ≤ BACKGROUND**
- **> 1 TO 2 TIMES BACKGROUND**
- **> 2 TO 5 TIMES BACKGROUND**
- **> 5 TO 20 TIMES BACKGROUND**
- **> 20 TIMES BACKGROUND**

N

0' 100' 200' 300'

1" = 200'

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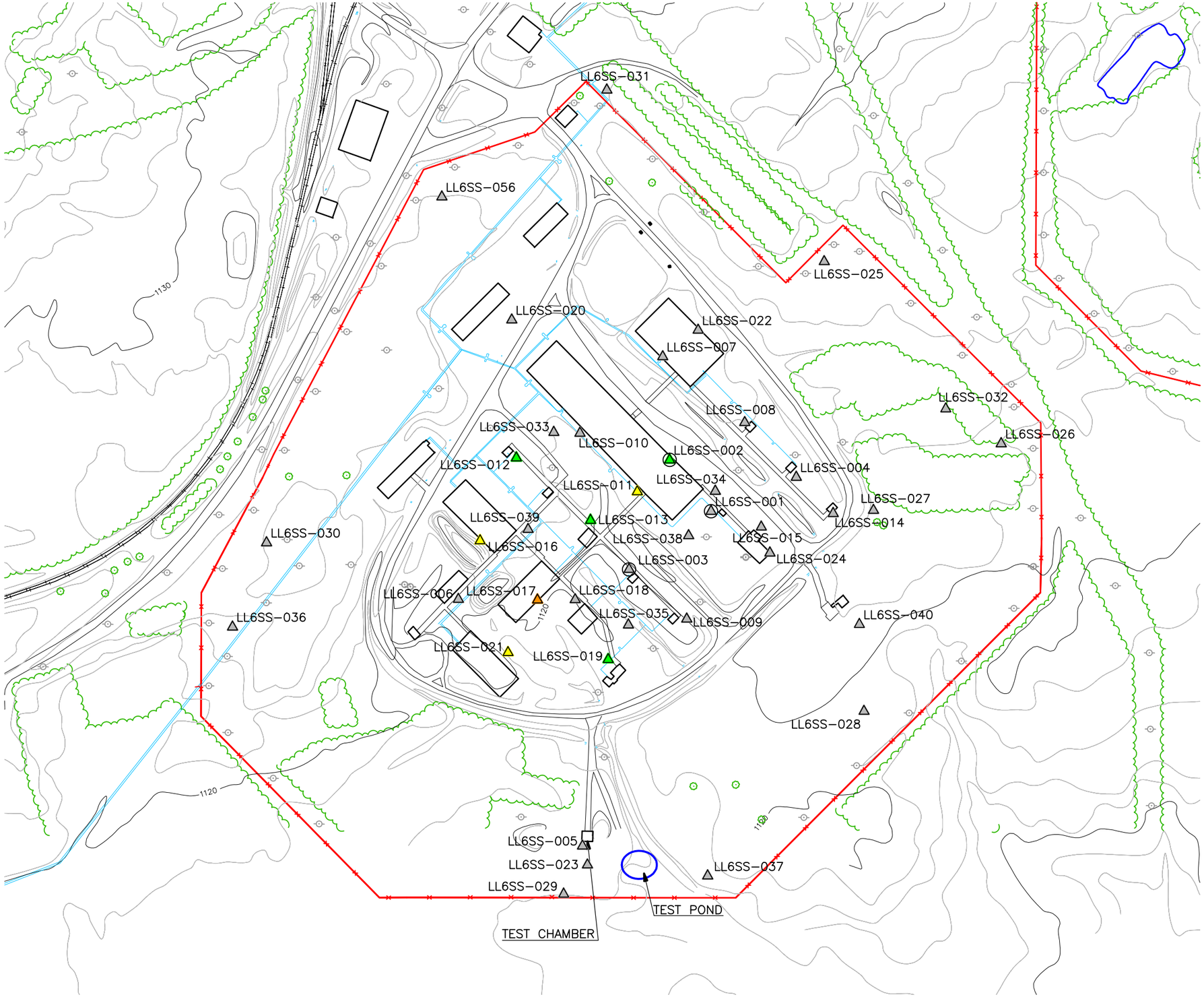
FIGURE 4-9

SURFACE SOIL SAMPLE (0-1Ft)
MAGNESIUM

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
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LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- BUILDING
- FENCE
- SURFACE SOIL SAMPLE LOCATION
- SURFACE SOIL SAMPLING LOCATION TAKEN DURING AZIDE SCREENING

SURFACE BACKGROUND VALUE FOR MERCURY = 0.04 mg/Kg

CONCENTRATION

- **NON-DETECT OR ≤ BACKGROUND**
- **> 1 TO 2 TIMES BACKGROUND**
- **> 2 TO 5 TIMES BACKGROUND**
- **> 5 TO 20 TIMES BACKGROUND**
- **> 20 TIMES BACKGROUND**

N

0' 100' 200' 300'

1" = 200'

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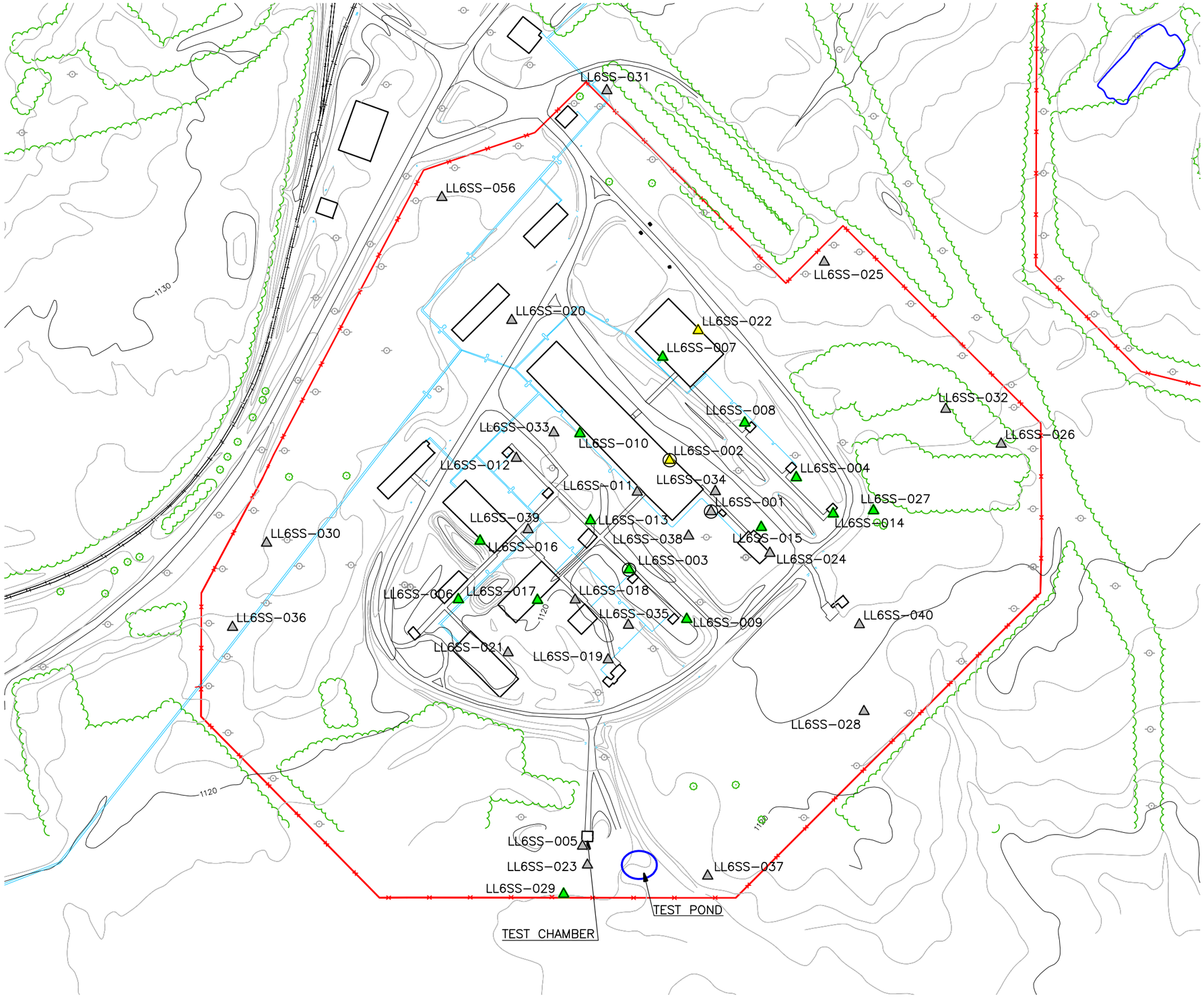
FIGURE 4-10

SURFACE SOIL SAMPLE (0–1Ft)
MERCURY

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2

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LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- BUILDING
- FENCE
- SURFACE SOIL SAMPLE LOCATION
- SURFACE SOIL SAMPLING LOCATION TAKEN DURING AZIDE SCREENING

SURFACE BACKGROUND VALUE FOR ZINC =61.8 mg/Kg

CONCENTRATION

- **NON-DETECT OR ≤ BACKGROUND**
- **> 1 TO 2 TIMES BACKGROUND**
- **> 2 TO 5 TIMES BACKGROUND**
- **> 5 TO 20 TIMES BACKGROUND**
- **> 20 TIMES BACKGROUND**

N

0' 100' 200' 300'

1" = 200'

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FIGURE 4-11

SURFACE SOIL SAMPLE (0-1Ft)
ZINC

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2

DRAWN BY	R. BOWMAN	APPR. BY	SL

Nitrocellulose was detected above the RVAAP installation background criterion of zero (WBG Phase II RI, 2001) in 6 surface samples, 1 of which was a duplicate, with a maximum concentration of 10.1 mg/kg detected in sample LL6SS–010–0001–SO. However, the nitrocellulose results were qualified as estimated (J), or (B) the concentration of nitrocellulose in the method blank was detected above the reporting limit, or both (B) (J). Figure 4–1 shows surface soil exceedances for explosives and propellants at LL–6. Figure 4–1 shows surface soil exceedances for explosives and propellants at LL–6.

4.1.1.2 TAL Metals and Cyanide

Figure 4–2 shows surface soil exceedances for TAL metals at LL–6. The following metals were detected above RVAAP installation background criteria (WBG Phase II RI, 2001) or Region 9 residential soil PRGs for surface soil (0–1 ft bgs):

- Aluminum was detected above the Region 9 residential soil PRG (7,614 mg/kg) in 36 samples, 4 of which were duplicates. Aluminum was also detected above the RVAAP installation background criterion (17,700 mg/kg) and the Region 9 residential soil PRG in 2 samples with a maximum concentration of 18,000 mg/kg detected in samples LL6SS–029–0001–SO and LL6SS–032–0001–SO.
- Arsenic was detected above the Region 9 residential soil PRG (0.39 mg/kg) in 42 samples, 3 of which were duplicates. Arsenic was also detected above the RVAAP installation background criterion (15.4 mg/kg) and the Region 9 residential soil PRG in 4 samples, 1 of which was a duplicate, with a maximum concentration of 41 mg/kg detected in sample LL6SS–007–0001–SO.
- Barium was detected above the RVAAP installation background criterion (88.4 mg/kg) in 9 samples, 1 of which was a duplicate, with a maximum concentration of 180 mg/kg detected in sample LL6SS–032–0001–SO.
- Beryllium was detected above the RVAAP installation background criterion (0.88 m/kg) in 7 samples, 1 of which was a duplicate, with a maximum concentration of 2.1 mg/kg detected in samples LL6SS–032–0001–SO and LL6SS–032–0001–DUP.
- Cadmium was detected above the RVAAP installation background criterion (0.0 m/kg) in 9 samples. Cadmium was also above the Region 9 residential soil PRG (3.7 mg/kg) and the RVAAP installation background criteria in 2 samples, 1 of which was a duplicate, with a maximum concentration of 6.8 mg/kg detected in sample LL6SS–002–0001–SO.
- Calcium was detected above the RVAAP installation background criterion (15,800 mg/kg) in 11 samples, 1 of which was a duplicate, with a maximum concentration of 184,000 (H) mg/kg detected in sample LL6SS–002–0001–SO. However, the maximum result was qualified (H) because the batch QC was greater than the reporting limit or a negative instrument reading lower than the absolute value of the reporting limit was recorded.

- Chromium was detected above the RVAAP installation background criterion (17.4 mg/kg) in 12 samples, 1 of which was a duplicate, with a maximum concentration of 25 mg/kg detected in sample LL6SS–029–0001–SO.
- Cobalt was detected above the RVAAP installation background criterion (10.4 mg/kg) in 5 samples with a maximum concentration of 13 mg/kg detected in sample LL6SS–033–0001–SO.
- Copper was detected above the RVAAP installation background criterion (17.7 mg/kg) in 23 samples, 2 of which were duplicates. Copper was also detected above the Region 9 residential soil PRG (313 mg/kg) and the RVAAP installation background criterion in 1 sample with a concentration of 627 mg/kg detected in sample LL6SS–002–0001–SO.
- Iron was detected above the Region 9 residential soil PRG (2,346 mg/kg) in 29 samples, 2 of which were duplicates. Iron was also detected above the RVAAP installation background criterion (23,100 mg/kg) and the Region 9 residential soil PRG in 17 samples, 2 of which were duplicates, with a maximum concentration of 35,000 mg/kg detected in sample LL6SS–029–0001–SO.
- Lead was detected above the RVAAP installation background criterion (26.1 mg/kg) in 15 samples with a maximum concentration of 180 mg/kg detected in sample LL6SS–034–0001–SO.
- Magnesium was detected above the RVAAP installation background criterion (3,030 mg/kg) in 18 samples, 3 of which were duplicates, with a maximum concentration of 8,800 mg/kg detected in sample LL6SS–032–0001–SO.
- Manganese was detected above the Region 9 residential soil PRG (176 mg/kg) in 43 samples, 4 of which were duplicates. Manganese was also detected above the RVAAP installation background criterion (1,450 mg/kg) and the Region 9 residential soil PRG in 1 sample with a maximum concentration of 1,800 mg/kg detected in sample LL6SS–032–0001–SO.
- Mercury was detected above the RVAAP installation background criterion (0.06 mg/kg) in 9 samples with a maximum concentration of 0.6 mg/kg detected in sample LL6SS–017–0001–SO.
- Nickel was detected above the RVAAP installation background criterion (17.7 mg/kg) in 8 samples with a maximum concentration of 32 mg/kg detected in sample LL6SS–033–0001–SO.
- Potassium exceeded the RVAAP installation background criterion in 38 samples, 4 of which are duplicates, with a maximum concentration of 2,800 mg/kg detected in sample LL6SS–033–0001–SO.
- Selenium was detected above the RVAAP installation background criterion (1.4 mg/kg) in 7 samples, 1 of which was a duplicate, with a maximum concentration of 1.7 mg/kg detected in samples LL6SS–030–0001–SO, LL6SS–032–0001–SO, and LL6SS–033–0001–SO.

- Sodium exceeded the RVAAP installation background criterion in 23 samples, 3 of which were duplicates, with a maximum concentration of 1,400 mg/kg detected in samples LL6SS–012–0001–SO, LL6SS–015–0001–SO, LL6SS–038–0001–SO, and LL6SS–040–0001–SO.
- Vanadium was detected above the Region 9 residential soil PRG (7.8 mg/kg) in 43 samples, 4 of which were duplicates, with a maximum concentration of 30 mg/kg detected in sample LL6SS–027–0001–SO.
- Zinc exceeded the RVAAP installation background criterion in 18 samples with a maximum concentration of 180 mg/kg detected in sample LL6SS–002–0001–DUP (W–13S).

4.1.1.3 Pesticides and PCBs

No pesticides were detected in the surface soil samples. One PCB (aroclor 1254) was detected in sample LL6SS–010–0001–SO with a concentration of 0.033 mg/kg, but this concentration was below the Region 9 residential soil PRG (0.22 mg/kg). Figure 4–3 shows the surface soil PCB detection at LL–6.

4.1.1.4 Volatiles and Semi-volatiles

Although some SVOCs were detected above the established installation-wide background (including acenephthene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[ghi]perylene, bis[2-ethylhexyl]phthalate, chrysene, dibenzo[a,h]anthracene, fluoranthene, indeno[1,2,3-cd]pyrene, phenanthrene, and pyrene) none were detected above laboratory reporting limits or Region 9 residential soil PRGs. Figure 4–11 shows the surface soil SVOC detections at LL–6. No VOCs were detected.

4.1.2 Subsurface Soils Exceedances

Subsurface soil samples were collected from 47 locations at LL–6 during the RI. Six duplicate samples were also collected during the RI. Most samples were collected from a depth of 1-3 feet bgs. Subsurface soil samples collected during the RI were submitted for analysis of TAL metals. In addition, 5 of the samples collected were also analyzed for the RVAAP full analytical suite of TAL metals, explosives, cyanides, VOCs, SVOCs, PCBs, pesticides, and propellants. Four of the 47 samples collected during the RI were collected from a VOC grid targeted around a former solvent building. The 4 samples collected from the VOC grid were submitted for analysis of VOCs, SVOCs, total petroleum hydrocarbons−diesel range organics (TPH–DRO), and total petroleum hydrocarbons–gasoline range organics (TPH–GRO). Analytical results were compared to RVAAP installation background criteria and Region 9 residential soil PRGs.

One propellant (nitrocellulose), one SVOC (benzo(a)pyrene), and metals (including aluminum, arsenic, barium, beryllium, cadmium, chromium, lead, and mercury) were detected at concentrations greater than RVAAP installation background criteria, Region 9 residential soil

PRGs or both. Therefore, the lateral and vertical extent of propellant, SVOC, and TAL metals contamination in subsurface soils were not fully delineated during this Phase I RI. The subsurface soil contamination at LL–6 (as determined by this Phase I RI) is shown in Figures 4–12, 4–13 and 4–14. The distribution of selected site-related contaminants (beryllium, lead, and mercury), identified as COPCs in Section 6.2.3 of this document, is shown in Figures 4–15 through 4–17. The distribution and exposure pathways for SRCs are further discussed in the conceptual site model included in Section 5.4. The concentration ranges listed in the figures were developed using a statistical distribution of minimum, maximum, and median background values.

Analytical results for the subsurface soil samples are summarized in Table 4–4, and a summary of subsurface soil exceedances are summarized in Table 4–5. Surface soil analytical results and laboratory results are located in Appendix J.

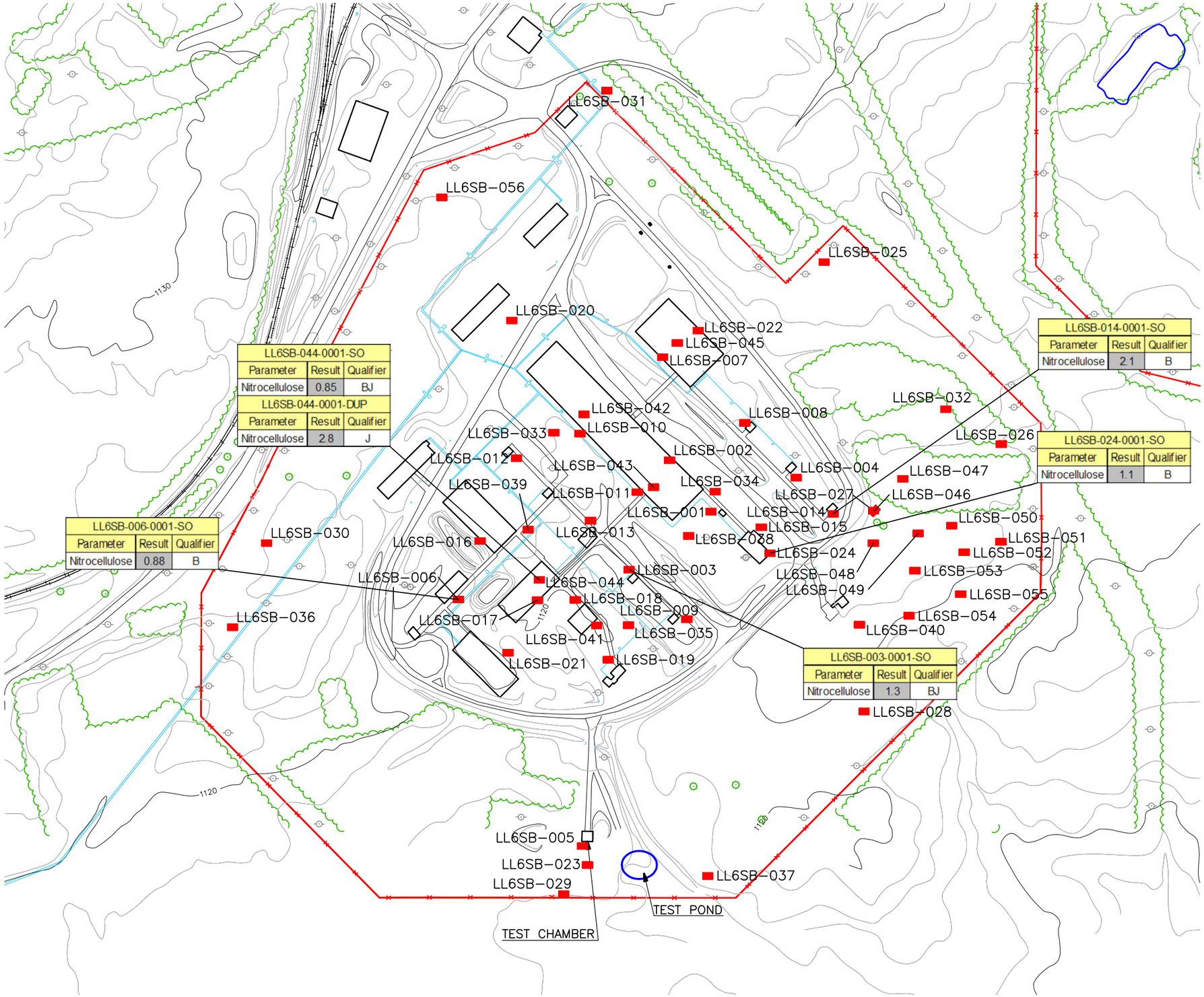
4.1.2.1 Explosives and Propellants

Explosives were not detected in the subsurface soil samples collected during the RI. However, secondary explosives were detected in surface samples and only five subsurface samples were collected. Therefore the vertical extent of secondary explosives is not adequately defined. Nitrocellulose was detected in four subsurface soil samples and one duplicate at concentrations above the method detection limit but below the reporting limit. However, the nitrocellulose results were qualified as estimated (J), or (B) the concentration of nitrocellulose in the method blank was detected above the reporting limit, or both (B) (J). Figure 4–12 shows subsurface soil exceedances for explosives and propellants at LL–6.

4.1.2.2 TAL Metals and Cyanide

Figure 4–13 shows subsurface soil exceedances for TAL metals and cyanide at LL–6. The following metals were detected above comparable RVAAP installation background criteria (WBG Phase II RI, 2001), Region 9 residential soil PRGs for subsurface soil (>1 ft bgs), or both:

- Aluminum was detected above the Region 9 residential soil PRG (7,614 mg/kg) in 44 samples, 5 of which were duplicates. Aluminum was also detected above the RVAAP installation background criterion (19,500 mg/kg) and the Region 9 residential soil PRG in 1 sample with a maximum concentration of 21,000 mg/kg detected in samples LL6SB–012–0001–DUP.
- Arsenic was detected above the Region 9 residential soil PRG (0.39 mg/kg) in 45 samples, 5 of which were duplicates. Arsenic was also detected above the RVAAP installation background criterion (19.8 mg/kg) and the Region 9 residential soil PRG in 4 samples, 1 of which was a duplicate, with a maximum concentration of 26 mg/kg detected in samples LL6SB–033–0001–SO and LL6SB–033–0001–DUP.
- Barium was detected above the RVAAP installation background criterion (124 mg/kg) in 1 sample with a concentration of 160 mg/kg detected in sample LL6SB–028–0001–SO.



LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SUBSURFACE SOIL SAMPLE LOCATION
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN mg/kg
IF RESULT ≥ BACKGROUND, THEN THE VALUE IS SHADED
IF RESULT ≥ THE PRG THEN THE VALUE IS LISTED IN BOLD TEXT
IF RESULT ≥ BACKGROUND AND THE PRG THE VALUE IS BOLD + SHADED
IF RESULT < BACKGROUND AND PRG THEN THE VALUE IS LISTED IN NORMAL TEXT

ORGANIC QUALIFIERS
J – RESULT IS AN ESTIMATED VALUE BELOW THE RL

ORGANIC FLAGS
B – METHOD BLANK: BATCH QC IS GREATER THAN RL

N

0' 100' 200' 300'
1" = 200'

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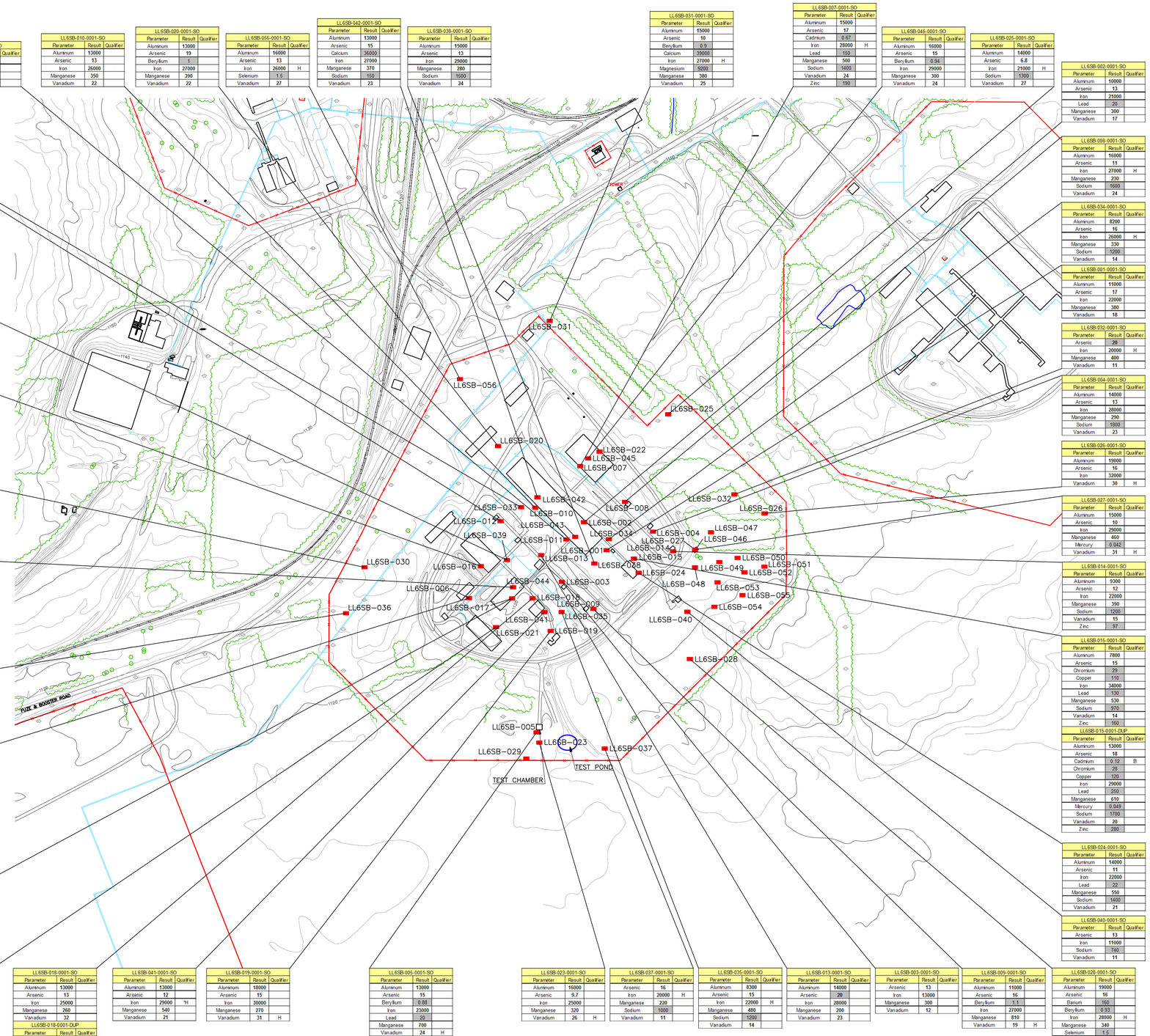
FIGURE 4-12

SUBSURFACE SOIL SAMPLE (>1Ft)
EXCEEDANCES EXPLOSIVES/PROPELLANTS

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2

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LL6SB-011-0001-SO		
Parameter	Result	Qualifier
Aluminum	13000	
Arsenic	9.9	
Iron	23000	
Manganese	360	

LL6SB-010-0001-SO		
Parameter	Result	Qualifier
Aluminum	13000	
Arsenic	13	
Iron	26000	
Manganese	350	
Vanadium	22	

LL6SB-020-0001-SO		
Parameter	Result	Qualifier
Aluminum	13000	
Arsenic	19	
Beryllium	1	
Iron	27000	
Manganese	390	
Vanadium	22	

LL6SB-055-0001-SO		
Parameter	Result	Qualifier
Aluminum	16000	
Arsenic	13	
Iron	26000	H
Selenium	1.5	
Vanadium	27	

LL6SB-042-0001-SO		
Parameter	Result	Qualifier
Aluminum	13000	
Arsenic	15	
Calcium	26000	
Iron	27000	
Manganese	370	
Sodium	150	
Vanadium	23	

LL6SB-038-0001-SO		
Parameter	Result	Qualifier
Aluminum	15000	
Arsenic	13	
Iron	29000	
Manganese	280	
Sodium	1500	
Vanadium	24	

LL6SB-031-0001-SO		
Parameter	Result	Qualifier
Aluminum	15000	
Arsenic	10	
Beryllium	0.9	
Calcium	39000	
Iron	27000	H
Magnesium	9200	
Manganese	380	
Vanadium	25	

LL6SB-007-0001-SO		
Parameter	Result	Qualifier
Aluminum	15000	
Arsenic	17	
Cadmium	0.67	
Iron	28000	H
Lead	150	
Manganese	500	
Sodium	1400	
Vanadium	24	
Zinc	150	

LL6SB-045-0001-SO		
Parameter	Result	Qualifier
Aluminum	16000	
Arsenic	15	
Beryllium	0.94	
Iron	29000	
Manganese	300	
Vanadium	24	

LL6SB-025-0001-SO		
Parameter	Result	Qualifier
Aluminum	14000	
Arsenic	6.8	
Iron	21000	H
Sodium	1300	
Vanadium	27	

LL6SB-033-0001-SO		
Parameter	Result	Qualifier
Aluminum	8400	
Arsenic	26	
Iron	24000	H
Manganese	290	
Vanadium	13	

LL6SB-033-0001-DUP		
Parameter	Result	Qualifier
Aluminum	9200	
Arsenic	26	
Iron	25000	H
Manganese	290	
Vanadium	15	

LL6SB-012-0001-SO		
Parameter	Result	Qualifier
Aluminum	15000	
Arsenic	12	
Iron	30000	
Manganese	340	
Sodium	1600	
Vanadium	29	

LL6SB-012-0001-DUP		
Parameter	Result	Qualifier
Aluminum	21000	
Arsenic	11	
Iron	32000	
Vanadium	30	

LL6SB-039-0001-SO		
Parameter	Result	Qualifier
Aluminum	13000	
Arsenic	11	
Iron	25000	
Manganese	400	
Sodium	1400	
Vanadium	22	

LL6SB-016-0001-SO		
Parameter	Result	Qualifier
Aluminum	14000	
Arsenic	13	
Cobalt	33	
Iron	28000	
Lead	20	
Manganese	570	
Mercury	0.041	
Vanadium	20	

LL6SB-030-0001-SO		
Parameter	Result	Qualifier
Aluminum	19000	
Arsenic	11	
Iron	45000	H
Manganese	440	
Selenium	2.5	
Vanadium	31	

LL6SB-044-0001-SO		
Parameter	Result	Qualifier
Aluminum	9100	
Arsenic	4.3	
Iron	16000	
Vanadium	18	

LL6SB-044-0001-DUP		
Parameter	Result	Qualifier
Aluminum	8500	
Arsenic	5.2	
Iron	15000	
Manganese	210	
Vanadium	17	

LL6SB-036-0001-SO		
Parameter	Result	Qualifier
Aluminum	9400	
Arsenic	15	
Iron	23000	H
Manganese	220	
Vanadium	15	

LL6SB-006-0001-SO		
Parameter	Result	Qualifier
Aluminum	13000	
Arsenic	14	
Iron	24000	
Lead	24	
Manganese	660	
Mercury	0.044	
Vanadium	25	

LL6SB-006-0001-DUP		
Parameter	Result	Qualifier
Aluminum	13000	
Arsenic	11	
Iron	27000	
Manganese	1100	
Vanadium	27	

LL6SB-017-0001-SO		
Parameter	Result	Qualifier
Aluminum	11000	
Arsenic	5	
Beryllium	0.9	
Cadmium	0.45	
Iron	17000	
Lead	47	
Manganese	820	
Mercury	0.29	
Vanadium	20	H

LL6SB-021-0001-SO		
Parameter	Result	Qualifier
Aluminum	11000	
Arsenic	2.6	
Iron	10000	
Vanadium	15	H

LL6SB-018-0001-SO		
Parameter	Result	Qualifier
Aluminum	13000	
Arsenic	13	
Iron	25000	
Manganese	260	
Vanadium	32	

LL6SB-018-0001-DUP		
Parameter	Result	Qualifier
Aluminum	12000	
Arsenic	11	
Cobalt	33	
Iron	24000	
Manganese	1600	
Vanadium	26	

LL6SB-041-0001-SO		
Parameter	Result	Qualifier
Aluminum	13000	
Arsenic	12	
Iron	29000	H
Manganese	540	
Vanadium	21	

LL6SB-015-0001-SO		
Parameter	Result	Qualifier
Aluminum	18000	
Arsenic	15	
Iron	30000	
Manganese	270	
Vanadium	31	H

LL6SB-005-0001-SO		
Parameter	Result	Qualifier
Aluminum	13000	
Arsenic	15	
Beryllium	0.88	
Iron	23000	
Lead	20	
Manganese	700	
Vanadium	24	H

LL6SB-023-0001-SO		
Parameter	Result	Qualifier
Aluminum	16000	
Arsenic	9.7	
Iron	25000	
Manganese	320	
Vanadium	26	H

LL6SB-037-0001-SO		
Parameter	Result	Qualifier
Arsenic	16	
Iron	20000	H
Manganese	220	
Sodium	1000	
Vanadium	11	

LL6SB-035-0001-SO		
Parameter	Result	Qualifier
Aluminum	8300	
Arsenic	15	
Iron	22000	H
Manganese	480	
Sodium	1200	
Vanadium	14	

LL6SB-013-0001-SO		
Parameter	Result	Qualifier
Aluminum	14000	
Arsenic	20	
Iron	28000	
Manganese	200	
Vanadium	23	

LL6SB-003-0001-SO		
Parameter	Result	Qualifier
Arsenic	13	
Iron	13000	
Manganese	300	
Vanadium	12	

LL6SB-009-0001-SO		
Parameter	Result	Qualifier
Aluminum	11000	
Arsenic	16	
Beryllium	1.1	
Iron	27000	
Manganese	810	
Vanadium	19	H

LL6SB-028-0001-SO		
Parameter	Result	Qualifier
Aluminum	15000	
Arsenic	16	
Barium	160	
Beryllium	0.93	
Iron	28000	H
Manganese	340	
Selenium	1.5	
Vanadium	27	

LL6SB-002-0001-SO		
Parameter	Result	Qualifier
Aluminum	10000	
Arsenic	13	
Iron	21000	
Lead	20	
Manganese	300	
Vanadium	17	

LL6SB-008-0001-SO		
Parameter	Result	Qualifier
Aluminum	16000	
Arsenic	11	
Iron	27000	H
Manganese	230	
Sodium	1600	
Vanadium	24	

LL6SB-034-0001-SO		
Parameter	Result	Qualifier
Aluminum	8200	
Arsenic	16	
Iron	26000	H
Manganese	330	
Sodium	1200	
Vanadium	14	

LL6SB-001-0001-SO		
Parameter	Result	Qualifier
Aluminum	11000	
Arsenic	17	
Iron	22000	
Manganese	380	
Vanadium	18	

LL6SB-032-0001-SO		
Parameter	Result	Qualifier
Arsenic	20	
Iron	20000	H
Manganese	400	
Vanadium	11	

LL6SB-004-0001-SO		
Parameter	Result	Qualifier
Aluminum	14000	
Arsenic	13	
Iron	28000	
Manganese	290	
Sodium	1900	
Vanadium	23	

LL6SB-026-0001-SO		
Parameter	Result	Qualifier
Aluminum	19000	
Arsenic	16	
Iron	32000	
Vanadium	30	H

LL6SB-027-0001-SO		
Parameter	Result	Qualifier
Aluminum	15000	
Arsenic	10	
Iron	29000	
Manganese	460	
Mercury	0.042	
Vanadium	31	H

LL6SB-014-0001-SO		
Parameter	Result	Qualifier
Aluminum	9300	
Arsenic	12	
Iron	22000	
Manganese	390	
Sodium	1200	
Vanadium	15	
Zinc	97	

LL6SB-015-0001-SO		
Parameter	Result	Qualifier
Aluminum	7800	
Arsenic	15	
Chromium	29	
Copper	110	
Iron	34000	
Lead	130	
Manganese	530	
Sodium	970	
Vanadium	14	
Zinc	160	

LL6SB-015-0001-DUP		
Parameter	Result	Qualifier
Aluminum	13000	
Arsenic	18	
Cadmium	0.12	B
Chromium	28	
Copper	120	
Iron	29000	
Lead	250	
Manganese	610	
Mercury	0.049	
Sodium	1700	
Vanadium	20	
Zinc	280	

LL6SB-024-0001-SO		
Parameter	Result	Qualifier
Aluminum	14000	
Arsenic	11	
Iron	22000	
Lead	22	
Manganese	550	
Sodium	1400	
Vanadium	21	

LL6SB-040-0001-SO		
Parameter	Result	Qualifier
Arsenic	13	
Iron	11000	
Sodium	740	
Vanadium	11	

LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SURFACE SOIL SAMPLE LOCATION
- SURFACE SOIL SAMPLING LOCATION TAKEN DURING AZIDE SCREENING
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN mk/kg

IF RESULT ≥ BACKGROUND, THEN THE VALUE IS SHADED
IF RESULT ≥ THE PRG THEN THE VALUE IS LISTED IN BOLD TEXT
IF RESULT ≥ BACKGROUND AND THE PRG THE VALUE IS BOLD + SHADED
IF RESULT < BACKGROUND AND PRG THEN THE VALUE IS LISTED IN NORMAL TEXT

INORGANIC QUALIFIERS
J – RESULT IS LESS THAN THE RL, BUT GREATER THAN OR EQUAL TO THE MDL
B – RESULT IS LESS THAN THE CRDL/RL, BUT GREATER THAN OR EQUAL TO THE IDL/MDL

INORGANIC FLAGS
H – BATCH QC IS GREATER THAN RL

N

0' 100' 200' 300'
1" = 200'

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Stafford, TX 77477

RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

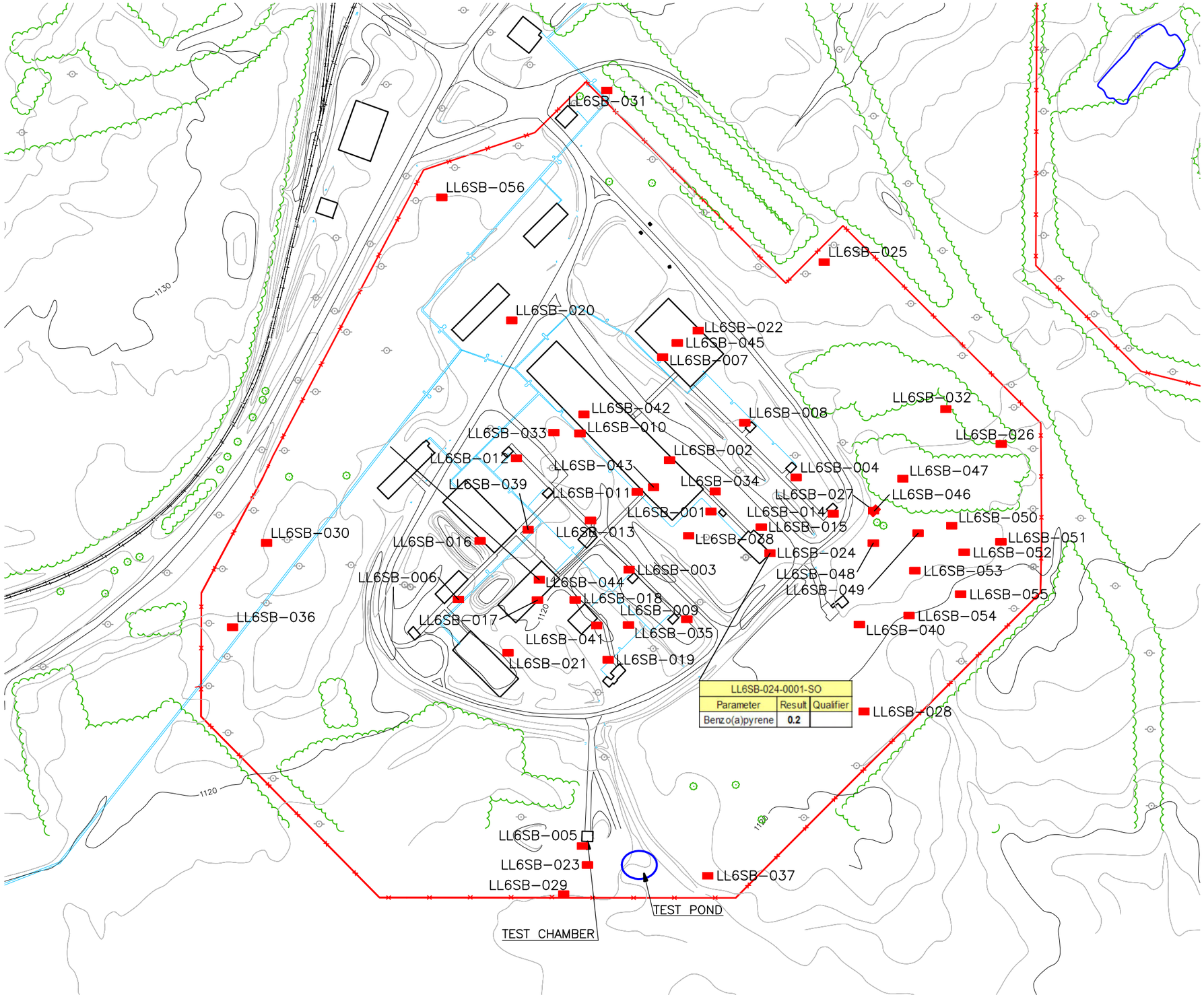
FIGURE 4-13

SUBSURFACE SOIL SAMPLE (>1Ft) EXCEEDANCES TAL METALS/CYANIDE

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
D	02-02-0085	MAY 2007	2

DRAWN BY	R. BOWMAN	APPR. BY	SL



LL6SB-024-0001-SO		
Parameter	Result	Qualifier
Benzo(a)pyrene	0.2	

LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SUBSURFACE SOIL SAMPLE LOCATION
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN mg/kg
IF RESULT ≥ BACKGROUND, THEN THE VALUE IS SHADED
IF RESULT ≥ THE PRG THEN THE VALUE IS LISTED IN BOLD TEXT
IF RESULT ≥ BACKGROUND AND THE PRG THE VALUE IS BOLD + SHADED
IF RESULT < BACKGROUND AND PRG THEN THE VALUE IS LISTED IN NORMAL TEXT

ORGANIC QUALIFIERS
J – RESULT IS AN ESTIMATED VALUE BELOW THE RL

ORGANIC FLAGS
B – METHOD BLANK: BATCH QC IS GREATER THAN RL

N

0' 100' 200' 300'
1" = 200'

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RAVENNA, OHIO

FIGURE 4-14

SUBSURFACE SOIL SAMPLE (>1Ft)
EXCEEDANCES VOCs/SVOCs

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2
DRAWN BY	R. BOWMAN	APPR. BY	SL

LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- BUILDING
- FENCE
- SUBSURFACE SOIL SAMPLE LOCATION

SUBSURFACE BACKGROUND VALUE FOR BERYLLIUM = 0.88 mg/Kg

CONCENTRATION

- **NON-DETECT OR ≤ BACKGROUND**
- **> 1 TO 2 TIMES BACKGROUND**
- **> 2 TO 5 TIMES BACKGROUND**
- **> 5 TO 20 TIMES BACKGROUND**
- **> 20 TIMES BACKGROUND**

N

0' 100' 200' 300'

1" = 200'

LL6SB–031
LL6SB–056
LL6SB–025
LL6SB–020
LL6SB–045
LL6SB–007
LL6SB–032
LL6SB–042
LL6SB–010
LL6SB–008
LL6SB–033
LL6SB–026
LL6SB–012
LL6SB–002
LL6SB–004
LL6SB–039
LL6SB–034
LL6SB–011
LL6SB–001
LL6SB–014
LL6SB–027
LL6SB–030
LL6SB–016
LL6SB–013
LL6SB–015
LL6SB–028
LL6SB–024
LL6SB–006
LL6SB–003
LL6SB–044
LL6SB–018
LL6SB–009
LL6SB–036
LL6SB–017
LL6SB–035
LL6SB–041
LL6SB–040
LL6SB–021
LL6SB–019
LL6SB–028
LL6SB–005
LL6SB–023
LL6SB–037
TEST CHAMBER
TEST POND
1130
1120

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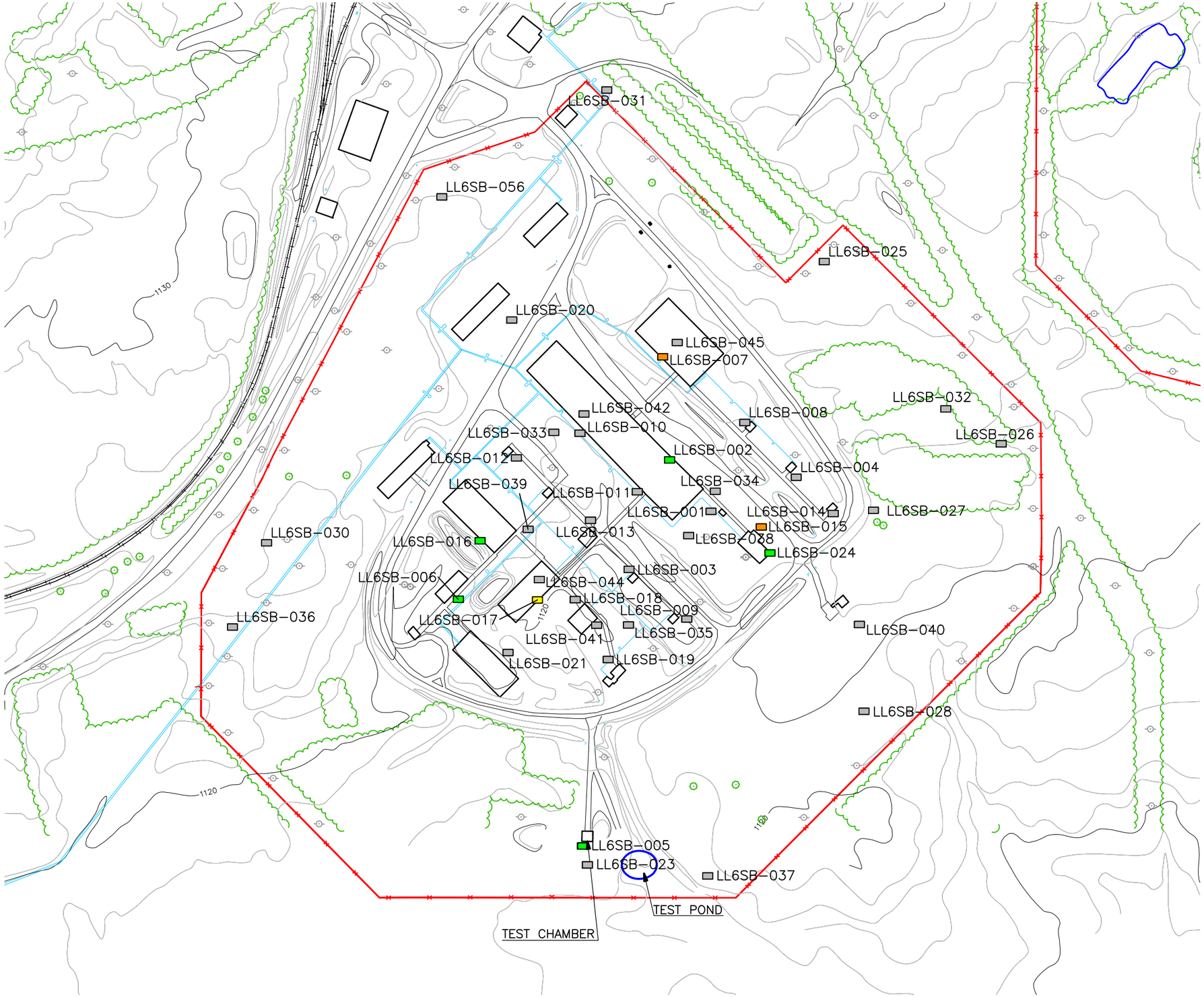
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RAVENNA, OHIO

FIGURE 4–15

SUBSURFACE SOIL SAMPLE (>1Ft)
BERYLLIUM

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02–02–0085	MAY 2007	2
DRAWN BY	R. BOWMAN	APPR. BY	SL



LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- BUILDING
- FENCE
- SUBSURFACE SOIL SAMPLE LOCATION

SUBSURFACE BACKGROUND VALUE FOR LEAD = 19.1 mg/Kg

CONCENTRATION

- **NON-DETECT OR ≤ BACKGROUND**
- **> 1 TO 2 TIMES BACKGROUND**
- **> 2 TO 5 TIMES BACKGROUND**
- **> 5 TO 20 TIMES BACKGROUND**
- **> 20 TIMES BACKGROUND**

N

0' 100' 200' 300'

1" = 200'

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RAVENNA, OHIO

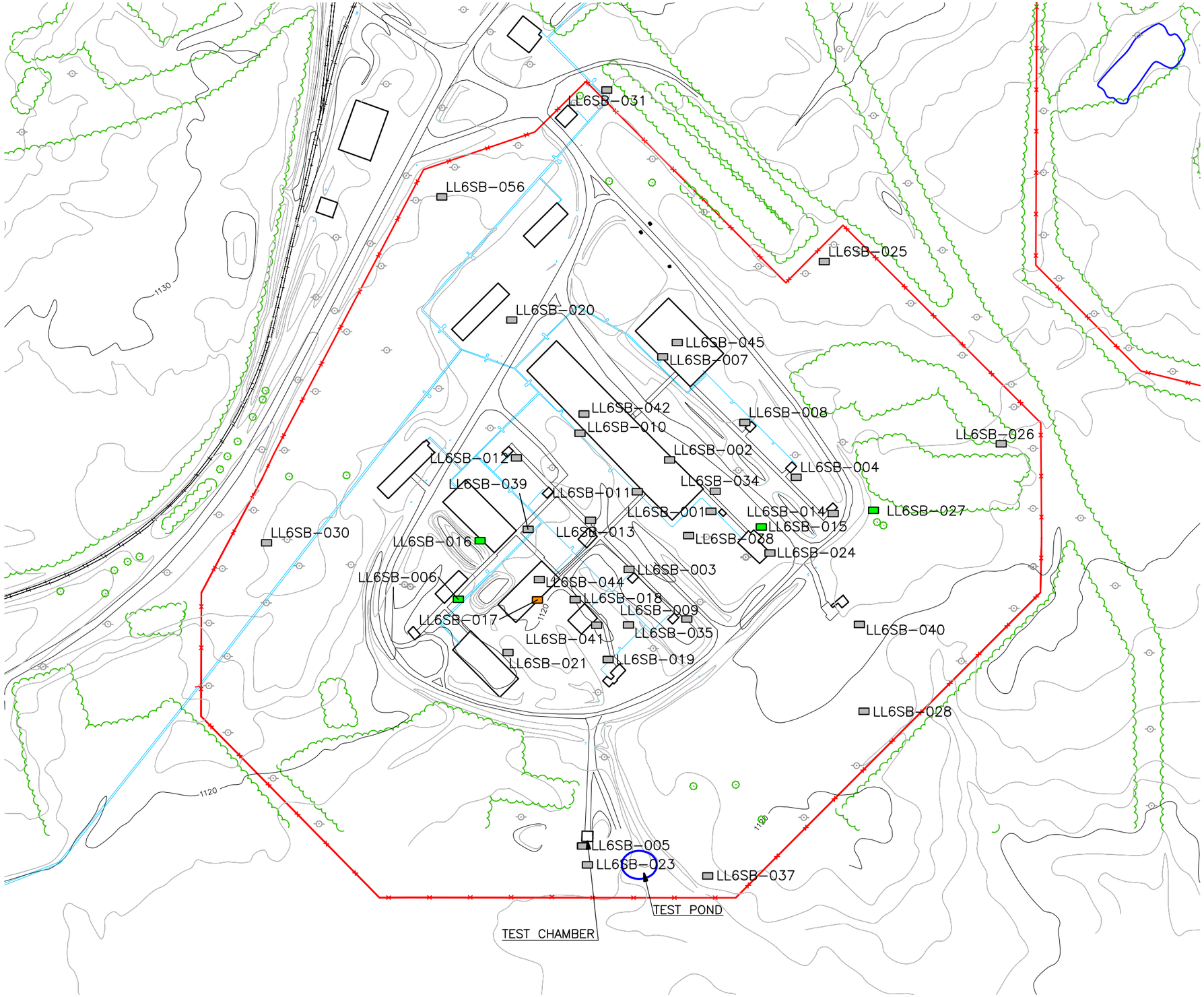
FIGURE 4–16

SUBSURFACE SOIL SAMPLE (>1Ft)
LEAD

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02–02–0085	MAY 2007	2

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LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- BUILDING
- FENCE
- SUBSURFACE SOIL SAMPLE LOCATION

SUBSURFACE BACKGROUND VALUE FOR MERCURY = 0.04 mg/Kg

CONCENTRATION

- **NON-DETECT OR ≤ BACKGROUND**
- **> 1 TO 2 TIMES BACKGROUND**
- **> 2 TO 5 TIMES BACKGROUND**
- **> 5 TO 20 TIMES BACKGROUND**
- **> 20 TIMES BACKGROUND**

N

0' 100' 200' 300'

1" = 200'

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FIGURE 4–17

SUBSURFACE SOIL SAMPLE (>1Ft)
MERCURY

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02–02–0085	MAY 2007	2

DRAWN BY	R. BOWMAN	APPR. BY	SL

- Beryllium was detected above the RVAAP installation background criterion (0.88 mg/kg) in 7 samples with a maximum concentration of 1.1 mg/kg detected in sample LL6SB–009–0001–SO.

- Cadmium was detected above the RVAAP installation background criterion (0.0 mg/kg) in 3 samples, 1 of which was a duplicate, with a maximum concentration of 0.67 mg/kg detected in sample LL6SB–007–0001–SO.

- Calcium was detected above the RVAAP installation background criterion (35,500 mg/kg) in 2 samples with a maximum concentration of 39,000 mg/kg detected in sample LL6SB–031–0001–SO.

- Chromium was detected above the RVAAP installation background criterion (27.2 mg/kg) in 2 samples with a maximum concentration of 29 mg/kg detected in sample LL6SB–015–0001–SO.

- Cobalt was detected above the RVAAP installation background criterion (23.2 mg/kg) in 2 samples, 1 of which was a duplicate, with a maximum concentration of 33 mg/kg detected in sample LL6SB–016–0001–SO and LL6SB–018–0001–DUP.

- Copper was detected above the RVAAP installation background criterion (32.3 mg/kg) in 2 samples, 1 of which was a duplicate, with a maximum concentration of 120 mg/kg detected in sample LL6SB–015–0001–DUP.

- Iron was detected above the Region 9 residential soil PRG (2,346 mg/kg) in 48 samples and was detected above RVAAP installation background criterion (35,200 mg/kg) and the Region 9 residential soil PRG in 1 sample with a maximum concentration of 45,000 mg/kg (H) detected in sample LL6SB–030–0001–SO. However, the maximum result was qualified (H) because the batch QC was greater than the reporting limit or a negative instrument reading lower than the absolute value of the reporting limit was recorded.

- Lead was detected above the RVAAP installation background criterion (19.1 mg/kg) in 9 samples, 1 of which is a duplicate, with a maximum concentration of 250 mg/kg detected in sample LL6SB–015–0001–DUP.

- Magnesium was detected above the RVAAP installation background criterion (8,790 mg/kg) in 1 sample with a concentration of 9,200 mg/kg detected in sample LL6SB–031–0001–SO.

- Manganese was detected above the Region 9 residential soil PRG (176 mg/kg) in 42 samples, 5 of which were duplicates, with a maximum concentration of 1,600 mg/kg detected in sample LL6SB–018–0001–DUP.

- Mercury was detected above the RVAAP installation background criterion (0.04 mg/kg) in 5 samples, 1 of which was a duplicate, with a maximum concentration of 0.29 mg/kg detected in sample LL6SB–017–0001–SO.

- Selenium was detected above the RVAAP installation background criterion (1.5 mg/kg) in 3 samples with a maximum concentration of 2.5 mg/kg detected in sample LL6SB–030–0001–SO.
- Sodium was detected above the RVAAP installation background criterion (145 mg/kg) in 16 samples, 1 of which was a duplicate, with a maximum concentration of 1,800 mg/kg detected in sample LL6SB–004–0001–SO.
- Vanadium was detected above the Region 9 residential soil PRG (7.8 mg/kg) in 49 samples, 6 of which were duplicates, with a maximum concentration of 32 mg/kg detected in sample LL6SB–018–0001–SO.
- Zinc was detected above the RVAAP installation background criterion (93.3 mg/kg) in 4 samples, 1 of which was a duplicate, with a maximum concentration of 280 mg/kg detected in sample LL6SB–015–0001–DUP.

4.1.2.3 Pesticides and PCBs

No pesticides or PCBs were detected in the subsurface soil samples.

4.1.2.4 Volatiles and Semi-volatiles

Although some SVOCs were detected, only benzo(a)pyrene exceeded the Region 9 residential soil PRG (0.062 mg/kg), which was detected in sample LL6SB–024–0001–SO with a concentration of 0.2 mg/kg. Figure 4–17 shows subsurface soil exceedances for VOCs and SVOCs at LL–6. No VOCs were detected.

4.2 Groundwater

This section summarizes the physical and chemical data collected from the LL–6 groundwater monitoring wells.

4.2.1 Hydraulic Conductivity and Water Level Measurements

In June 2004, slug tests were performed on the newly installed wells at LL–6. Test results were field checked for validity before leaving the site. However, data files for MW–001, MW–002, and MW–006 were corrupted after field collection. Slug tests were re–performed on MW–002 and MW–006 (MW–001 does not contain a sufficient water column to conduct a slug test). The revised data are included in Appendix L. Slug test data records for the six wells (MW–002, MW–003, MW–004, MW–005, MW–006 and MW–007) are also provided in Appendix L. As shown in Table 4–6, hydraulic conductivities ranged from 5.11E-04 to 9.541E-03 centimeters/second (cm/s) in the soil underlying LL–6. Previous slug tests performed at wells located at other sites within RVAAP indicate average hydraulic conductivities between 1.7E-03

cm/s to 4.46E-06 cm/s. Available slug test results for the six wells were consistent, and provide good representation of the site conditions.

Table 4–6
Hydraulic Conductivity Data

Monitoring Well	Screened Interval Depth (bgs)	Total Depth (ft)	Hydraulic Conductivity (cm/s)	Material Well Screened In
MW–001	7 – 17	18	NA	Unconsolidated Overburden
MW–002	12.5 – 22.5	23	9.54E-03	Unconsolidated Overburden
MW–003	12.5 – 22.5	23.4	2.36E-03	Unconsolidated Overburden
MW–004	12.5 – 22.5	23	8.35E-03	Unconsolidated Overburden
MW–005	9.5 – 19.5	19.9	7.05E-04	Unconsolidated Overburden
MW–006	7 – 17	20	5.11E-04	Unconsolidated Overburden
MW–007	9.5 – 19.5	20	5.37E-03	Unconsolidated Overburden

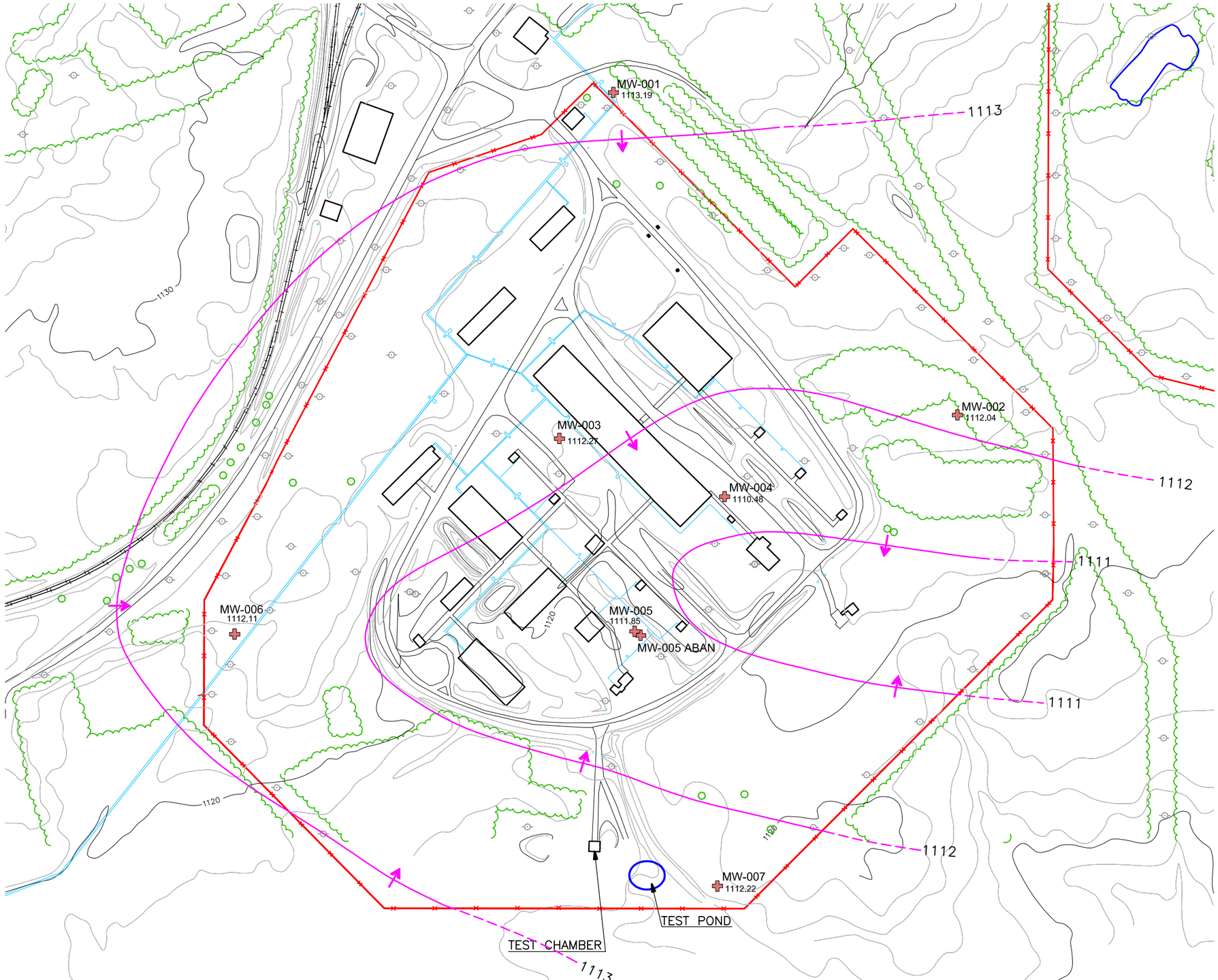
NA – not available because of corrupted data files and insufficient water volume.

MW–001 was installed at a location believed to be upgradient to the AOC and confirmed on the potentiometric maps. Hence, MW–001 can be used to characterize the quality of groundwater upgradient from this AOC. Groundwater levels were measured on two occasions: December 3, 2003, and June 4, 2004. (see Appendix H). Data from those two rounds of well gauging were used to produce the potentiometric surface maps for LL–6 (Figures 4–18 and 4–19). A potentiometric low is indicated on both figures representing the two rounds of groundwater elevation monitoring. The low elevation values are geographically centered around monitoring wells MW–004 and MW–005. The sewer lines (presently inactive) installed at the site are up to 14 feet bgs, which would be sufficient depth to act as a conduit. Additionally, the LL–6 sanitary sewers at the site were observed on several occasions to have a substantial flow across and off the AOC. Because the sewers are inactive, this flow may represent groundwater infiltration into the sewers.

4.2.2 Groundwater Exceedances

Groundwater samples were collected from each of the seven newly installed monitoring wells (MW–001 through MW–007) and analyzed for the RVAAP full analytical suite for TAL metals (filtered), cyanide, explosives, propellants, VOCs, SVOCs, pesticides and PCBs. In addition, one duplicate sample was collected for the RVAAP full analytical suite. Analytical results were compared to RVAAP installation background criteria (unconsolidated aquifer) and Region 9 tap water PRGs.

One propellant (nitrocellulose), two SVOCs (4–nitroaniline and bis(2–ethylhexyl) phthalate), and metals (including antimony, arsenic, copper, manganese, and selenium) were detected at concentrations greater than RVAAP installation background criteria, Region 9 tap water PRGs or both.



LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- POTENTIOMETRIC CONTOUR LINES
- STEAM LINE POST
- MONITORING WELL SAMPLE LOCATION
- BUILDING
- FENCE
- POTENTIOMETRIC FLOW DIRECTION

N

0' 100' 200' 300'

1" = 200'

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Stafford, TX 77477

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RAVENNA, OHIO

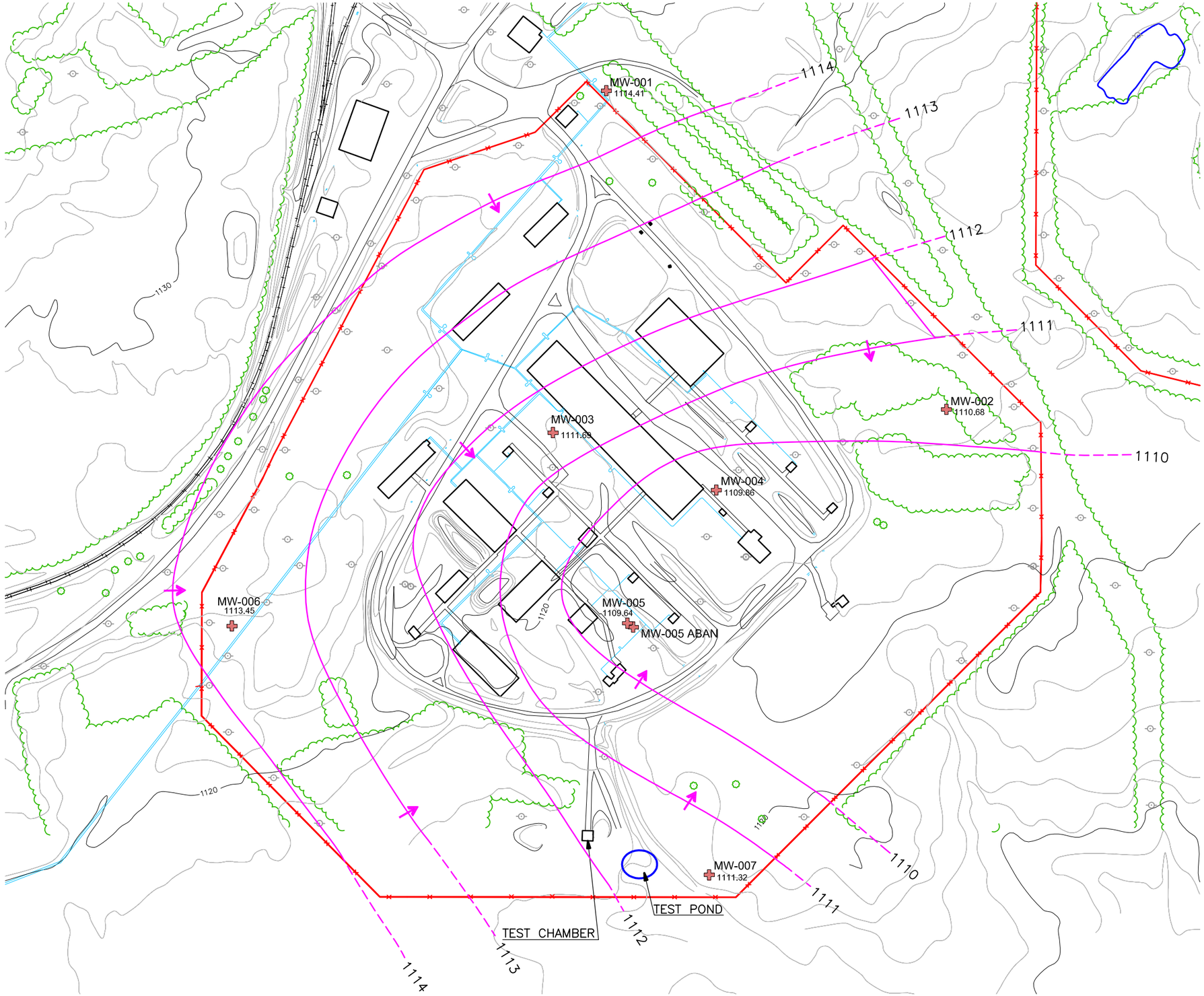
FIGURE 4-18

POTENTIOMETRIC SURFACE
DECEMBER 17, 2003

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	AUG 2007	3

DRAWN BY	RB/KP	APPR. BY	MT



LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- POTENTIOMETRIC CONTOUR LINE
- STEAM LINE POST
- MONITORING WELL SAMPLE LOCATION
- BUILDING
- FENCE
- POTENTIOMETRIC FLOW DIRECTION

N

0' 100' 200' 300'

1" = 200'

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FIGURE 4-19

POTENTIOMETRIC SURFACE
JUNE 29, 2004

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	AUG 2007	3

DRAWN BY	RB/KP	APPR. BY	MT

Exceedances for propellants, SVOCs, and TAL metals have not been fully delineated during this Phase I RI. Analytical results for the groundwater samples are listed in Table 4–7, and a summary of groundwater exceedances are summarized in Table 4–8. Groundwater analytical results and laboratory results are located in Appendix M. Analytes detected above RVAAP–specific unconsolidated background criteria and/or Region 9 tap water PRGs values are illustrated in Figures 4–20 through 4–22.

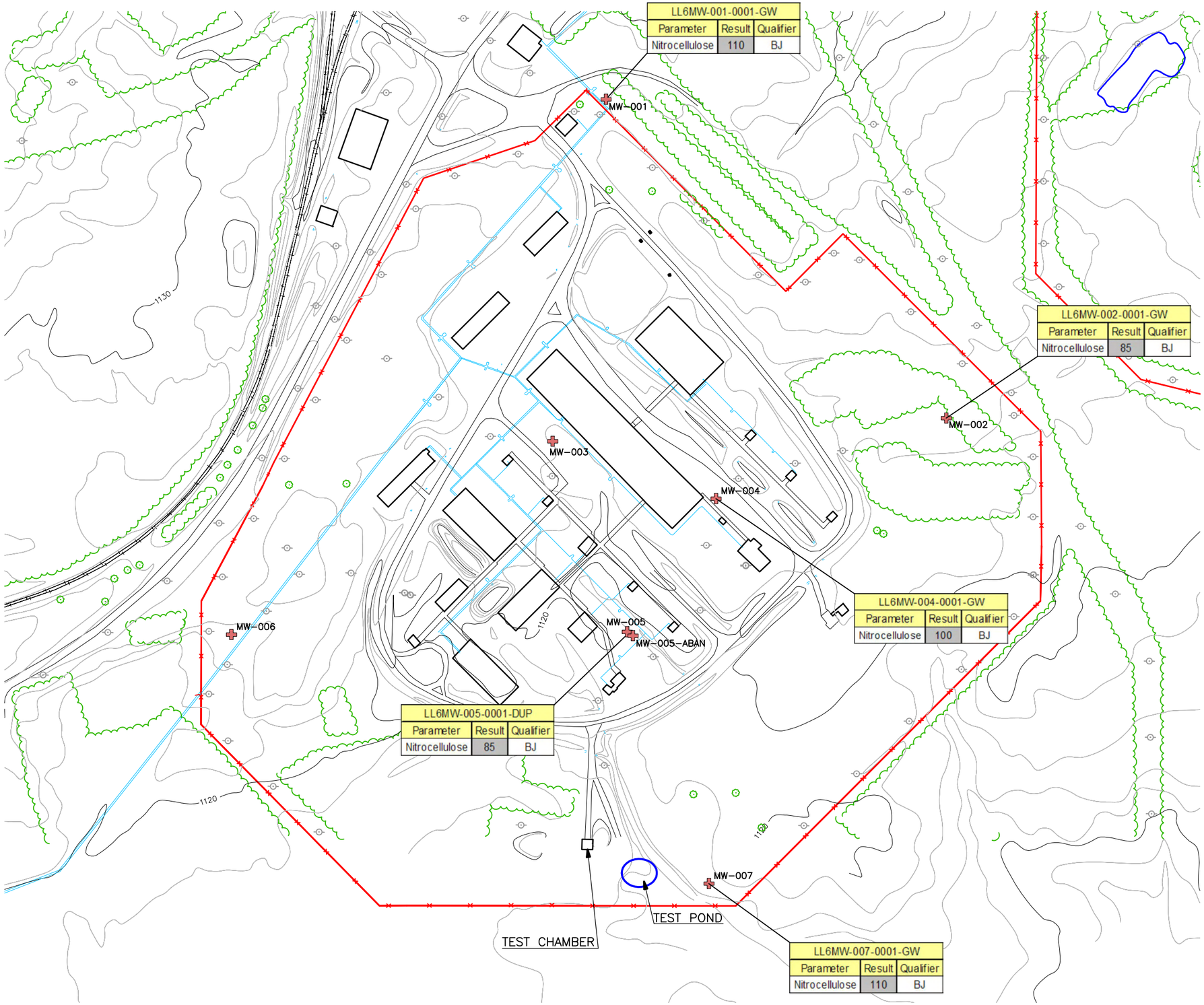
4.2.2.1 Explosives and Propellants

Explosives concentrations were not reported above the laboratory detection limit in the groundwater samples collected during the RI. Nitrocellulose was detected in five groundwater samples at concentrations above the method detection limit but below the reporting limit. However, the nitrocellulose results were qualified as estimated (J) and (B) the concentration of nitrocellulose in the method blank was detected above the reporting limit. Figure 4–20 shows groundwater exceedances for propellants at LL–6.

4.2.2.2 TAL Metals and Cyanide

When the RVAAP-specific unconsolidated background criteria for groundwater were established, no background criteria were established for antimony, cobalt or copper; therefore, the background criteria assigned to these metals, for the purpose of this RI, was zero. Figure 4–21 shows groundwater exceedances for TAL metals at LL–6. The following metals were detected above RVAAP–specific unconsolidated background criteria (WBG Phase II RI, 2001) Region 9 tap water PRGs, or both:

- Antimony was detected above the RVAAP-specific unconsolidated installation background criterion (0.0 µg/L) in 3 samples with a maximum concentration of 4.2 µg/L detected in sample LL6MW–003–0001–GW.
- Arsenic was detected above Region 9 tap water PRG (0.045 µg/L) in 1 sample and the RVAAP–specific unconsolidated background criterion (11.7 µg/L) and Region 9 tap water PRG in 2 samples, 1 of which was a duplicate, with a maximum concentration of 13 µg/L detected in sample LL6MW–005–0001–GW.
- Calcium was detected above the RVAAP-specific unconsolidated background criterion (115,000 µg/L) in 1 sample with a concentration of 130,000 (H) µg/L detected in sample LL6MW–002–0001–GW. However, the maximum result was qualified (H) because the batch QC was greater than the reporting limit or a negative instrument reading lower than the absolute value of the reporting limit was recorded.



LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- MONITORING WELL SAMPLE LOCATION
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN ug/L
IF RESULT ≥ BACKGROUND, THEN THE VALUE IS SHADED
IF RESULT ≥ THE PRG THEN THE VALUE IS LISTED IN BOLD TEXT
IF RESULT ≥ BACKGROUND AND THE PRG THE VALUE IS BOLD + SHADED
IF RESULT < BACKGROUND AND PRG THEN THE VALUE IS LISTED IN NORMAL TEXT

ORGANIC QUALIFIERS
J – RESULT IS AN ESTIMATED VALUE BELOW THE RL

ORGANIC FLAGS
B – METHOD BLANK: BATCH QC IS GREATER THAN RL

N

0' 100' 200' 300'
1" = 200'

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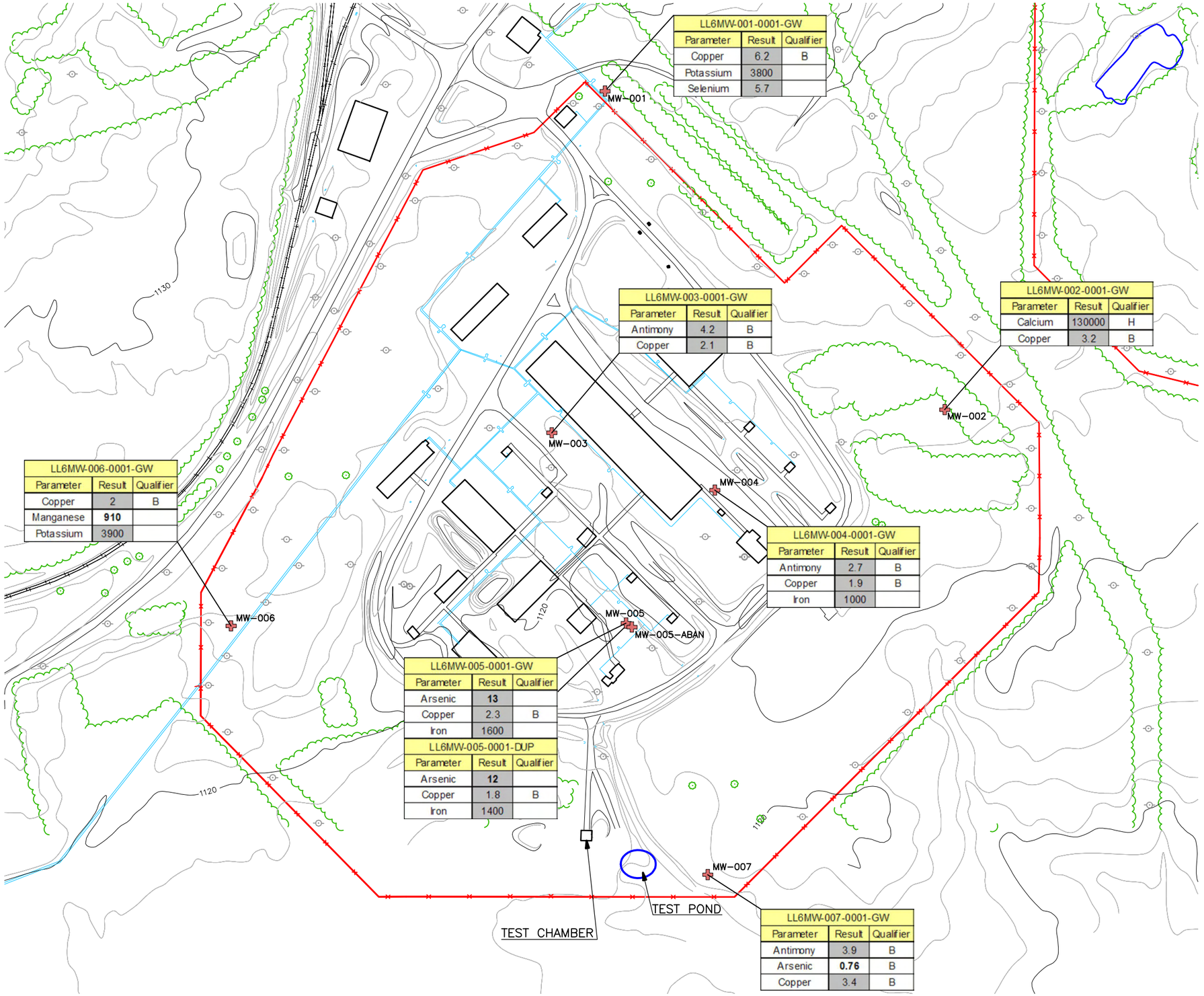
FIGURE 4-20

GROUNDWATER SAMPLE EXCEEDANCES EXPLOSIVES/PROPELLANTS

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2

DRAWN BY	R. BOWMAN	APPR. BY	SL



LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- MONITORING WELL SAMPLE LOCATION
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN ug/L
IF RESULT ≥ BACKGROUND, THEN THE VALUE IS SHADED
IF RESULT ≥ THE PRG THEN THE VALUE IS LISTED IN BOLD TEXT
IF RESULT ≥ BACKGROUND AND THE PRG THE VALUE IS BOLD + SHADED
IF RESULT < BACKGROUND AND PRG THEN THE VALUE IS LISTED IN NORMAL TEXT

INORGANIC QUALIFIERS
J – RESULT IS LESS THAN THE RL, BUT GREATER THAN OR EQUAL TO THE MDL
B – RESULT IS LESS THAN THE CRDL/RL, BUT GREATER THAN OR EQUAL TO THE IDL/MDL

INORGANIC FLAGS
H – BATCH QC IS GREATER THAN RL

N

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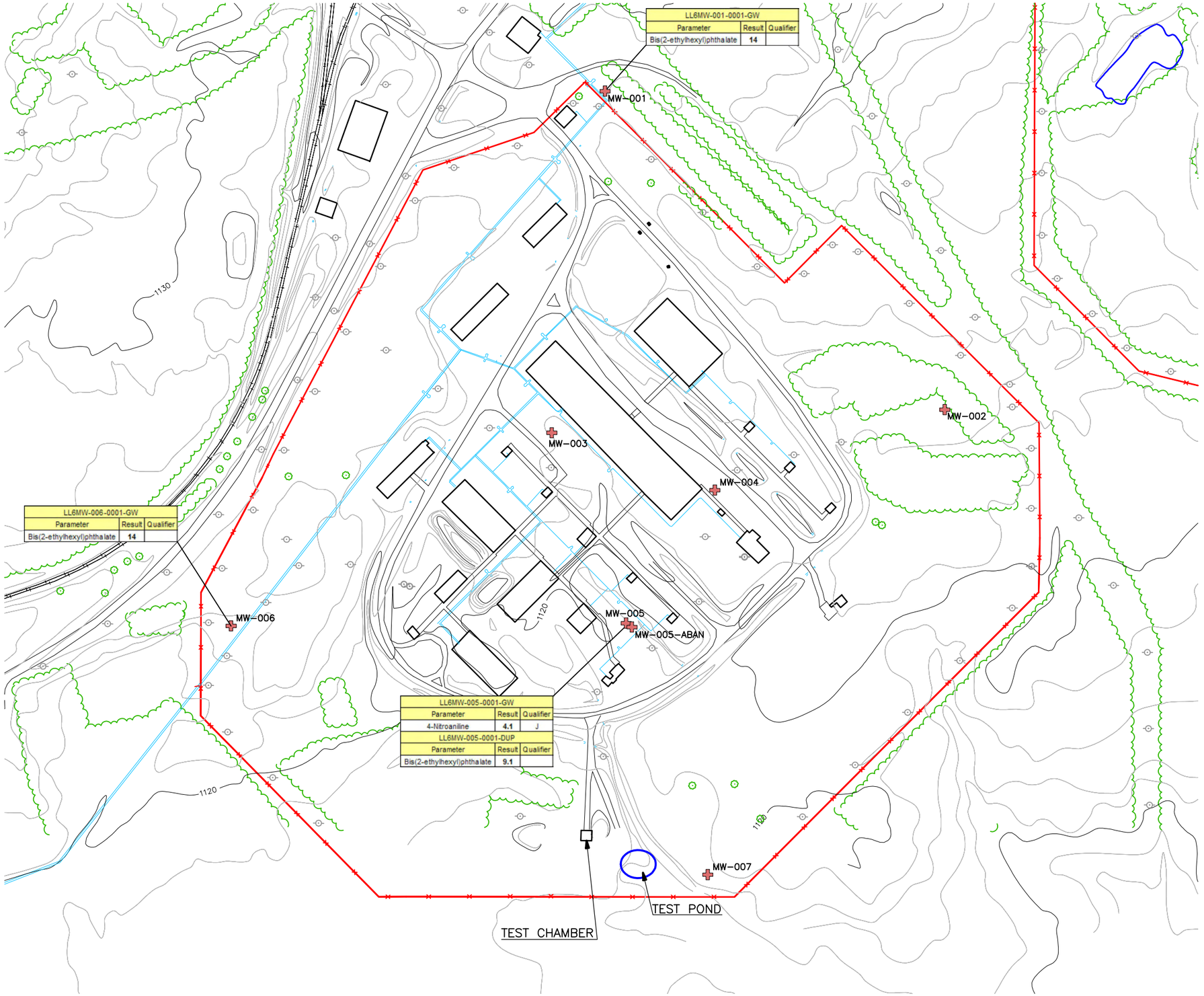
FIGURE 4-21

GROUNDWATER SAMPLE EXCEEDANCES TAL METALS AND CYANIDE

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	AUG 2007	3

DRAWN BY	RB/KP	APPR. BY	MT



LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- MONITORING WELL SAMPLE LOCATION
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN ug/L
IF RESULT ≥ BACKGROUND, THEN THE VALUE IS SHADED
IF RESULT ≥ THE PRG THEN THE VALUE IS LISTED IN BOLD TEXT
IF RESULT ≥ BACKGROUND AND THE PRG THE VALUE IS BOLD + SHADED
IF RESULT < BACKGROUND AND PRG THEN THE VALUE IS LISTED IN NORMAL TEXT

ORGANIC QUALIFIERS
J – RESULT IS AN ESTIMATED VALUE BELOW THE RL

ORGANIC FLAGS
B – METHOD BLANK: BATCH QC IS GREATER THAN RL

N

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1" = 200'

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FIGURE 4-22

GROUNDWATER SAMPLE EXCEEDANCES VOCs/SVOCs

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2

DRAWN BY	R. BOWMAN	APPR. BY	SL

- Copper was detected above the RVAAP-specific unconsolidated background criterion (0.0 µg/L) in 8 samples, 1 of which was a duplicate, with a maximum concentration of 6.2 µg/L detected in sample LL6MW–001–0001–GW.
- Iron was detected above the RVAAP-specific unconsolidated background criterion (279 µg/L) in 3 samples, 1 of which was a duplicate, with a maximum concentration of 1,600 µg/L detected in sample LL6MW–005–0001–GW.
- Manganese was detected above the Region 9 tap water PRG (876 µg/L) in 1 sample with a concentration of 910 µg/L detected in sample LL6MW–006–0001–GW.
- Potassium was detected above the RVAAP-specific unconsolidated background criterion (2,890 µg/L) in 2 samples with a maximum concentration of 3,900 µg/L detected in sample LL6MW–006–0001–GW.
- Selenium was detected above the RVAAP-specific unconsolidated background criterion (0.0 µg/L) in 1 sample with a concentration of 5.7 µg/L detected in sample LL6MW–001–0001–GW.

4.2.2.3 Pesticides and PCBs

No pesticides or PCBs were detected in the groundwater samples.

4.2.2.4 Volatiles and Semi-volatiles

The only SVOCs detected at concentrations greater than laboratory detection limits were 4–nitroaniline and bis(2–ethylhexyl)phthalate. 4–Nitroaniline was detected above the Region 9 tap water PRG (3.2 µg/L) in sample LL6MW–005–0001–GW with an estimated concentration of 4.1 µg/L (J). However, the maximum result was qualified as estimated (J) because the concentration was detected below the reporting limit but greater than or equal to the method detection limit. Bis(2–ethylhexyl)phthalate was detected above Region 9 tap water PRG (4.8 µg/L) in three samples, one of which was a duplicate, with a maximum concentration of 14 µg/L detected in samples LL6MW–001–0001–GW and LL6MW–006–0001–GW. Figure 4–22 shows groundwater exceedances for SVOCs at LL–6. No VOCs were detected.

4.3 Surface Water

This section summarizes the physical and chemical data collected from surface water sources at LL–6.

4.3.1 Surface Water Exceedances

Surface water samples were collected from 7 locations at LL–6 during the azide screening and RI sampling activities. One surface water sample and 1 duplicate were collected during the

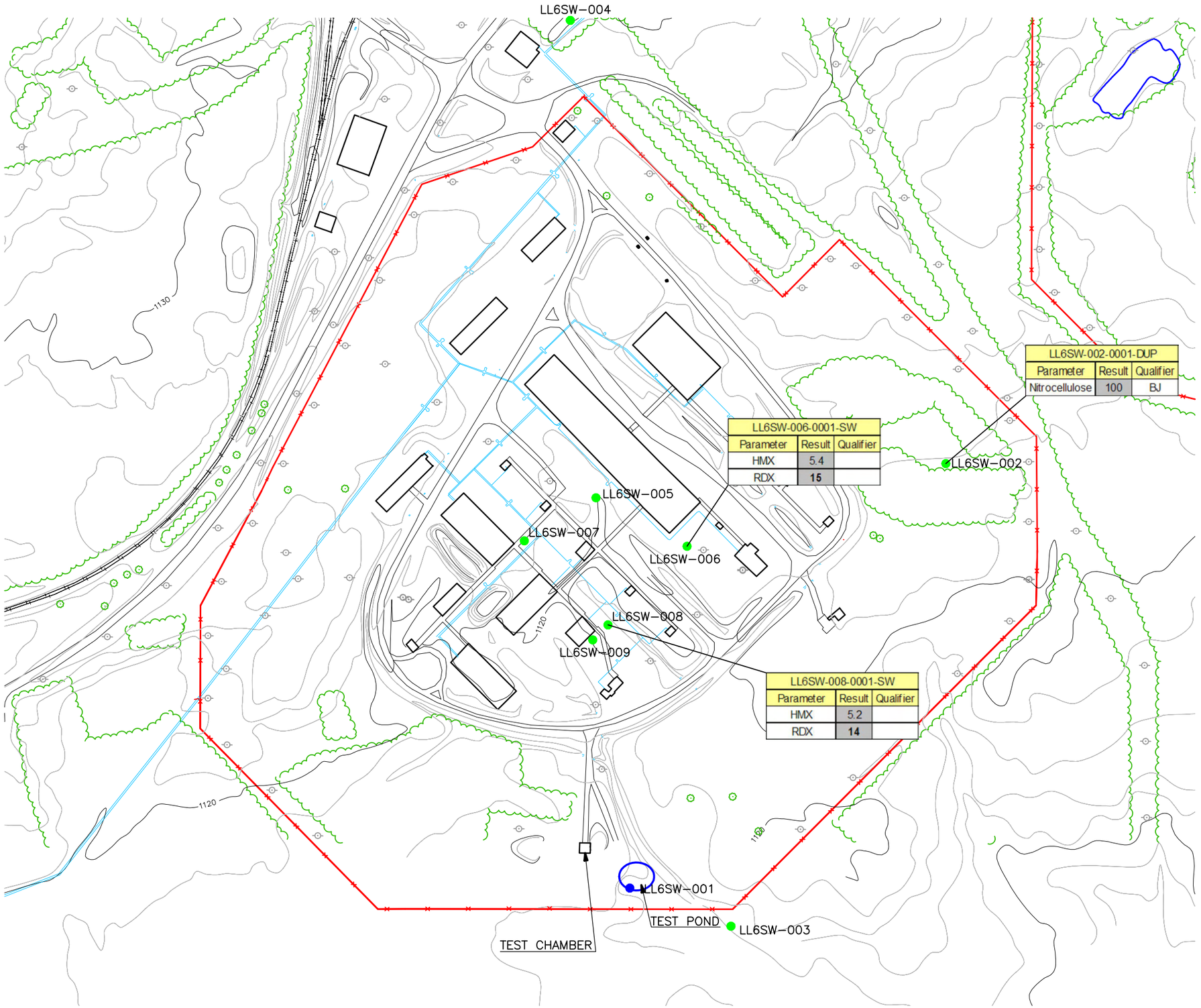
azide screening and 6 surface water samples and 1 duplicate were collected during the RI. Surface water samples collected during the azide screening and RI were submitted for analysis of TAL metals and explosives. In addition, 1 surface water sample was analyzed for the RVAAP full analytical suite of TAL metals, explosives, cyanides, VOCs, SVOCs, PCBs, pesticides, and propellants. Analytical results were compared to RVAAP installation background criteria and Region 9 tap water PRGs.

One propellant (nitrocellulose), two explosives (HMX and RDX), several SVOCs, and metals including (aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, vanadium, and zinc) were detected at concentrations greater than RVAAP installation background criteria, Region 9 tap water PRGs or both. Exceedances for propellants, explosives, TAL metals, and SVOCs has not been fully delineated during this Phase I RI.

Analytical results for the surface water samples are summarized in Table 4–9; surface water results during azide screening are summarized in Table 4–10; and surface soil exceedances are summarized in Table 4–11. Surface water analytical results and laboratory results are located in Appendix N. Azide screening results for surface water are located in Appendix F. Analytes detected above RVAAP installation background criteria and Region 9 tap water PRGs values are illustrated in Figures 4–23 through 4–25.

4.3.1.1 Explosives and Propellants

HMX and RDX were detected above the RVAAP installation background criteria (WBG Phase II RI, 2001) in 2 samples. HMX was detected above the RVAAP installation background criterion detected in sample LL6SW–006–0001–SW with a concentration of 5.4 µg/L and sample LL6SW–008–0001–SW with concentration of 5.2 µg/L. RDX was detected above the RVAAP installation background criterion detected in sample LL6SW–006–0001–SW with a concentration of 15 µg/L and sample LL6SW–008–0001–SW with concentration of 14 µg/L. Nitrocellulose was detected above the RVAAP installation background criterion in one surface water sample (LL6SW–002–0001–DUP) with an estimated concentration of 100 µg/L (B) (J). However, the maximum result was qualified as estimated (J) because the concentration in the method blank was detected above the reporting limit (B). Figure 4–23 shows surface water exceedances for explosives and propellants at LL–6.



LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SURFACE WATER SAMPLING LOCATION
- SURFACE WATER SAMPLING LOCATION TAKEN DURING AZIDE SCREENING
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN ug/L
IF RESULT ≥ BACKGROUND, THEN THE VALUE IS SHADED
IF RESULT ≥ THE PRG THEN THE VALUE IS LISTED IN BOLD TEXT
IF RESULT ≥ BACKGROUND AND THE PRG THE VALUE IS BOLD + SHADED
IF RESULT < BACKGROUND AND PRG THEN THE VALUE IS LISTED IN NORMAL TEXT

ORGANIC QUALIFIERS
J – RESULT IS AN ESTIMATED VALUE BELOW THE RL

ORGANIC FLAGS
B – METHOD BLANK: BATCH QC IS GREATER THAN RL

N

0' 100' 200' 300'
1" = 200'

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RAVENNA, OHIO

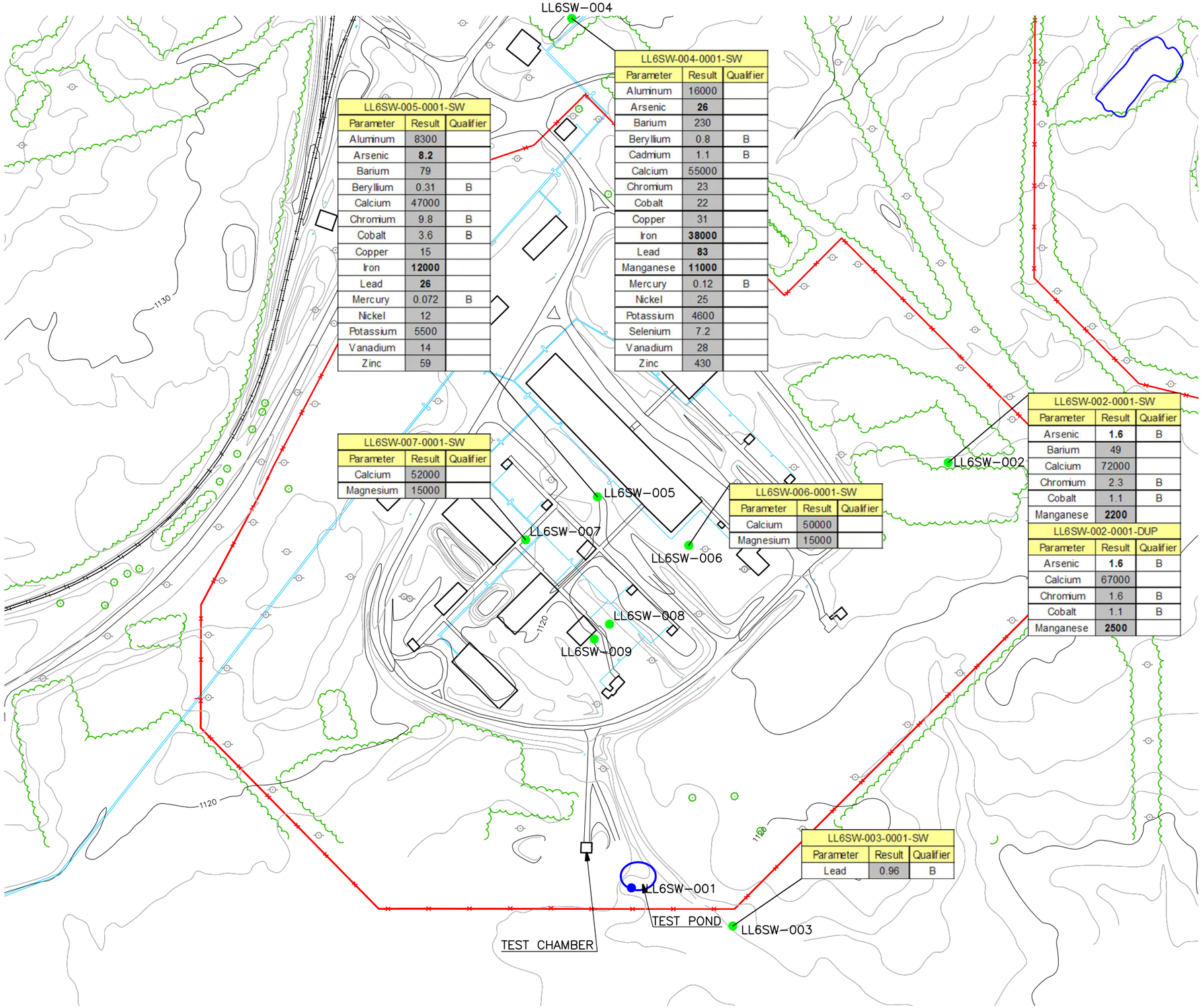
FIGURE 4-23

SURFACE WATER EXCEEDANCES
EXPLOSIVES/PROPELLANTS

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2

DRAWN BY	APPR. BY
R. BOWMAN	SL



LL6SW-005-0001-SW		
Parameter	Result	Qualifier
Aluminum	8300	
Arsenic	**8.2**	
Barium	79	
Beryllium	0.31	B
Calcium	47000	
Chromium	9.8	B
Cobalt	3.6	B
Copper	15	
Iron	**12000**	
Lead	**26**	
Mercury	0.072	B
Nickel	12	
Potassium	5500	
Vanadium	14	
Zinc	59	

LL6SW-004-0001-SW		
Parameter	Result	Qualifier
Aluminum	16000	
Arsenic	**26**	
Barium	230	
Beryllium	0.8	B
Cadmium	1.1	B
Calcium	55000	
Chromium	23	
Cobalt	22	
Copper	31	
Iron	**38000**	
Lead	**83**	
Manganese	**11000**	
Mercury	0.12	B
Nickel	25	
Potassium	4600	
Selenium	7.2	
Vanadium	28	
Zinc	430	

LL6SW-007-0001-SW		
Parameter	Result	Qualifier
Calcium	52000	
Magnesium	15000	

LL6SW-006-0001-SW		
Parameter	Result	Qualifier
Calcium	50000	
Magnesium	15000	

LL6SW-002-0001-SW		
Parameter	Result	Qualifier
Arsenic	**1.6**	B
Barium	49	
Calcium	72000	
Chromium	2.3	B
Cobalt	1.1	B
Manganese	**2200**	

LL6SW-002-0001-DUP		
Parameter	Result	Qualifier
Arsenic	**1.6**	B
Calcium	67000	
Chromium	1.6	B
Cobalt	1.1	B
Manganese	**2500**	

LL6SW-003-0001-SW		
Parameter	Result	Qualifier
Lead	0.96	B

LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SURFACE WATER SAMPLING LOCATION
- SURFACE WATER SAMPLING LOCATION TAKEN DURING AZIDE SCREENING
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN ug/L
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INORGANIC QUALIFIERS
J – RESULT IS LESS THAN THE RL, BUT GREATER THAN OR EQUAL TO THE MDL
B – RESULT IS LESS THAN THE CRDL/RL, BUT GREATER THAN OR EQUAL TO THE IDL/MDL

N

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1" = 200'

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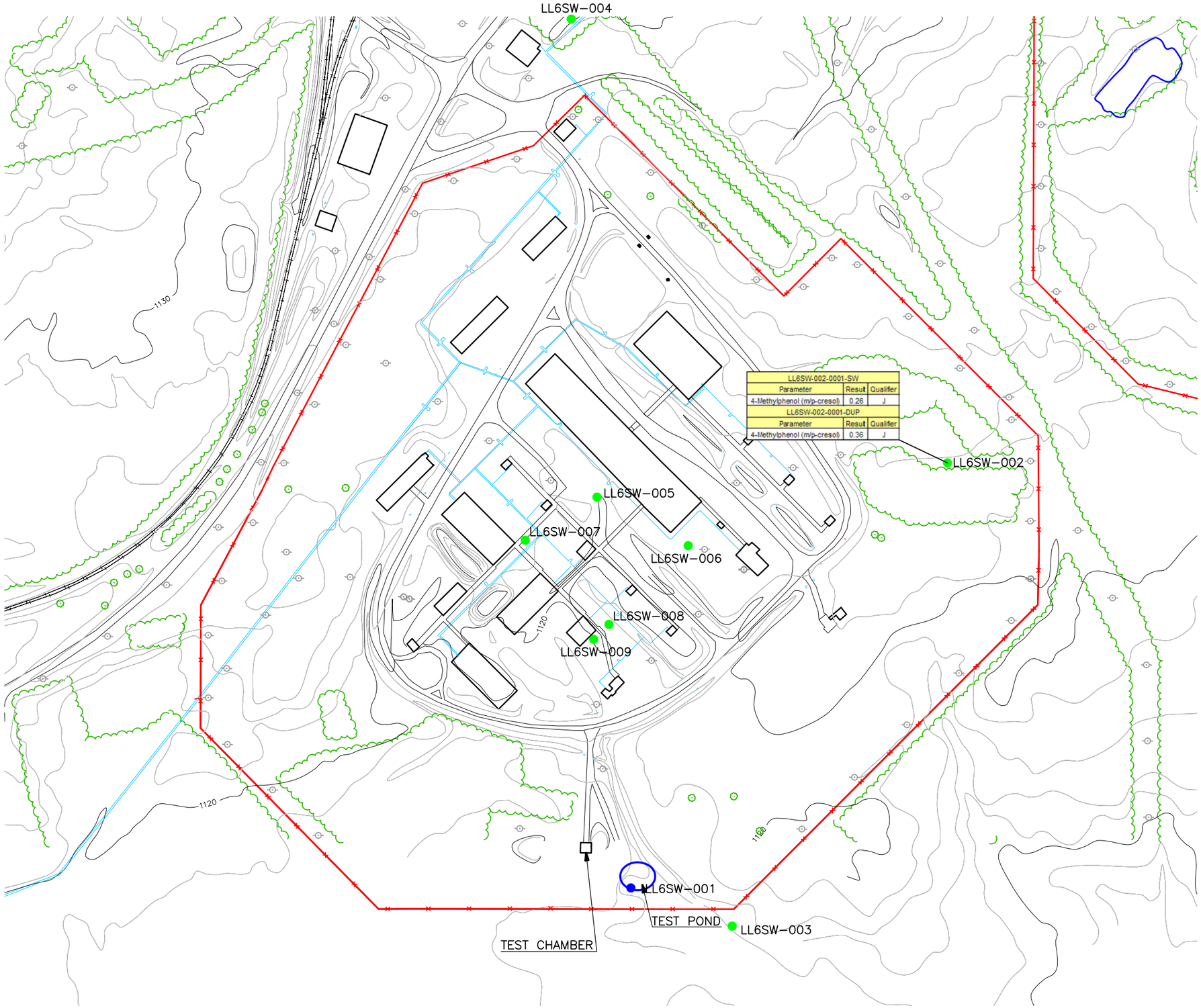
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RAVENNA, OHIO

FIGURE 4-24

SURFACE WATER EXCEEDANCES
TAL METALS AND CYANIDE

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2
DRAWN BY	R. BOWMAN	APPR. BY	SL



LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SURFACE WATER SAMPLING LOCATION
- SURFACE WATER SAMPLING LOCATION TAKEN DURING AZIDE SCREENING
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN ug/L
IF RESULT ≥ BACKGROUND, THEN THE VALUE IS SHADED
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IF RESULT ≥ BACKGROUND AND THE PRG THE VALUE IS BOLD + SHADED
IF RESULT < BACKGROUND AND PRG THEN THE VALUE IS LISTED IN NORMAL TEXT

ORGANIC QUALIFIERS
J – RESULT IS AN ESTIMATED VALUE BELOW THE RL

ORGANIC FLAGS
B – METHOD BLANK: BATCH QC IS GREATER THAN RL

N

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FIGURE 4-25

SURFACE WATER EXCEEDANCES
VOCs AND SVOCs

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2

DRAWN BY	R. BOWMAN	APPR. BY	SL

4.3.1.2 TAL Metals and Cyanide

When the RVAAP installation background criteria for surface water were established, no background criteria were established for beryllium, chromium, cobalt, lead, mercury, nickel, or vanadium; therefore, the background criteria assigned to these metals, for the purpose of this RI, was zero.

Figure 4–24 shows groundwater exceedances for TAL metals at LL–6. The following metals were detected above comparable RVAAP installation background criteria (WBG Phase II RI, 2001), Region 9 tap water PRGs, or both:

- Aluminum was detected above RVAAP installation background criterion (3,370 µg/L) in 2 samples with a maximum concentration of 16,000 µg/L detected in sample LL6SW–004–0001–SW.
- Arsenic was detected above Region 9 tap water PRG (0.045 µg/L) in 2 samples, 1 of which was a duplicate. Arsenic was also detected above the RVAAP installation background criterion (3.2 µg/L) and Region 9 tap water PRG in 2 samples with a maximum concentration of 26 µg/L detected in sample LL6SW–004–0001–SW.
- Barium was detected above RVAAP installation background criterion (47.5 µg/L) in 3 samples with a maximum concentration of 230 µg/L detected in sample LL6SW–004–0001–SW.
- Beryllium was detected above the RVAAP installation background criterion (0.0 µg/L) in 2 samples with a maximum concentration of 0.8 µg/L detected in sample LL6SW–004–0001–SW.
- Cadmium was detected above the RVAAP installation background criterion (0.0 µg/L) in 1 sample with a maximum concentration of 1.1 (B) µg/L detected in sample LL6SW–004–0001–SW. However, the maximum result was qualified (B) because the concentration detected was less than the reporting limit, but greater than or equal to the method detection limit.
- Calcium was detected above the RVAAP installation background criterion (41,400 µg/L) in 6 samples, 1 of which was a duplicate, with a maximum concentration of 72,000 µg/L detected in sample LL6SW–002–0001–SW.
- Chromium was detected above the RVAAP installation background criterion (0.0 µg/L) in 4 samples, 1 of which was a duplicate, with a maximum concentration of 23 µg/L detected in sample LL6SW–004–0001–SW.
- Cobalt was detected above the RVAAP installation background criterion (0.0 µg/L) in 4 samples, 1 of which was a duplicate, with a maximum concentration of 22 µg/L detected in sample LL6SW–004–0001–SW.

- Copper was detected above the RVAAP installation background criterion (7.9 µg/L) in 2 samples with a maximum concentration of 31 µg/L detected in sample LL6SW–004–0001–SW.
- Iron was detected above the RVAAP installation background criterion (2,560 µg/L) and Region 9 tap water PRG (10,950 µg/L) in 2 samples with a maximum concentration of 38,000 µg/L detected in sample LL6SW–004–0001–SW.
- Lead was detected above the RVAAP installation background criterion (0.0 µg/L) in 1 sample and Region 9 tap water PRG (15 µg/L) and RVAAP installation background criterion in 2 samples with a maximum concentration of 83 µg/L detected in sample LL6SW–004–0001–SW.
- Magnesium was detected above the RVAAP installation background criterion (10,800 µg/L) in 2 samples with a maximum concentration of 15,000 µg/L detected in sample LL6SW–006–0001–SW and LL6SW–008–0001–SW.
- Manganese was detected above the RVAAP installation background criterion (391 µg/L) and Region 9 tap water PRG (876 µg/L) in 3 samples, 1 of which was a duplicate, with a maximum concentration of 11,000 µg/L detected in sample LL6SW–004–0001–SW.
- Mercury was detected above the RVAAP installation background criterion (0.0 µg/L) in 2 samples with a maximum concentration of 0.12 µg/L detected in sample LL6SW–004–0001–SW.
- Nickel was detected above the RVAAP installation background criterion (0.0 µg/L) in 2 samples with a maximum concentration of 25 µg/L detected in sample LL6SW–004–0001–SW.
- Potassium was detected above the RVAAP installation background criterion (3,170 µg/L) in 2 samples with a maximum concentration of 5,500 µg/L detected in sample LL6SW–005–0001–SW.
- Vanadium was detected above the RVAAP installation background criterion (0.0 µg/L) in 2 samples with a maximum concentration of 28 µg/L detected in sample LL6SW–004–0001–SW.
- Zinc was detected above the RVAAP installation background criterion (42 µg/L) in 2 samples with a maximum concentration of 430 µg/L detected in sample LL6SW–004–0001–SW.

4.3.1.3 Pesticides and PCBs

No pesticides or PCBs were detected in the surface water samples.

4.3.1.4 Volatiles and Semi–volatiles

Although one SVOCs (4-methylphenol) was detected including, the concentration was less than the laboratory reporting limit and the Region 9 Region 9 tap water PRG. Figure 4–25 shows the surface water SVOC detection at LL–6.

4.4 Sediment

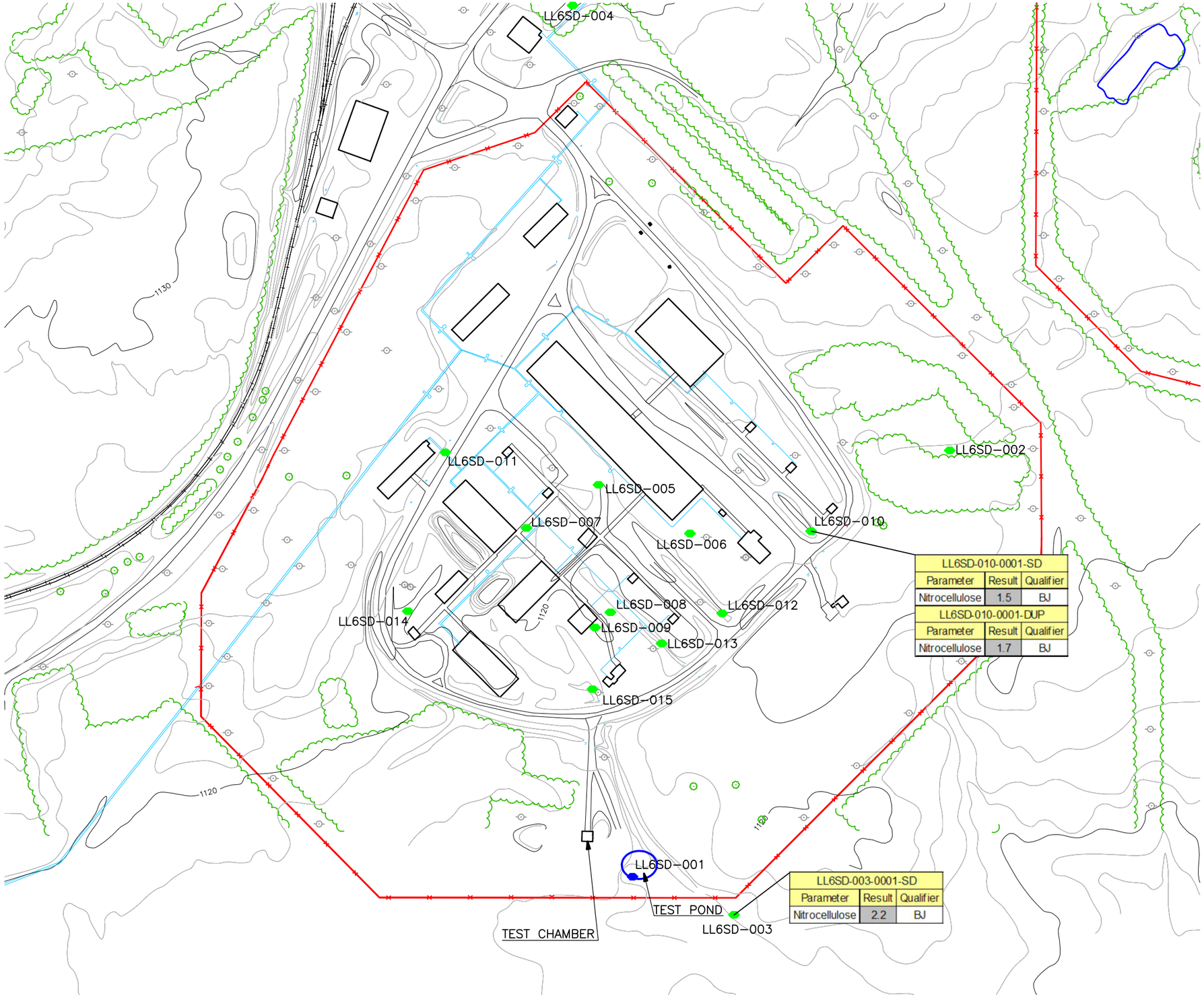
This section summarizes the physical and chemical data collected from sediment sample locations at LL–6.

4.4.1 RI Results

Sediment samples were collected from 12 locations at LL–6 during the azide screening and RI sampling activities. One sediment sample was collected during the azide screening and 11 sediment samples and two duplicates were collected during the RI. Samples collected during the azide screening were submitted for analysis of TAL metals and explosives. Samples collected during the RI were submitted for analysis of TAL metals, TOC, and grain size. In addition, three of the sediment samples collected were also analyzed for the RVAAP full analytical suite of TAL metals, explosives, cyanides, VOCs, SVOCs, PCBs, pesticides, and propellants. Analytical results were compared to RVAAP installation background criteria and Region 9 residential soil PRGs.

One propellant (nitrocellulose), 1 pesticide (4,4–DDE), 1 PCB (aroclor 1260), several SVOCs, and metals (including aluminum, antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, and vanadium) were detected at concentrations greater than RVAAP installation background criteria, Region 9 residential soil PRGs or both. The nature and extent of propellants, pesticides, PCBs, TAL metals, and SVOCs have not been fully delineated during this Phase I RI. The lateral extent of sediment contamination at LL–6 (as determined by this Phase I RI) is shown in Figures 4–26 through 4–29. The distribution and exposure pathways for SRCs are further discussed in the conceptual site model included in Section 5.4.

A summary of analytical results for the sediment samples are summarized in Table 4–12, sediment results during azide screening are summarized in Table 4–13 and sediment exceedances are summarized in Table 4–14. Sediment analytical results and laboratory results are located in Appendix P. Azide screening results for sediment are located in Appendix F. Analytes detected above RVAAP installation background criteria, Region 9 residential soil PRGs values, or both are illustrated in Figures 4–26 through 4–29.



LL6SD-010-0001-SD		
Parameter	Result	Qualifier
Nitrocellulose	1.5	BJ
LL6SD-010-0001-DUP		
Parameter	Result	Qualifier
Nitrocellulose	1.7	BJ

LL6SD-003-0001-SD		
Parameter	Result	Qualifier
Nitrocellulose	2.2	BJ

LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SEDIMENT SAMPLING LOCATION
- SEDIMENT SAMPLING LOCATION TAKED DURING AZIDE SCREENING
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN mg/kg
IF RESULT ≥ BACKGROUND, THEN THE VALUE IS SHADED
IF RESULT ≥ THE PRG THEN THE VALUE IS LISTED IN BOLD TEXT
IF RESULT ≥ BACKGROUND AND THE PRG THE VALUE IS BOLD + SHADED
IF RESULT < BACKGROUND AND PRG THEN THE VALUE IS LISTED IN NORMAL TEXT

ORGANIC QUALIFIERS
J – RESULT IS AN ESTIMATED VALUE BELOW THE RL

ORGANIC FLAGS
B – METHOD BLANK: BATCH QC IS GREATER THAN RL

N

0' 100' 200' 300'
1" = 200'

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FIGURE 4-26

SEDIMENT EXCEEDANCES
EXPLOSIVES/PROPELLANTS

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2
DRAWN BY	R. BOWMAN	APPR. BY	SL

LL6SD-011-0001-SD		
Parameter	Result	Qualifier
Aluminum	**12000**	
Arsenic	**11**	
Beryllium	0.74	
Calcium	10000	
Cobalt	10	
Iron	**26000**	
Lead	65	
Magnesium	4300	
Manganese	**410**	
Nickel	23	
Vanadium	**22**	

LL6SD-004-0001-SD		
Parameter	Result	Qualifier
Aluminum	**13000**	
Arsenic	**37**	
Beryllium	0.69	
Cadmium	1.1	
Chromium	21	
Cobalt	9.7	
Copper	57	
Iron	**23000**	
Lead	85	
Manganese	**450**	
Mercury	0.094	
Nickel	20	
Vanadium	**23**	

LL6SD-005-0001-SD		
Parameter	Result	Qualifier
Aluminum	**11000**	
Arsenic	**11**	
Beryllium	0.45	B
Cadmium	0.51	
Iron	**22000**	
Lead	44	
Magnesium	2900	
Manganese	**400**	
Mercury	0.13	
Nickel	18	
Vanadium	**21**	

LL6SD-005-0001-DUP		
Parameter	Result	Qualifier
Aluminum	**11000**	
Arsenic	**11**	
Beryllium	0.43	B
Cadmium	0.39	
Cobalt	9.4	
Iron	**23000**	
Lead	43	
Magnesium	2900	
Manganese	**350**	
Mercury	0.18	
Nickel	19	
Vanadium	**21**	

LL6SD-010-0001-SD		
Parameter	Result	Qualifier
Aluminum	**8900**	
Arsenic	**15**	
Beryllium	0.43	B
Cadmium	0.97	
Calcium	14000	
Cobalt	11	
Iron	**24000**	
Lead	51	
Magnesium	3600	
Manganese	**670**	
Nickel	31	
Vanadium	**16**	

LL6SD-010-0001-DUP		
Parameter	Result	Qualifier
Aluminum	**8600**	
Arsenic	**18**	
Beryllium	0.46	B
Cadmium	0.88	
Calcium	22000	
Cobalt	9.7	
Copper	29	
Iron	**22000**	
Lead	46	
Magnesium	3700	
Manganese	**450**	
Nickel	31	
Vanadium	**15**	

LL6SD-014-0001-SD		
Parameter	Result	Qualifier
Aluminum	**13000**	
Arsenic	**14**	
Beryllium	0.82	
Cadmium	0.22	B
Cobalt	9.9	
Copper	97	
Iron	**25000**	
Magnesium	3500	
Manganese	**340**	
Nickel	25	
Vanadium	**22**	

LL6SD-002-0001-SD		
Parameter	Result	Qualifier
Aluminum	**9600**	
Arsenic	**8.7**	
Beryllium	0.41	B
Iron	**20000**	
Lead	36	
Manganese	**380**	
Vanadium	**17**	

LL6SD-013-0001-SD		
Parameter	Result	Qualifier
Arsenic	**12**	
Beryllium	0.49	
Iron	**16000**	
Manganese	**250**	
Vanadium	**13**	

LL6SD-015-0001-SD		
Parameter	Result	Qualifier
Aluminum	**12000**	
Arsenic	**6.8**	
Beryllium	0.73	
Iron	**21000**	
Lead	39	
Manganese	**240**	
Mercury	0.25	
Vanadium	**22**	

LL6SD-001-0001-SD		
Parameter	Result	Qualifier
Aluminum	**16200**	
Antimony	0.6	
Arsenic	**11.6**	
Beryllium	0.71	
Chromium	23.2	
Cobalt	10.2	
Copper	68.4	
Iron	**27500**	H
Lead	156	
Magnesium	3880	
Manganese	**315**	
Nickel	28.4	
Sodium	243	
Vanadium	**27.2**	

LL6SD-003-0001-SD		
Parameter	Result	Qualifier
Arsenic	**9**	
Beryllium	0.62	
Cadmium	0.1	B
Cobalt	15	
Iron	**21000**	
Manganese	**770**	
Vanadium	**13**	

LL6SD-012-0001-SD		
Parameter	Result	Qualifier
Arsenic	**18**	
Beryllium	0.47	
Iron	**19000**	
Manganese	**370**	
Vanadium	**13**	

LL6SD-004
LL6SD-011
LL6SD-005
LL6SD-007
LL6SD-006
LL6SD-010
LL6SD-002
LL6SD-014
LL6SD-008
LL6SD-012
LL6SD-009
LL6SD-013
LL6SD-015
LL6SD-001
LL6SD-003
TEST POND
TEST CHAMBER
1130
1120
1120
1120

LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SEDIMENT SAMPLING LOCATION
- SEDIMENT SAMPLING LOCATION TAKED DURING AZIDE SCREENING
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN mg/kg

IF RESULT ≥ BACKGROUND, THEN THE VALUE IS SHADED
IF RESULT ≥ THE PRG THEN THE VALUE IS LISTED IN BOLD TEXT
IF RESULT ≥ BACKGROUND AND THE PRG THE VALUE IS BOLD + SHADED
IF RESULT < BACKGROUND AND PRG THEN THE VALUE IS LISTED IN NORMAL TEXT

INORGANIC QUALIFIERS
J – RESULT IS LESS THAN THE RL, BUT GREATER THAN OR EQUAL TO THE MDL
B – RESULT IS LESS THAN THE CRDL/RL, BUT GREATER THAN OR EQUAL TO THE IDL/MDL

INORGANIC FLAGS
H – BATCH QC IS GREATER THAN RL

N

0' 100' 200' 300'
1" = 200'

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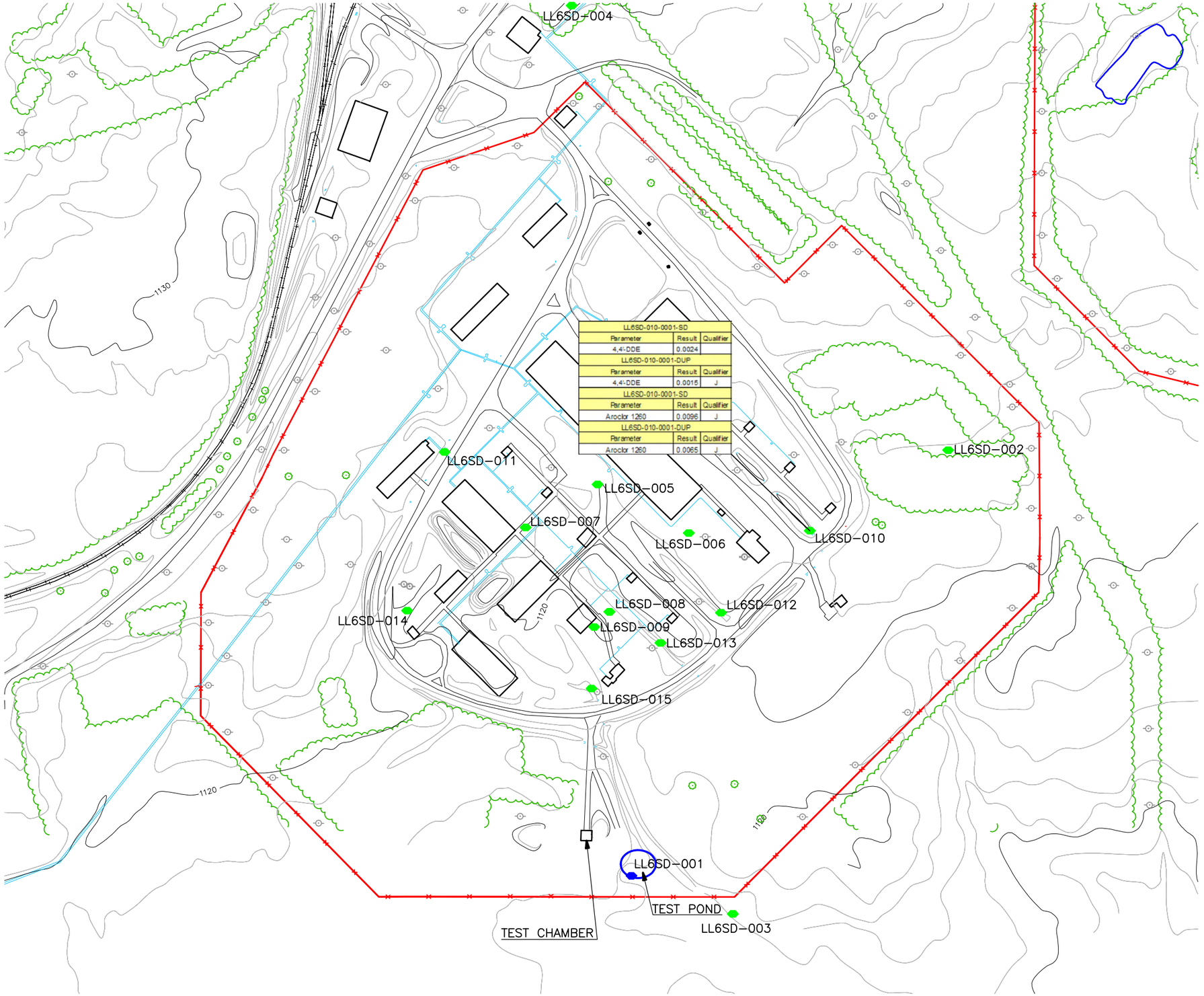
FIGURE 4-27

SEDIMENT EXCEEDANCES
TAL METALS AND CYANIDE

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2

DRAWN BY	R. BOWMAN	APPR. BY	SL



LL6SD-010-0001-SD		
Parameter	Result	Qualifier
4,4'-DDE	0.0024	
LL6SD-010-0001-DUP		
Parameter	Result	Qualifier
4,4'-DDE	0.0015	J
LL6SD-010-0001-SD		
Parameter	Result	Qualifier
Aroclor 1260	0.0096	J
LL6SD-010-0001-DUP		
Parameter	Result	Qualifier
Aroclor 1260	0.0065	J

LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SEDIMENT SAMPLING LOCATION
- SEDIMENT SAMPLING LOCATION TAKED DURING AZIDE SCREENING
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN mg/kg
IF RESULT ≥ BACKGROUND, THEN THE VALUE IS SHADED
IF RESULT ≥ THE PRG THEN THE VALUE IS LISTED IN BOLD TEXT
IF RESULT ≥ BACKGROUND AND THE PRG THE VALUE IS BOLD + SHADED
IF RESULT < BACKGROUND AND PRG THEN THE VALUE IS LISTED IN NORMAL TEXT

ORGANIC QUALIFIERS
J – RESULT IS AN ESTIMATED VALUE BELOW THE RL

ORGANIC FLAGS
B – METHOD BLANK: BATCH QC IS GREATER THAN RL

N

0' 100' 200' 300'
1" = 200'

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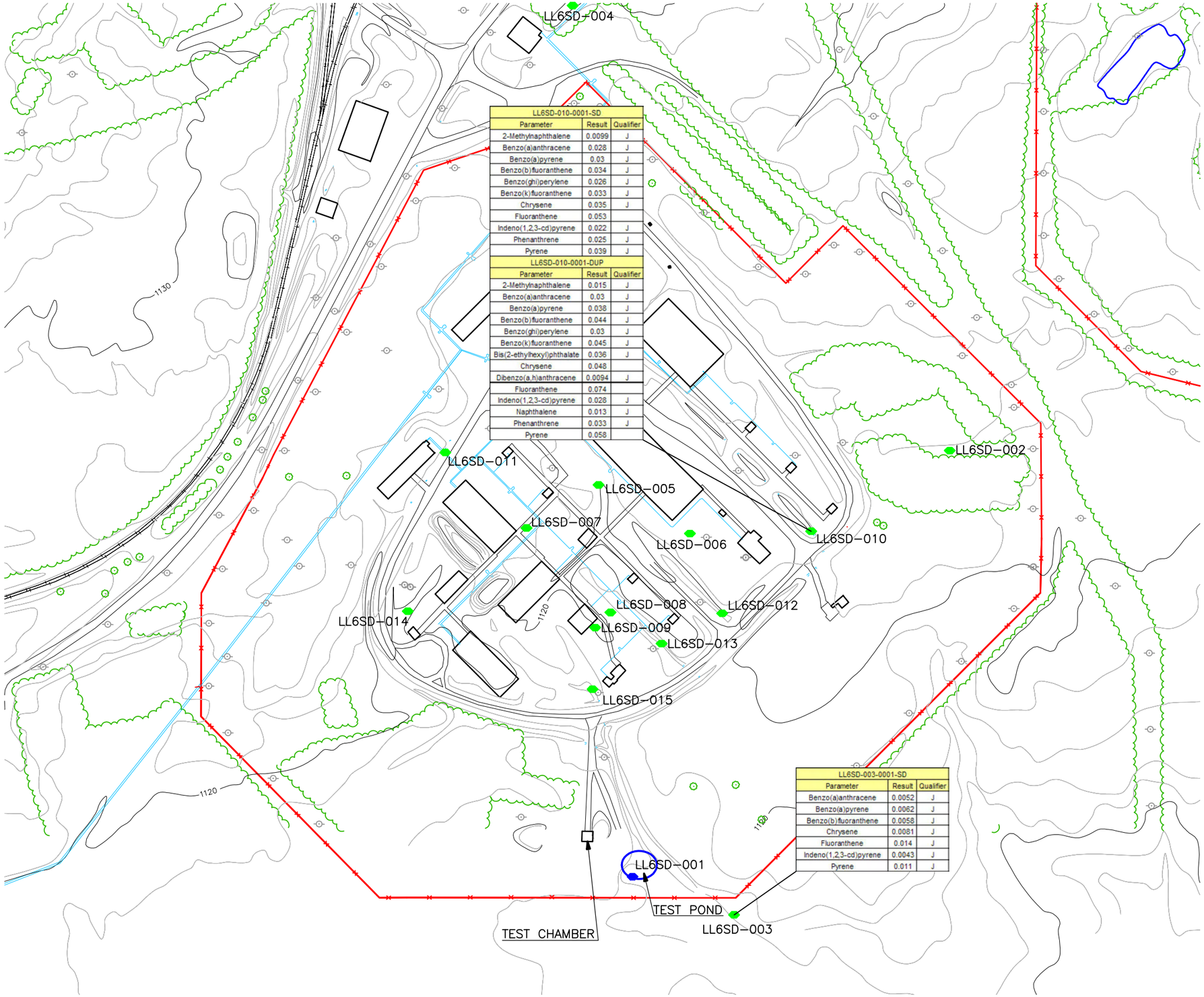
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RAVENNA, OHIO

FIGURE 4-28

SEDIMENT EXCEEDANCES
PESTICIDES/PCBs

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2
DRAWN BY	R. BOWMAN	APPR. BY	SL



LL6SD-010-0001-SD		
Parameter	Result	Qualifier
2-Methylnaphthalene	0.0099	J
Benzo(a)anthracene	0.028	J
Benzo(a)pyrene	0.03	J
Benzo(b)fluoranthene	0.034	J
Benzo(ghi)perylene	0.026	J
Benzo(k)fluoranthene	0.033	J
Chrysene	0.035	J
Fluoranthene	0.053	
Indeno(1,2,3-cd)pyrene	0.022	J
Phenanthrene	0.025	J
Pyrene	0.039	J

LL6SD-010-0001-DUP		
Parameter	Result	Qualifier
2-Methylnaphthalene	0.015	J
Benzo(a)anthracene	0.03	J
Benzo(a)pyrene	0.038	J
Benzo(b)fluoranthene	0.044	J
Benzo(ghi)perylene	0.03	J
Benzo(k)fluoranthene	0.045	J
Bis(2-ethylhexyl)phthalate	0.036	J
Chrysene	0.048	
Dibenzo(a,h)anthracene	0.0094	J
Fluoranthene	0.074	
Indeno(1,2,3-cd)pyrene	0.028	J
Naphthalene	0.013	J
Phenanthrene	0.033	J
Pyrene	0.058	

LL6SD-003-0001-SD		
Parameter	Result	Qualifier
Benzo(a)anthracene	0.0052	J
Benzo(a)pyrene	0.0062	J
Benzo(b)fluoranthene	0.0058	J
Chrysene	0.0081	J
Fluoranthene	0.014	J
Indeno(1,2,3-cd)pyrene	0.0043	J
Pyrene	0.011	J

LEGEND:

- VEGETATION
- INTERMITTENT STREAM
- STREAM
- PIPING
- ROAD
- 10 ft INTERVAL
- 2 ft INTERVAL
- STEAM LINE POST
- SEDIMENT SAMPLING LOCATION
- SEDIMENT SAMPLING LOCATION TAKED DURING AZIDE SCREENING
- BUILDING
- FENCE

NOTES:

RESULTS SHOWN IN mg/kg
IF RESULT ≥ BACKGROUND, THEN THE VALUE IS SHADED
IF RESULT ≥ THE PRG THEN THE VALUE IS LISTED IN BOLD TEXT
IF RESULT ≥ BACKGROUND AND THE PRG THE VALUE IS BOLD + SHADED
IF RESULT < BACKGROUND AND PRG THEN THE VALUE IS LISTED IN NORMAL TEXT

ORGANIC QUALIFIERS
J – RESULT IS AN ESTIMATED VALUE BELOW THE RL

ORGANIC FLAGS
B – METHOD BLANK: BATCH QC IS GREATER THAN RL

N

0' 100' 200' 300'
1" = 200'

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FIGURE 4-29
SEDIMENT EXCEEDANCES VOCs/SVOCs

LL 6 REMEDIAL INVESTIGATION

SIZE	PROJECT NO.	DATE:	REV
B	02-02-0085	MAY 2007	2
DRAWN BY	R. BOWMAN	APPR. BY	SL

4.4.1.1 Explosives and Propellants

Explosives concentrations were not detected above the laboratory detection limit in the sediment samples collected during the azide screen and RI. Nitrocellulose was detected in two sediment samples and one duplicate sample at concentrations above the method detection limit but below the reporting limit. However, the nitrocellulose results were qualified as estimated (J) and (B) the concentration of nitrocellulose in the method blank was detected above the reporting limit. Figure 4–26 shows sediment exceedances for propellants at LL–6.

4.4.1.2 TAL Metals and Cyanide

When the RVAAP installation background criteria for sediment were established, no background criteria were established for antimony or cadmium; therefore, the background value assigned to these metals, for the purpose of this RI, was zero. Figure 4–27 shows sediment exceedances for TAL metals at LL–6. The following metals were detected above comparable RVAAP installation background criteria (WBG Phase II RI, 2001), Region 9 residential soil PRGs, or both:

- Aluminum was detected above Region 9 residential soil PRG (7,614 mg/kg) in 9 samples, 2 of which were duplicates. Aluminum was also detected above the RVAAP installation background criterion (13,900 mg/kg) and Region 9 residential soil PRG in 1 sample with a concentration of 16,200 mg/kg detected in sample LL6SD–001–0001–SD.
- Antimony was detected above the RVAAP installation background criterion (0.0 mg/kg) in 1 sample with a concentration of 0.6 mg/kg detected in sample LL6SD–001–0001–SD.
- Arsenic was detected above Region 9 residential soil PRG (0.39 mg/kg) in 12 samples, 2 of which were duplicates. Arsenic was also detected above the RVAAP installation background criterion (19.5 mg/kg) and Region 9 residential soil PRG in 1 sample with a concentration of 37 mg/kg detected in sample LL6SD–004–0001–SD.
- Beryllium was detected above the RVAAP installation background criterion (0.38 mg/kg) in 13 samples with a maximum concentration of 0.82 mg/kg detected in sample LL6SD–014–0001–SD.
- Cadmium was detected above the RVAAP installation background criterion (0.0 mg/kg) in 7 samples, 2 of which were duplicates, with a maximum concentration of 1.1 mg/kg detected in sample LL6SD–004–0001–SD.

- Calcium was detected above the RVAAP installation background criterion (5,510 mg/kg) in 3 samples, 1 of which was a duplicate, with a maximum concentration of 22,000 mg/kg detected in sample LL6SD–010–0001–DUP.
- Chromium was detected above the RVAAP installation background criterion (18.1 mg/kg) in 2 samples with a maximum concentration of 23.2 mg/kg detected in sample LL6SD–001–0001–SD.
- Cobalt was detected above the RVAAP installation background criterion (9.1 mg/kg) in 8 samples, 2 of which were duplicates, with a maximum concentration of 15 mg/kg detected in sample LL6SD–003–0001–SD.
- Copper was detected above the RVAAP installation background criterion (27.6 mg/kg) in 4 samples, 1 of which was a duplicate, with a maximum concentration of 97 mg/kg detected in sample LL6SD–014–0001–SD.
- Iron was detected above Region 9 residential soil PRG (2,346 mg/kg) in 13 samples, 2 of which were duplicates, with a maximum concentration of 27,500 mg/kg (H) detected in sample LL6SD–001–0001–SD. However, the maximum result was qualified (H) because the batch QC was greater than the reporting limit or a negative instrument reading lower than the absolute value of the reporting limit was recorded.
- Lead was detected above the RVAAP installation background criterion (27.4 mg/kg) in 9 samples, 2 of which were duplicates, with a maximum concentration of 156 mg/kg detected in sample LL6SD–001–0001–SD.
- Magnesium was detected above the RVAAP installation background criterion (2,760 mg/kg) in 7 samples, 2 of which were duplicates, with a maximum concentration of 4,300 mg/kg detected in sample LL6SD–011–0001–SD.
- Manganese was detected above Region 9 residential soil PRG (176 mg/kg) in 13 samples, 2 of which were duplicates, with a maximum concentration of 770 mg/kg detected in sample LL6SD–003–0001–SD.
- Mercury was detected above the RVAAP installation background criterion (0.06 mg/kg) in 4 samples, 1 of which was a duplicate, with a maximum concentration of 0.25 mg/kg detected in sample LL6SD–015–0001–SD.
- Nickel was detected above the RVAAP installation background criterion (17.7 mg/kg) in 8 samples, 2 of which were duplicates, with a maximum concentration of 31 mg/kg detected in samples LL6SD–010–0001–SD and LL6SD–010–0001–DUP.
- Sodium was detected above the RVAAP installation background criterion (112 mg/kg) in 1 sample with a concentration of 243 mg/kg detected in sample LL6SD–001–0001–SD.
- Vanadium was detected above Region 9 residential soil PRG (7.8 mg/kg) in 12 samples, 2 of which were duplicates. Vanadiium was also detected above the RVAAP installation

background criterion (26.1 mg/kg) and Region 9 residential soil PRG in 1 sample with a maximum concentration of 27.2 mg/kg detected in sample LL6SD–001–0001–SD.

4.4.1.3 Pesticides and PCBs

Aroclor 1260 was detected above the laboratory detection limit but below Region 9 residential soil PRG (0.22 mg/kg) in 2 samples, 1 of which was a duplicate. Aroclor 1260 was detected in sample LL6SD–010–0001–SD with an estimated concentration of 0.0096 mg/kg (J) and detected in sample LL6SD–010–0001–DUP with an estimated concentration of 0.0065 mg/kg (J). However, the maximum result was qualified as estimated (J) because the concentration was detected below the reporting limit. 4,4–DDE was detected above the laboratory detection limit but below Region 9 residential soil PRG (1.7 mg/kg) in 2 samples, 1 of which was a duplicate. 4,4–DDE was detected in sample LL6SD–010–0001–SD with an estimated concentration of 0.0024 mg/kg (J) and in sample LL6SD–010–0001–DUP with an estimated concentration of 0.0015 mg/kg (J). However, the maximum result was qualified as estimated (J) because the concentration was detected below the reporting limit. Figure 4–28 shows sediment detections for pesticides/PCBs at LL–6.

4.4.1.4 Volatiles and Semi–volatiles

Although SVOCs (2-methylnaphthalene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[ghi]perylene, bis[2-ethylhexyl]phthalate, chrysene, dibenzo[a,h]anthracene, fluoranthene, indeno[1,2,3-cd]pyrene, naphthalene, phenanthrene, and pyrene) were detected at concentrations greater than the installation background criteria, the detected concentrations were less than laboratory reporting limits and Region 9 residential soil PRGs. Figure 4–29 shows the sediment SVOC detections at LL–6. No VOCs were detected.

4.4.2 Geotechnical Samples

Three geotechnical samples were obtained from the borings that were advanced to install monitoring wells MW–001 (sample LL6SB–031–0001–SO), MW–003 sample (LL6SB–033–0001–SO, and MW–006 sample LL6SB–036–0001–SO). Results obtained included grain–size analysis and hydraulic conductivity (from the boring samples). Geotechnical sampling results are included in Appendix R.

Grain-size analysis from the Shelby tube samples at LL–6 indicated a grain–size range of 8.4% to 26% sand, 35.7% to 53.3% silt, and 17.8% to 51.6% clay. Average hydraulic conductivities ranged from 7.1E-07 in sample LL6SB–031–0001–SO to 1.4E-08 in sample LL6SB–033–0001–SO. The conductivity and grain–size results for these samples match the anticipated values based upon a visual description of the soils during the advancement of the borings. Because these samples represent the range of visually described cohesive soil samples at the AOC, the hydraulic conductivity results can be used as a reference for similarly described soils.

Table 4−1
Summary of Surface Soil Results (0−1 ft)

							LL6SS-004-0001-SO	LL6SS-005-0001-SO	LL6SS-006-0001-SO	LL6SS-007-0001-SO	LL6SS-008-0001-SO	LL6SS-009-0001-SO	LL6SS-010-0001-SO	LL6SS-011-0001-SO	LL6SS-012-0001-SO	LL6SS-013-0001-SO	LL6SS-014-0001-SO	LL6SS-015-0001-SO	LL6SS-016-0001-SO	LL6SS-017-0001-SO
						Sample Date	11/25/03	11/19/03	11/21/03	11/14/03	11/14/03	11/20/03	12/02/03	12/03/03	11/25/03	11/21/03	11/25/03	11/25/03	11/21/03	11/19/03
						Sample Depth	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SS PRG Basis	RVAAP Surface Soil Background Criteria	Units														
Cyanide 9012A	9014/9010B	Cyanide, Total	122	nc	0.00	mg/kg							0.16 U							
Explosives 8330	8330	1,3,5-Trinitrobenzene	183	nc	0.00	mg/kg							0.017 U							
		1,3-Dinitrobenzene	0.61	nc	0.00	mg/kg							0.018 U							
		2,4,6-TNT	16	ca	0.00	mg/kg							0.033 U							
		2,4-Dinitrotoluene	12	nc	0.00	mg/kg							0.035 U							
		2,6-Dinitrotoluene	6.1	nc	0.00	mg/kg							0.047 U							
		2-Nitrotoluene	0.88	ca	0.00	mg/kg							0.033 U							
		3-Nitrotoluene	73	nc	0.00	mg/kg							0.05 U							
		4-Nitrotoluene	12	ca	0.00	mg/kg							0.046 U							
		HMX	306	nc	0.00	mg/kg							0.11 U							
		Nitrobenzene	2	nc	0.00	mg/kg							0.022 U							
		RDX	4.4	ca	0.00	mg/kg							0.058 U							
		Tetryl	61	nc	0.00	mg/kg							0.043 U							
PCB TCL 8082	8082	Aroclor 1016	0.39	nc	--	mg/kg							0.0022 U							
		Aroclor 1221	0.22	ca	--	mg/kg							0.0023 U							
		Aroclor 1232	0.22	ca	--	mg/kg							0.0023 U							
		Aroclor 1242	0.22	ca	--	mg/kg							0.0023 U							
		Aroclor 1248	0.22	ca	--	mg/kg							0.0023 U							
		Aroclor 1254	0.22	ca	--	mg/kg							0.033							
		Aroclor 1260	0.22	ca	--	mg/kg							0.0016 U							
Pesticides 8081A	8081A	4,4'-DDD	2.4	ca	--	mg/kg							0.00042 U							
		4,4'-DDE	1.7	ca	--	mg/kg							0.00076 U							
		4,4'-DDT	1.7	ca	--	mg/kg							0.00043 U							
		Aldrin	0.029	ca	--	mg/kg							0.00015 U							
		alpha-BHC	0.09	sat	--	mg/kg							0.00019 U							
		alpha-Chlordane	1.6	ca	--	mg/kg							0.00014 U							
		beta-BHC	0.32	ca	--	mg/kg							0.00018 U							
		delta-BHC	--	--	--	mg/kg							0.00013 U							
		Dieldrin	0.030	ca	--	mg/kg							0.0004 U							
		Endosulfan I	37	nc	--	mg/kg							0.00032 U							
		Endosulfan II	37	nc	--	mg/kg							0.00033 U							
		Endosulfan sulfate	37	nc	--	mg/kg							0.00034 U							
		Endrin	1.8	nc	--	mg/kg							0.0005 U							
		Endrin aldehyde	--	--	--	mg/kg							0.00039 U							
		Endrin ketone	--	--	--	mg/kg							0.00034 U							
		gamma-BHC (Lindane)	0.44	ca	--	mg/kg							0.00027 U							
		gamma-Chlordane	1.6	ca	--	mg/kg							0.00018 U							
		Heptachlor	0.11	ca	--	mg/kg							0.00021 U							
		Heptachlor epoxide	0.053	ca	--	mg/kg							0.00016 U							
		Methoxychlor	31	nc	--	mg/kg							0.0027 U							
		Toxaphene	0.44	ca	--	mg/kg							0.0054 U							

Table 4−1
Summary of Surface Soil Results (0−1 ft)

							LL6SS-004-0001-SO	LL6SS-005-0001-SO	LL6SS-006-0001-SO	LL6SS-007-0001-SO	LL6SS-008-0001-SO	LL6SS-009-0001-SO	LL6SS-010-0001-SO	LL6SS-011-0001-SO	LL6SS-012-0001-SO	LL6SS-013-0001-SO	LL6SS-014-0001-SO	LL6SS-015-0001-SO	LL6SS-016-0001-SO	LL6SS-017-0001-SO
						Sample Date	11/25/03	11/19/03	11/21/03	11/14/03	11/14/03	11/20/03	12/02/03	12/03/03	11/25/03	11/21/03	11/25/03	11/25/03	11/21/03	11/19/03
						Sample Depth	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SS PRG Basis	RVAAP Surface Soil Background Criteria	Units														
Propellants 8330	353.2	Nitrocellulose	--	--	0.00	mg/kg							10.1							
	8330	Nitroglycerin	35	ca	0.00	mg/kg							0.5 U							
	UV/HPLC per SOP	Nitroguanidine	611	nc	0.00	mg/kg							0.25 U							
SVOCs TCL 8270 C	8270C	1,2,4-Trichlorobenzene	6.2	nc	--	mg/kg							0.07 U							
		1,2-Dichlorobenzene	600	sat	--	mg/kg							0.093 U							
		1,3-Dichlorobenzene	53	nc	--	mg/kg							0.093 U							
		1,4-Dichlorobenzene	3.4	ca	--	mg/kg							0.084 U							
		2,2-oxybis (1-chloropropane)	2.9	ca	--	mg/kg							0.088 U							
		2,4,5-Trichlorophenol	611	nc	--	mg/kg							0.045 U							
		2,4,6-Trichlorophenol	0.61	nc	--	mg/kg							0.055 U							
		2,4-Dichlorophenol	18	nc	--	mg/kg							0.057 U							
		2,4-Dimethylphenol	122	nc	--	mg/kg							0.071 U							
		2,4-Dinitrophenol	12	nc	--	mg/kg							0.13 U							
		2-Chloronaphthalene	494	nc	--	mg/kg							0.057 U							
		2-Chlorophenol	6.3	nc	--	mg/kg							0.07 U							
		2-Methylnaphthalene	--	--	--	mg/kg							0.0018 U							
		2-Methylphenol (o-cresol)	306	nc	--	mg/kg							0.0099 U							
		2-Nitroaniline	18.3	nc	--	mg/kg							0.04 U							
		2-Nitrophenol	--	--	--	mg/kg							0.074 U							
		3,3-Dichlorobenzidine	1.1	ca	--	mg/kg							0.021 U							
		3-Nitroaniline	1.8	nc	--	mg/kg							0.13 U*							
		4,6-Dinitro-2-methylphenol	0.61	nc	--	mg/kg							0.11 U*							
		4-Bromophenyl phenyl ether	--	--	--	mg/kg							0.0037 U							
		4-Chloro-3-methylphenol	--	--	--	mg/kg							0.045 U							
		4-Chloroaniline	24	nc	--	mg/kg							0.12 U							
		4-Chlorophenyl phenyl ether	--	--	--	mg/kg							0.0042 U							
		4-Methylphenol (m/p-cresol)	31	nc	--	mg/kg							0.0068 U							
		4-Nitroaniline	23	ca	--	mg/kg							0.046 U							
		4-Nitrophenol	--	--	--	mg/kg							0.097 U							
		Acenaphthene	368	nc	--	mg/kg							0.0017 U							
		Acenaphthylene	--	--	--	mg/kg							0.0011 U							
		Anthracene	2189	nc	--	mg/kg							0.001 U							
		Benzo(a)anthracene	0.62	ca	--	mg/kg							0.0013 U							
		Benzo(a)pyrene	0.062	ca	--	mg/kg							0.0026 U							
		Benzo(b)fluoranthene	0.62	ca	--	mg/kg							0.0025 U							
		Benzo(ghi)perylene	--	--	--	mg/kg							0.0022 U							
		Benzo(k)fluoranthene	6.2	ca	--	mg/kg							0.0033 U							
		Bis(2-chloroethoxy)methane	--	--	--	mg/kg							0.0034 U							
		Bis(2-chloroethyl)ether	0.22	ca	--	mg/kg							0.0024 U							
		Bis(2-ethylhexyl)phthalate	35	ca	--	mg/kg							0.027 Ja							
		Butyl benzyl phthalate	1222	nc	--	mg/kg							0.0048 U							
		Carbazole	24	ca	--	mg/kg							0.041 U							
		Chrysene	62	ca	--	mg/kg							0.0021 U							
		Dibenzo(a,h)anthracene	0.062	ca	--	mg/kg							0.0026 U							
		Dibenzofuran	15	nc	--	mg/kg							0.0032 U							

Table 4−1
Summary of Surface Soil Results (0−1 ft)

							LL6SS-004-0001-SO	LL6SS-005-0001-SO	LL6SS-006-0001-SO	LL6SS-007-0001-SO	LL6SS-008-0001-SO	LL6SS-009-0001-SO	LL6SS-010-0001-SO	LL6SS-011-0001-SO	LL6SS-012-0001-SO	LL6SS-013-0001-SO	LL6SS-014-0001-SO	LL6SS-015-0001-SO	LL6SS-016-0001-SO	LL6SS-017-0001-SO
						Sample Date	11/25/03	11/19/03	11/21/03	11/14/03	11/14/03	11/20/03	12/02/03	12/03/03	11/25/03	11/21/03	11/25/03	11/25/03	11/21/03	11/19/03
						Sample Depth	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SS PRG Basis	RVAAP Surface Soil Background Criteria	Units														
		Diethyl phthalate	4888	nc	--	mg/kg							0.0044 U							
		Dimethyl phthalate	100000	max	--	mg/kg							0.0042 U							
		Di-n-butyl phthalate	611	nc	--	mg/kg							0.024 U							
		Di-n-octyl phthalate	244	nc	--	mg/kg							0.01 U							
		Fluoranthene	229	nc	--	mg/kg							0.0013 U							
		Fluorene	275	nc	--	mg/kg							0.0019 U							
		Hexachlorobenzene	0.30	ca	--	mg/kg							0.0021 U							
		Hexachlorobutadiene	6.2	ca	--	mg/kg							0.0039 U							
		Hexachlorocyclopentadiene	37	nc	--	mg/kg							0.064 U							
		Hexachloroethane	35	ca	--	mg/kg							0.0039 U							
		Indeno(1,2,3-cd)pyrene	0.62	ca	--	mg/kg							0.0025 U							
		Isophorone	512	ca	--	mg/kg							0.0028 U							
		Naphthalene	5.6	nc	--	mg/kg							0.002 U							
		n-Nitroso-di-n-propylamine	0.069	ca	--	mg/kg							0.0027 U							
		n-Nitrosodiphenylamine	99	ca	--	mg/kg							0.0034 U							
		Pentachlorophenol	3.0	ca	--	mg/kg							0.12 U							
		Phenanthrene	--	--	--	mg/kg							0.0012 U							
		Phenol	1833	nc	--	mg/kg							0.0019 U							
		Pyrene	232	nc	--	mg/kg							0.0024 U							
TAL Metals 6010B	6010B	Aluminum	7614	nc	17700	mg/kg	**17000**	**13000**	**11000**	7400	**12000**	**12000**	**12000**	**11000**	**14000**	**13000**	7300	**10000**	**14000**	**12000**
		Barium	538	nc	88.4	mg/kg	64	64	64	47	67	58	100	66	68	53	34	57	71	84
		Beryllium	15	nc	0.88	mg/kg	0.51	0.71	0.5	0.25 B	0.47	0.6	0.95	0.41 B	0.44 B	0.32 B	0.25 B	0.43 B	0.54	1.2
		Cadmium	3.7	nc	0.00	mg/kg	0.092 U	0.09 U	0.089 U	0.13 B	0.092 U	0.091 U	0.088 U	0.089 U	0.094 U	0.11 B	0.085 U	0.092 U	0.25	0.92
		Calcium	--	[n]	15800	mg/kg	2100	1900	3300	4900	2400	890	3200	2600	2300	1700	1600	8900	5900	20000
		Chromium	30	ca	17.4	mg/kg	21	17	14	11	15	15	16	16	18	16	10	20	19	11
		Cobalt	902	ca	10.4	mg/kg	8.8	8.9	9.6	8.7	9.3	9.9	12	9	9.5	6.2	6.4	9.6	11	6.2
		Copper	313	nc	17.7	mg/kg	21	21	21	20	17	16	20	19	14	12	24	35	21	26
		Iron	2346	nc	23100	mg/kg	**28000**	**25000**	**27000**	**19000** H	**21000** H	**22000**	**23000**	**21000**	**24000**	**22000**	**18000**	**24000**	**26000**	**19000**
		Magnesium	--	[n]	3030	mg/kg	3500	2800	2600	2400	2800	2500	3400	2800	3100	2300	1900	4100	3900	3600
		Manganese	176	nc	1450	mg/kg	**300**	**350**	**700**	**430**	**350**	**480**	**200**	**400**	**520**	**280**	**370**	**390**	**330**	**980**
		Nickel	156	nc	21.1	mg/kg	22	19	16	16	20	17	23	18	18	13	15	24	23	15
		Potassium	--	[n]	927	mg/kg	1700	1100	870	930	1300	980	1100	990	1400	940	760	1500	1400	1300
		Selenium	39	nc	1.4	mg/kg	0.46 U	0.45 U	0.52 B	0.41 U	0.46 U	0.46 U	0.44 U	0.45 B	0.57 B	0.45 U	0.42 U	0.46 U	0.56 B	0.46 U
		Silver	39	nc	0.00	mg/kg	0.36 U	0.35 U	0.34 U	0.32 U	0.36 U	0.35 U	0.34 U	0.35 U	0.36 U	0.35 U	0.33 U	0.36 U	0.36 U	0.35 U
		Sodium	--	[n]	123	mg/kg	1300	98 U	96 U	960	1200	99 U	96 U	97 U	1400	98 U	960	1400	100 U	160
		Vanadium	7.8	nc	31.1	mg/kg	**27**	**25** H	**21**	**14**	**19**	**21** H	**19**	**20**	**24**	**23**	**12**	**17**	**23**	**16** H
		Zinc	2346	nc	61.8	mg/kg	77	55	71	82	65	68	62	60	58	63	81	93	78	88
	7041	Antimony	3.1	nc	0.96	mg/kg	0.53 U	0.46 U	0.45 U	0.3 B	0.32 B	0.53 U	0.49 U	0.49 U	0.51 U	0.52 U	0.48 U	0.5 U	0.46 U	0.44 U
	7060A	Arsenic	0.39	ca	15.4	mg/kg	**12**	**12**	**12**	**41**	**11**	**10**	**16**	**13**	**11**	**12**	**12**	**14**	**12**	**11**
	7421	Lead	400	pbk	26.1	mg/kg	78	14	30	53	32	19	17	29	26	40	26	44	48	61
	7471A	Mercury	2.3	nc	0.04	mg/kg	0.031	0.024	0.038	0.018	0.032	0.026	0.02	0.082	0.041	0.043	0.032	0.026	0.1	0.6
	7841	Thallium	0.52	nc	0.00	mg/kg	1.2 U	0.2 U	0.19 U	0.2 U	0.22 U	1.1 U	0.21 U	0.21 U	0.22 U	0.22 U	1 U	1.1 U	0.2 U	0.19 U

Table 4−1
Summary of Surface Soil Results (0−1 ft)

							LL6SS-004-0001-SO	LL6SS-005-0001-SO	LL6SS-006-0001-SO	LL6SS-007-0001-SO	LL6SS-008-0001-SO	LL6SS-009-0001-SO	LL6SS-010-0001-SO	LL6SS-011-0001-SO	LL6SS-012-0001-SO	LL6SS-013-0001-SO	LL6SS-014-0001-SO	LL6SS-015-0001-SO	LL6SS-016-0001-SO	LL6SS-017-0001-SO
						Sample Date	11/25/03	11/19/03	11/21/03	11/14/03	11/14/03	11/20/03	12/02/03	12/03/03	11/25/03	11/21/03	11/25/03	11/25/03	11/21/03	11/19/03
						Sample Depth	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SS PRG Basis	RVAAP Surface Soil Background Criteria	Units														
VOCs TCL 8260B	8260B	1,1,1-Trichloroethane	1200	sat	--	mg/kg							0.0013 U							
		1,1,2,2-Tetrachloroethane	0.41	ca	--	mg/kg							0.0011 U							
		1,1,2-Trichloroethane	0.73	ca	--	mg/kg							0.0013 U							
		1,1-Dichloroethane	51	nc	--	mg/kg							0.0012 U							
		1,1-Dichloroethene	12	nc	--	mg/kg							0.0016 U							
		1,2-Dichloroethane	0.28	ca	--	mg/kg							0.0011 U							
		1,2-Dichloroethene (total)	6.9	nc	--	mg/kg							0.0025 U							
		1,2-Dichloropropane	0.34	ca	--	mg/kg							0.0012 U							
		2-Butanone (MEK)	2231	nc	--	mg/kg							0.0047 U							
		2-Hexanone	530	nc	--	mg/kg							0.0013 U							
		4-Methyl-2-pentanone (MIBK)	528	nc	--	mg/kg							0.0012 U							
		Acetone	1412	nc	--	mg/kg							0.0055 U							
		Benzene	0.64	ca	--	mg/kg							0.0013 U							
		Bromodichloromethane	0.82	ca	--	mg/kg							0.0011 U							
		Bromoform	62	ca	--	mg/kg							0.00089 U							
		Bromomethane	0.39	nc	--	mg/kg							0.0016 U							
		Carbon disulfide	36	nc	--	mg/kg							0.0014 U							
		Carbon tetrachloride	0.25	ca	--	mg/kg							0.0013 U							
		Chlorobenzene	15	nc	--	mg/kg							0.0013 U							
		Chloroethane	3.0	ca	--	mg/kg							0.0012 U							
		Chloroform	0.22	ca	--	mg/kg							0.0013 U							
		Chloromethane	4.7	nc	--	mg/kg							0.0013 U							
		cis-1,3-Dichloropropene	0.78	ca	--	mg/kg							0.0011 U							
		Dibromochloromethane	1.1	ca	--	mg/kg							0.00094 U							
		Ethylbenzene	395	sat	--	mg/kg							0.0013 U							
		Methylene chloride	9.1	ca	--	mg/kg							0.0035 U							
		Styrene	1700	sat	--	mg/kg							0.0013 U							
		Tetrachloroethene	0.48	ca	--	mg/kg							0.0014 U							
		Toluene	520	sat	--	mg/kg							0.0013 U							
		trans-1,3-Dichloropropene	0.78	ca	--	mg/kg							0.00094 U							
		Trichloroethene	0.053	ca	--	mg/kg							0.0013 U							
		Vinyl chloride	0.079	ca	--	mg/kg							0.0013 U							
		Xylenes (total)	27	nc	--	mg/kg							0.0041 U							

Table 4−1
Summary of Surface Soil Results (0−1 ft)

Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SS PRG Basis	RVAAP Surface Soil Background Criteria	Units	LL6SS-018-0001-SO	LL6SS-019-0001-SO	LL6SS-020-0001-DUP	LL6SS-020-0001-SO	LL6SS-021-0001-SO	LL6SS-022-0001-SO	LL6SS-023-0001-SO	LL6SS-024-0001-SO	LL6SS-025-0001-SO	LL6SS-026-0001-SO	LL6SS-027-0001-SO	LL6SS-028-0001-SO	LL6SS-029-0001-DUP	LL6SS-029-0001-SO
Sample Date							12/02/03	11/19/03	12/02/03	12/02/03	11/19/03	11/14/03	11/19/03	11/25/03	11/14/03	11/20/03	11/20/03	11/18/03	11/25/03	11/25/03
Sample Depth							0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.
Cyanide 9012A	9014/9010B	Cyanide, Total	122	nc	0.00	mg/kg			0.22 U	0.22 U			0.27 U							
Explosives 8330	8330	1,3,5-Trinitrobenzene	183	nc	0.00	mg/kg			0.018 U	0.018 U			0.017 U							
		1,3-Dinitrobenzene	0.61	nc	0.00	mg/kg			0.018 U	0.018 U			0.018 U							
		2,4,6-TNT	16	ca	0.00	mg/kg			0.034 U	0.034 U			0.033 U							
		2,4-Dinitrotoluene	12	nc	0.00	mg/kg			0.036 U	0.036 U			0.035 U							
		2,6-Dinitrotoluene	6.1	nc	0.00	mg/kg			0.048 U	0.048 U			0.047 U*							
		2-Nitrotoluene	0.88	ca	0.00	mg/kg			0.033 U	0.033 U			0.033 U							
		3-Nitrotoluene	73	nc	0.00	mg/kg			0.05 U	0.05 U			0.05 U							
		4-Nitrotoluene	12	ca	0.00	mg/kg			0.047 U	0.047 U			0.046 U							
		HMX	306	nc	0.00	mg/kg			0.11 U	0.11 U			0.11 U							
		Nitrobenzene	2	nc	0.00	mg/kg			0.022 U	0.022 U			0.022 U							
		RDX	4.4	ca	0.00	mg/kg			0.059 U	0.059 U			0.058 U							
		Tetryl	61	nc	0.00	mg/kg			0.043 U	0.043 U			0.043 U							
PCB TCL 8082	8082	Aroclor 1016	0.39	nc	--	mg/kg			0.0022 U	0.0022 U			0.0023 U							
		Aroclor 1221	0.22	ca	--	mg/kg			0.0024 U	0.0023 U			0.0024 U							
		Aroclor 1232	0.22	ca	--	mg/kg			0.0024 U	0.0023 U			0.0024 U							
		Aroclor 1242	0.22	ca	--	mg/kg			0.0024 U	0.0023 U			0.0024 U							
		Aroclor 1248	0.22	ca	--	mg/kg			0.0024 U	0.0023 U			0.0024 U							
		Aroclor 1254	0.22	ca	--	mg/kg			0.0024 U	0.0023 U			0.0024 U							
		Aroclor 1260	0.22	ca	--	mg/kg			0.0017 U	0.0016 U			0.0017 U							
Pesticides 8081A	8081A	4,4'-DDD	2.4	ca	--	mg/kg			0.00043 U	0.00041 U			0.00043 U							
		4,4'-DDE	1.7	ca	--	mg/kg			0.00077 U	0.00074 U			0.00078 U							
		4,4'-DDT	1.7	ca	--	mg/kg			0.00044 U	0.00042 U			0.00044 U							
		Aldrin	0.029	ca	--	mg/kg			0.00015 U	0.00015 U			0.00016 U							
		alpha-BHC	0.09	sat	--	mg/kg			0.00019 U	0.00018 U			0.00019 U							
		alpha-Chlordane	1.6	ca	--	mg/kg			0.00014 U	0.00014 U			0.00014 U							
		beta-BHC	0.32	ca	--	mg/kg			0.00018 U	0.00017 U			0.00018 U							
		delta-BHC	--	--	--	mg/kg			0.00013 U	0.00013 U			0.00013 U							
		Dieldrin	0.030	ca	--	mg/kg			0.0004 U	0.00039 U			0.00041 U							
		Endosulfan I	37	nc	--	mg/kg			0.00032 U	0.00031 U			0.00032 U							
		Endosulfan II	37	nc	--	mg/kg			0.00033 U	0.00032 U			0.00034 U							
		Endosulfan sulfate	37	nc	--	mg/kg			0.00034 U	0.00033 U			0.00035 U							
		Endrin	1.8	nc	--	mg/kg			0.00051 U	0.00049 U			0.00052 U							
		Endrin aldehyde	--	--	--	mg/kg			0.00039 U	0.00038 U			0.0004 U							
		Endrin ketone	--	--	--	mg/kg			0.00034 U	0.00033 U			0.00035 U							
		gamma-BHC (Lindane)	0.44	ca	--	mg/kg			0.00027 U	0.00026 U			0.00028 U							
		gamma-Chlordane	1.6	ca	--	mg/kg			0.00018 U	0.00017 U			0.00018 U							
		Heptachlor	0.11	ca	--	mg/kg			0.00021 U	0.00021 U			0.00022 U							
		Heptachlor epoxide	0.053	ca	--	mg/kg			0.00017 U	0.00016 U			0.00017 U							
		Methoxychlor	31	nc	--	mg/kg			0.0027 U	0.0026 U			0.0028 U							
		Toxaphene	0.44	ca	--	mg/kg			0.0054 U	0.0053 U			0.0055 U							

Table 4−1
Summary of Surface Soil Results (0−1 ft)

							LL6SS-018-0001-SO	LL6SS-019-0001-SO	LL6SS-020-0001-DUP	LL6SS-020-0001-SO	LL6SS-021-0001-SO	LL6SS-022-0001-SO	LL6SS-023-0001-SO	LL6SS-024-0001-SO	LL6SS-025-0001-SO	LL6SS-026-0001-SO	LL6SS-027-0001-SO	LL6SS-028-0001-SO	LL6SS-029-0001-DUP	LL6SS-029-0001-SO
						Sample Date	12/02/03	11/19/03	12/02/03	12/02/03	11/19/03	11/14/03	11/19/03	11/25/03	11/14/03	11/20/03	11/20/03	11/18/03	11/25/03	11/25/03
						Sample Depth	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SS PRG Basis	RVAAP Surface Soil Background Criteria	Units														
Propellants 8330	353.2	Nitrocellulose	--	--	0.00	mg/kg			1.8 B J	1.1 B J			2.4 B							
	8330	Nitroglycerin	35	ca	0.00	mg/kg			0.5 U	0.5 U			0.5 U							
	UV/HPLC per SOP	Nitroguanidine	611	nc	0.00	mg/kg			0.25 U	0.25 U			0.25 U							
SVOCs TCL 8270 C	8270C	1,2,4-Trichlorobenzene	6.2	nc	--	mg/kg			0.07 U	0.069 U			0.073 U							
		1,2-Dichlorobenzene	600	sat	--	mg/kg			0.093 U	0.093 U			0.097 U							
		1,3-Dichlorobenzene	53	nc	--	mg/kg			0.093 U	0.093 U			0.097 U							
		1,4-Dichlorobenzene	3.4	ca	--	mg/kg			0.084 U	0.083 U			0.087 U							
		2,2-oxybis (1-chloropropane)	2.9	ca	--	mg/kg			0.089 U	0.088 U			0.092 U							
		2,4,5-Trichlorophenol	611	nc	--	mg/kg			0.045 U	0.045 U			0.047 U							
		2,4,6-Trichlorophenol	0.61	nc	--	mg/kg			0.056 U	0.055 U			0.058 U							
		2,4-Dichlorophenol	18	nc	--	mg/kg			0.057 U	0.056 U			0.059 U							
		2,4-Dimethylphenol	122	nc	--	mg/kg			0.071 U	0.071 U			0.074 U							
		2,4-Dinitrophenol	12	nc	--	mg/kg			0.13 U	0.13 U			0.14 U							
		2-Chloronaphthalene	494	nc	--	mg/kg			0.057 U	0.056 U			0.059 U							
		2-Chlorophenol	6.3	nc	--	mg/kg			0.07 U	0.069 U			0.073 U							
		2-Methylnaphthalene	--	--	--	mg/kg			0.0018 U	0.0018 U			0.0018 U							
		2-Methylphenol (o-cresol)	306	nc	--	mg/kg			0.0099 U	0.0099 U			0.01 U							
		2-Nitroaniline	18.3	nc	--	mg/kg			0.04 U	0.04 U			0.042 U							
		2-Nitrophenol	--	--	--	mg/kg			0.075 U	0.074 U			0.078 U							
		3,3-Dichlorobenzidine	1.1	ca	--	mg/kg			0.021 U	0.021 U			0.022 U							
		3-Nitroaniline	1.8	nc	--	mg/kg			0.13 U*	0.13 U*			0.14 U							
		4,6-Dinitro-2-methylphenol	0.61	nc	--	mg/kg			0.11 U*	0.11 U*			0.12 U							
		4-Bromophenyl phenyl ether	--	--	--	mg/kg			0.0037 U	0.0036 U			0.0038 U							
		4-Chloro-3-methylphenol	--	--	--	mg/kg			0.045 U	0.045 U			0.047 U							
		4-Chloroaniline	24	nc	--	mg/kg			0.12 U	0.12 U			0.12 U							
		4-Chlorophenyl phenyl ether	--	--	--	mg/kg			0.0043 U	0.0042 U			0.0044 U							
		4-Methylphenol (m/p-cresol)	31	nc	--	mg/kg			0.0069 U	0.0068 U			0.0071 U							
		4-Nitroaniline	23	ca	--	mg/kg			0.046 U	0.046 U			0.048 U							
		4-Nitrophenol	--	--	--	mg/kg			0.097 U	0.096 U			0.1 U							
		Acenaphthene	368	nc	--	mg/kg			0.0017 U	0.0016 U			0.0046 Ja							
		Acenaphthylene	--	--	--	mg/kg			0.0011 U	0.0011 U			0.0011 U							
		Anthracene	2189	nc	--	mg/kg			0.0017 Ja	0.001 U			0.0092 Ja							
		Benzo(a)anthracene	0.62	ca	--	mg/kg			0.0072 Ja	0.0055 Ja			0.041							
		Benzo(a)pyrene	0.062	ca	--	mg/kg			0.0075 Ja	0.0026 U			0.04 Ja							
		Benzo(b)fluoranthene	0.62	ca	--	mg/kg			0.0073 Ja	0.0067 Ja			0.044							
		Benzo(ghi)perylene	--	--	--	mg/kg			0.0055 Ja	0.0065 Ja			0.024 Ja							
		Benzo(k)fluoranthene	6.2	ca	--	mg/kg			0.0079 Ja	0.0042 Ja			0.028 Ja							
		Bis(2-chloroethoxy)methane	--	--	--	mg/kg			0.0034 U	0.0034 U			0.0036 U							
		Bis(2-chloroethyl)ether	0.22	ca	--	mg/kg			0.0024 U	0.0024 U			0.0025 U							
		Bis(2-ethylhexyl)phthalate	35	ca	--	mg/kg			0.019 Ja	0.11 Ja			0.045 Ja							
		Butyl benzyl phthalate	1222	nc	--	mg/kg			0.0048 U	0.0048 U			0.005 U							
		Carbazole	24	ca	--	mg/kg			0.041 U	0.041 U			0.043 U							
		Chrysene	62	ca	--	mg/kg			0.0078 Ja	0.007 Ja			0.043							
		Dibenzo(a,h)anthracene	0.062	ca	--	mg/kg			0.028 Ja	0.028 Ja			0.013 Ja							
		Dibenzofuran	15	nc	--	mg/kg			0.0032 U	0.0032 U			0.0033 U							

Table 4−1
Summary of Surface Soil Results (0−1 ft)

							LL6SS-018-0001-SO	LL6SS-019-0001-SO	LL6SS-020-0001-DUP	LL6SS-020-0001-SO	LL6SS-021-0001-SO	LL6SS-022-0001-SO	LL6SS-023-0001-SO	LL6SS-024-0001-SO	LL6SS-025-0001-SO	LL6SS-026-0001-SO	LL6SS-027-0001-SO	LL6SS-028-0001-SO	LL6SS-029-0001-DUP	LL6SS-029-0001-SO
						Sample Date	12/02/03	11/19/03	12/02/03	12/02/03	11/19/03	11/14/03	11/19/03	11/25/03	11/14/03	11/20/03	11/20/03	11/18/03	11/25/03	11/25/03
						Sample Depth	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SS PRG Basis	RVAAP Surface Soil Background Criteria	Units														
		Diethyl phthalate	4888	nc	--	mg/kg			0.0044 U	0.0043 U			0.0046 U							
		Dimethyl phthalate	100000	max	--	mg/kg			0.0043 U	0.0042 U			0.0044 U							
		Di-n-butyl phthalate	611	nc	--	mg/kg			0.024 U	0.024 U			0.025 U							
		Di-n-octyl phthalate	244	nc	--	mg/kg			0.01 U	0.01 U			0.011 U							
		Fluoranthene	229	nc	--	mg/kg			0.016 Ja	0.012 Ja			0.1							
		Fluorene	275	nc	--	mg/kg			0.0019 U	0.0019 U			0.002 U							
		Hexachlorobenzene	0.30	ca	--	mg/kg			0.0021 U	0.0021 U			0.0022 U							
		Hexachlorobutadiene	6.2	ca	--	mg/kg			0.0039 U	0.0039 U			0.0041 U							
		Hexachlorocyclopentadiene	37	nc	--	mg/kg			0.064 U	0.063 U			0.066 U							
		Hexachloroethane	35	ca	--	mg/kg			0.0039 U	0.0039 U			0.0041 U							
		Indeno(1,2,3-cd)pyrene	0.62	ca	--	mg/kg			0.02 Ja	0.02 Ja			0.023 Ja							
		Isophorone	512	ca	--	mg/kg			0.0028 U	0.0028 U			0.003 U							
		Naphthalene	5.6	nc	--	mg/kg			0.002 U	0.002 U			0.0021 U							
		n-Nitroso-di-n-propylamine	0.069	ca	--	mg/kg			0.0027 U	0.0027 U			0.0028 U							
		n-Nitrosodiphenylamine	99	ca	--	mg/kg			0.0034 U	0.0034 U			0.0036 U							
		Pentachlorophenol	3.0	ca	--	mg/kg			0.12 U	0.12 U			0.12 U							
		Phenanthrene	--	--	--	mg/kg			0.0078 Ja	0.0077 Ja			0.04 Ja							
		Phenol	1833	nc	--	mg/kg			0.0019 U	0.0019 U			0.0002 U							
		Pyrene	232	nc	--	mg/kg			0.0096 Ja	0.0096 Ja			0.068							
TAL Metals 6010B	6010B	Aluminum	7614	nc	17700	mg/kg	**11000**	**15000**	**13000**	**15000**	**11000**	7100	**12000**	**12000**	**14000**	**10000**	**17000**	**11000**	**15000**	**18000**
		Barium	538	nc	88.4	mg/kg	64	80	69	68	63	73	76	52	60	46	95	60	59	65
		Beryllium	15	nc	0.88	mg/kg	0.64	0.83	0.69	0.56	0.59	0.33 B	0.76	0.3 B	0.44 B	0.53	0.96	0.58	0.25 B	0.45 B
		Cadmium	3.7	nc	0.00	mg/kg	0.095 U	0.092 U	0.09 U	0.079 U	0.093 U	1.5	0.094 U	0.085 U	0.093 U	0.091 U	0.091 U	0.1 U	0.098 U	0.095 U
		Calcium	--	[n]	15800	mg/kg	1300	4200	4000	2700	2300	80000	2200	3400	780	1200	2400	600	120	140
		Chromium	30	ca	17.4	mg/kg	15	19	17	17	14	15	16	15	15	13	23	14	21	25
		Cobalt	902	ca	10.4	mg/kg	9.2	11	8.4	5.5	7.4	6.5	10	6.5	9.1	5.5	12	7.7	6.3	8.5
		Copper	313	nc	17.7	mg/kg	14	18	18	17	14	30	19	21	9.1	6	22	8.5	18	23
		Iron	2346	nc	23100	mg/kg	**22000**	**26000**	**24000**	**22000**	**19000**	**19000** H	**24000**	**22000**	**20000** H	**23000**	**31000**	**21000** H	**27000**	**35000**
		Magnesium	--	[n]	3030	mg/kg	2400	4000	3200	2600	2200	2800	3000	2800	2200	1500	4100	1800	3000	3900
		Manganese	176	nc	1450	mg/kg	**530**	**370**	**270**	120	**430**	**440**	**420**	**310**	**540**	**510**	**460**	**700**	**200**	170
		Nickel	156	nc	21.1	mg/kg	16	25	20	15	15	20	20	17	14	8.6	27	10	17	27
		Potassium	--	[n]	927	mg/kg	1100	1600	1100	1000	1100	1400	1300	1100	1100	580	1700	690	1400	1700
		Selenium	39	nc	1.4	mg/kg	0.48 U	0.46 U	0.45 U	0.4 U	0.46 U	0.48 B	0.47 U	0.51 B	0.72 B	0.45 U	0.45 U	1.4	0.49 U	0.47 U
		Silver	39	nc	0.00	mg/kg	0.37 U	0.36 U	0.35 U	0.31 U	0.36 U	0.36 U	0.36 U	0.33 U	0.36 U	0.35 U	0.35 U	0.39 U	0.38 U	0.37 U
		Sodium	--	[n]	123	mg/kg	100 U	100 U	97 U	86 U	100 U	790	100 U	1100	1300	98 U	98 U	110 U	1100	1200
		Vanadium	7.8	nc	31.1	mg/kg	**21**	**26** H	**21**	**21**	**19** H	**12**	**22** H	**20**	**23**	**25** H	**30** H	**23**	**26**	**28**
		Zinc	2346	nc	61.8	mg/kg	58	59	53	39	55	160	55	58	55	43	66	53	58	78
	7041	Antimony	3.1	nc	0.96	mg/kg	0.53 U	0.52 U	0.49 U	0.49 U	0.5 U	0.51 U*H^	0.52 U	0.45 U	0.62 B	0.52 U	0.52 U	0.5 U	0.5 U	0.52 U
	7060A	Arsenic	0.39	ca	15.4	mg/kg	**10**	**12**	**14**	**12**	**8.9**	**12**	**17.22**	**11**	**9.7**	**13**	**11**	**13**	**17**	**9.9**
	7421	Lead	400	pbk	26.1	mg/kg	22	22	17	16	25	90	30.83	23	9.9	19	11	19	18	19
	7471A	Mercury	2.3	nc	0.04	mg/kg	0.035	0.04 B	0.029	0.022	0.14	0.018 B	0.025	0.035	0.037	0.033	0.034	0.033	0.031	0.034
	7841	Thallium	0.52	nc	0.00	mg/kg	0.23 U	0.22 U	0.21 U	0.21 U	0.22 U	0.22 U	0.22 U	0.98 U	0.21 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U

Table 4−1
Summary of Surface Soil Results (0−1 ft)

Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SS PRG Basis	RVAAP Surface Soil Background Criteria	Units	LL6SS-018-0001-SO	LL6SS-019-0001-SO	LL6SS-020-0001-DUP	LL6SS-020-0001-SO	LL6SS-021-0001-SO	LL6SS-022-0001-SO	LL6SS-023-0001-SO	LL6SS-024-0001-SO	LL6SS-025-0001-SO	LL6SS-026-0001-SO	LL6SS-027-0001-SO	LL6SS-028-0001-SO	LL6SS-029-0001-DUP	LL6SS-029-0001-SO
		Sample Date					12/02/03	11/19/03	12/02/03	12/02/03	11/19/03	11/14/03	11/19/03	11/25/03	11/14/03	11/20/03	11/20/03	11/18/03	11/25/03	11/25/03
		Sample Depth					0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.
VOCs TCL 8260B	8260B	1,1,1-Trichloroethane	1200	sat	--	mg/kg			0.0013 U	0.0013 U			0.00076 U							
		1,1,2,2-Tetrachloroethane	0.41	ca	--	mg/kg			0.0011 U	0.0011 U			0.0008 U							
		1,1,2-Trichloroethane	0.73	ca	--	mg/kg			0.0013 U	0.0013 U			0.00088 U							
		1,1-Dichloroethane	51	nc	--	mg/kg			0.0012 U	0.0012 U			0.0011 U							
		1,1-Dichloroethene	12	nc	--	mg/kg			0.0016 U	0.0015 U			0.0012 U							
		1,2-Dichloroethane	0.28	ca	--	mg/kg			0.0011 U	0.0011 U			0.00072 U							
		1,2-Dichloroethene (total)	6.9	nc	--	mg/kg			0.0025 U	0.0025 U			0.0024 U							
		1,2-Dichloropropane	0.34	ca	--	mg/kg			0.0012 U	0.0012 U			0.0012 U							
		2-Butanone (MEK)	2231	nc	--	mg/kg			0.0047 U	0.0046 U			0.0052 U							
		2-Hexanone	530	nc	--	mg/kg			0.0013 U	0.0013 U			0.0021 U							
		4-Methyl-2-pentanone (MIBK)	528	nc	--	mg/kg			0.0012 U	0.0012 U			0.0037 U							
		Acetone	1412	nc	--	mg/kg			0.0055 U	0.0055 U			0.0051 U							
		Benzene	0.64	ca	--	mg/kg			0.0013 U	0.0013 U			0.00082 U							
		Bromodichloromethane	0.82	ca	--	mg/kg			0.0011 U	0.0011 U			0.00084 U							
		Bromoform	62	ca	--	mg/kg			0.0009 U	0.00089 U			0.0011 U							
		Bromomethane	0.39	nc	--	mg/kg			0.0016 U	0.0015 U			0.0036 U*							
		Carbon disulfide	36	nc	--	mg/kg			0.0014 U	0.0014 U			0.0025 U							
		Carbon tetrachloride	0.25	ca	--	mg/kg			0.0013 U	0.0013 U			0.001 U							
		Chlorobenzene	15	nc	--	mg/kg			0.0013 U	0.0013 U			0.0011 U							
		Chloroethane	3.0	ca	--	mg/kg			0.0012 U	0.0012 U			0.002 U							
		Chloroform	0.22	ca	--	mg/kg			0.0013 U	0.0013 U			0.00077 U							
		Chloromethane	4.7	nc	--	mg/kg			0.0013 U	0.0013 U			0.0012 U							
		cis-1,3-Dichloropropene	0.78	ca	--	mg/kg			0.0011 U	0.0011 U			0.00098 U							
		Dibromochloromethane	1.1	ca	--	mg/kg			0.00094 U	0.00094 U			0.00086 U							
		Ethylbenzene	395	sat	--	mg/kg			0.0013 U	0.0013 U			0.0014 U							
		Methylene chloride	9.1	ca	--	mg/kg			0.0035 U	0.0035 U			0.0022 U							
		Styrene	1700	sat	--	mg/kg			0.0013 U	0.0013 U			0.0012 U							
		Tetrachloroethene	0.48	ca	--	mg/kg			0.0014 U	0.0014 U			0.00083 U							
		Toluene	520	sat	--	mg/kg			0.0013 U	0.0013 U			0.0012 U							
		trans-1,3-Dichloropropene	0.78	ca	--	mg/kg			0.00094 U	0.00094 U			0.001 U							
		Trichloroethene	0.053	ca	--	mg/kg			0.0013 U	0.0013 U			0.00073 U							
		Vinyl chloride	0.079	ca	--	mg/kg			0.0013 U	0.0013 U			0.00092 U							
		Xylenes (total)	27	nc	--	mg/kg			0.0041 U	0.0041 U			0.0036 U							

Table 4−1
Summary of Surface Soil Results (0−1 ft)

Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SS PRG Basis	RVAAP Surface Soil Background Criteria	Units	LL6SS-030-0001-SO	LL6SS-031-0001-SO	LL6SS-032-0001-DUP	LL6SS-032-0001-SO	LL6SS-033-0001-SO	LL6SS-034-0001-SO	LL6SS-035-0001-SO	LL6SS-036-0001-SO	LL6SS-037-0001-SO	LL6SS-038-0001-SO	LL6SS-039-0001-SO	LL6SS-040-0001-DUP	LL6SS-040-0001-SO
Sample Date							11/18/03	11/13/03	11/13/03	11/13/03	11/18/03	11/14/03	11/13/03	11/13/03	11/13/03	11/05/03	11/05/03	11/05/03	11/05/03
Sample Depth							0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.
Cyanide 9012A	9014/9010B	Cyanide, Total	122	nc	0.00	mg/kg						0.2 U	0.094 U						
Explosives 8330	8330	1,3,5-Trinitrobenzene	183	nc	0.00	mg/kg			0.017 U	0.017 U		0.017 U	0.017 U					0.017 U	0.017 U
		1,3-Dinitrobenzene	0.61	nc	0.00	mg/kg			0.018 U	0.018 U		0.018 U	0.018 U					0.018 U	0.018 U
		2,4,6-TNT	16	ca	0.00	mg/kg			0.034 U	0.034 U		0.033 U	0.034 U					0.034 U	0.034 U
		2,4-Dinitrotoluene	12	nc	0.00	mg/kg			0.035 U	0.035 U		0.035 U	0.035 U					0.035 U	0.035 U
		2,6-Dinitrotoluene	6.1	nc	0.00	mg/kg			0.047 U*	0.047 U*		0.047 U	0.047 U*					0.047 U	0.047 U
		2-Nitrotoluene	0.88	ca	0.00	mg/kg			0.033 U	0.033 U		0.033 U	0.033 U					0.033 U	0.033 U
		3-Nitrotoluene	73	nc	0.00	mg/kg			0.05 U	0.05 U		0.05 U	0.05 U					0.05 U	0.05 U
		4-Nitrotoluene	12	ca	0.00	mg/kg			0.046 U	0.046 U		0.046 U	0.046 U					0.046 U	0.046 U
		HMX	306	nc	0.00	mg/kg			0.11 U	0.11 U		0.11 U	0.11 U					0.11 U	0.11 U
		Nitrobenzene	2	nc	0.00	mg/kg			0.022 U	0.022 U		0.022 U	0.022 U					0.022 U	0.022 U
		RDX	4.4	ca	0.00	mg/kg			0.058 U	0.058 U		0.058 U	0.058 U					0.058 U	0.058 U
		Tetryl	61	nc	0.00	mg/kg			0.043 U	0.043 U		0.043 U	0.043 U					0.043 U	0.043 U
PCB TCL 8082	8082	Aroclor 1016	0.39	nc	--	mg/kg						0.0023 U	0.0023 U						
		Aroclor 1221	0.22	ca	--	mg/kg						0.0024 U	0.0024 U						
		Aroclor 1232	0.22	ca	--	mg/kg						0.0024 U	0.0024 U						
		Aroclor 1242	0.22	ca	--	mg/kg						0.0024 U	0.0024 U						
		Aroclor 1248	0.22	ca	--	mg/kg						0.0024 U	0.0024 U						
		Aroclor 1254	0.22	ca	--	mg/kg						0.0024 U	0.0024 U						
		Aroclor 1260	0.22	ca	--	mg/kg						0.0017 U	0.0017 U						
Pesticides 8081A	8081A	4,4'-DDD	2.4	ca	--	mg/kg						0.00043 U	0.00044 U						
		4,4'-DDE	1.7	ca	--	mg/kg						0.00078 U	0.0008 U						
		4,4'-DDT	1.7	ca	--	mg/kg						0.00044 U	0.00045 U						
		Aldrin	0.029	ca	--	mg/kg						0.00016 U	0.00016 U						
		alpha-BHC	0.09	sat	--	mg/kg						0.00019 U	0.0002 U						
		alpha-Chlordane	1.6	ca	--	mg/kg						0.00014 U	0.00015 U						
		beta-BHC	0.32	ca	--	mg/kg						0.00018 U	0.00018 U						
		delta-BHC	--	--	--	mg/kg						0.00013 U	0.00013 U						
		Dieldrin	0.030	ca	--	mg/kg						0.00041 U	0.00042 U						
		Endosulfan I	37	nc	--	mg/kg						0.00032 U	0.00033 U						
		Endosulfan II	37	nc	--	mg/kg						0.00033 U	0.00034 U						
		Endosulfan sulfate	37	nc	--	mg/kg						0.00035 U	0.00035 U						
		Endrin	1.8	nc	--	mg/kg						0.00051 U	0.00053 U						
		Endrin aldehyde	--	--	--	mg/kg						0.00039 U	0.0004 U						
		Endrin ketone	--	--	--	mg/kg						0.00035 U	0.00035 U						
		gamma-BHC (Lindane)	0.44	ca	--	mg/kg						0.00027 U	0.00028 U						
		gamma-Chlordane	1.6	ca	--	mg/kg						0.00018 U	0.00018 U						
		Heptachlor	0.11	ca	--	mg/kg						0.00021 U	0.00022 U						
		Heptachlor epoxide	0.053	ca	--	mg/kg						0.00017 U	0.00017 U						
		Methoxychlor	31	nc	--	mg/kg						0.0027 U	0.0028 U						
		Toxaphene	0.44	ca	--	mg/kg						0.0055 U	0.0056 U						

Table 4−1
Summary of Surface Soil Results (0−1 ft)

							LL6SS-030-0001-SO	LL6SS-031-0001-SO	LL6SS-032-0001-DUP	LL6SS-032-0001-SO	LL6SS-033-0001-SO	LL6SS-034-0001-SO	LL6SS-035-0001-SO	LL6SS-036-0001-SO	LL6SS-037-0001-SO	LL6SS-038-0001-SO	LL6SS-039-0001-SO	LL6SS-040-0001-DUP	LL6SS-040-0001-SO
						Sample Date	11/18/03	11/13/03	11/13/03	11/13/03	11/18/03	11/14/03	11/13/03	11/13/03	11/13/03	11/05/03	11/05/03	11/05/03	11/05/03
						Sample Depth	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SS PRG Basis	RVAAP Surface Soil Background Criteria	Units													
Propellants 8330	353.2	Nitrocellulose	--	--	0.00	mg/kg						3.1	0.72 B						
	8330	Nitroglycerin	35	ca	0.00	mg/kg						0.5 U	0.5 U						
	UV/HPLC per SOP	Nitroguanidine	611	nc	0.00	mg/kg						0.25 U	0.25 U						
SVOCs TCL 8270 C	8270C	1,2,4-Trichlorobenzene	6.2	nc	--	mg/kg						0.073 U	0.073 U						
		1,2-Dichlorobenzene	600	sat	--	mg/kg						0.097 U	0.098 U						
		1,3-Dichlorobenzene	53	nc	--	mg/kg						0.097 U	0.098 U						
		1,4-Dichlorobenzene	3.4	ca	--	mg/kg						0.087 U	0.088 U						
		2,2-oxybis (1-chloropropane)	2.9	ca	--	mg/kg						0.092 U	0.093 U						
		2,4,5-Trichlorophenol	611	nc	--	mg/kg						0.047 U	0.047 U						
		2,4,6-Trichlorophenol	0.61	nc	--	mg/kg						0.058 U	0.058 U						
		2,4-Dichlorophenol	18	nc	--	mg/kg						0.059 U	0.059 U						
		2,4-Dimethylphenol	122	nc	--	mg/kg						0.074 U	0.074 U						
		2,4-Dinitrophenol	12	nc	--	mg/kg						0.14 U	0.14 U						
		2-Chloronaphthalene	494	nc	--	mg/kg						0.059 U	0.059 U						
		2-Chlorophenol	6.3	nc	--	mg/kg						0.073 U	0.073 U						
		2-Methylnaphthalene	--	--	--	mg/kg						0.0018 U	0.0019 U						
		2-Methylphenol (o-cresol)	306	nc	--	mg/kg						0.01 U	0.01 U						
		2-Nitroaniline	18.3	nc	--	mg/kg						0.042 U	0.042 U						
		2-Nitrophenol	--	--	--	mg/kg						0.078 U	0.078 U						
		3,3-Dichlorobenzidine	1.1	ca	--	mg/kg						0.022 U	0.022 U						
		3-Nitroaniline	1.8	nc	--	mg/kg						0.14 U	0.14 U						
		4,6-Dinitro-2-methylphenol	0.61	nc	--	mg/kg						0.12 U*	0.12 U						
		4-Bromophenyl phenyl ether	--	--	--	mg/kg						0.0038 U	0.0038 U						
		4-Chloro-3-methylphenol	--	--	--	mg/kg						0.047 U	0.047 U						
		4-Chloroaniline	24	nc	--	mg/kg						0.12 U	0.12 U						
		4-Chlorophenyl phenyl ether	--	--	--	mg/kg						0.0044 U	0.0045 U						
		4-Methylphenol (m/p-cresol)	31	nc	--	mg/kg						0.0071 U	0.0072 U						
		4-Nitroaniline	23	ca	--	mg/kg						0.048 U	0.048 U						
		4-Nitrophenol	--	--	--	mg/kg						0.1 U	0.1 U						
		Acenaphthene	368	nc	--	mg/kg						0.0017 U	0.0017 U						
		Acenaphthylene	--	--	--	mg/kg						0.0011 U	0.0011 U						
		Anthracene	2189	nc	--	mg/kg						0.0011 U	0.0011 U						
		Benzo(a)anthracene	0.62	ca	--	mg/kg						0.014 J	0.0049 J						
		Benzo(a)pyrene	0.062	ca	--	mg/kg						0.014 J	0.0037 J						
		Benzo(b)fluoranthene	0.62	ca	--	mg/kg						0.015 J	0.004 J						
		Benzo(ghi)perylene	--	--	--	mg/kg						0.009 J	0.0024 U						
		Benzo(k)fluoranthene	6.2	ca	--	mg/kg						0.012 J	0.0035 U						
		Bis(2-chloroethoxy)methane	--	--	--	mg/kg						0.0036 U	0.0036 U						
		Bis(2-chloroethyl)ether	0.22	ca	--	mg/kg						0.0025 U	0.0025 U						
		Bis(2-ethylhexyl)phthalate	35	ca	--	mg/kg						0.012 U	0.012 U						
		Butyl benzyl phthalate	1222	nc	--	mg/kg						0.005 U	0.0051 U						
		Carbazole	24	ca	--	mg/kg						0.043 U	0.043 U						
		Chrysene	62	ca	--	mg/kg						0.015 J	0.0047 J						
		Dibenzo(a,h)anthracene	0.062	ca	--	mg/kg						0.0027 U	0.0027 U						
		Dibenzofuran	15	nc	--	mg/kg						0.0033 U	0.0033 U						

Table 4−1
Summary of Surface Soil Results (0−1 ft)

							LL6SS-030-0001-SO	LL6SS-031-0001-SO	LL6SS-032-0001-DUP	LL6SS-032-0001-SO	LL6SS-033-0001-SO	LL6SS-034-0001-SO	LL6SS-035-0001-SO	LL6SS-036-0001-SO	LL6SS-037-0001-SO	LL6SS-038-0001-SO	LL6SS-039-0001-SO	LL6SS-040-0001-DUP	LL6SS-040-0001-SO
						Sample Date	11/18/03	11/13/03	11/13/03	11/13/03	11/18/03	11/14/03	11/13/03	11/13/03	11/13/03	11/05/03	11/05/03	11/05/03	11/05/03
						Sample Depth	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SS PRG Basis	RVAAP Surface Soil Background Criteria	Units													
		Diethyl phthalate	4888	nc	--	mg/kg						0.0046 U	0.0046 U						
		Dimethyl phthalate	100000	max	--	mg/kg						0.0044 U	0.0045 U						
		Di-n-butyl phthalate	611	nc	--	mg/kg						0.025 U	0.025 U						
		Di-n-octyl phthalate	244	nc	--	mg/kg						0.011 U	0.011 U						
		Fluoranthene	229	nc	--	mg/kg						0.025 J	0.0072 J						
		Fluorene	275	nc	--	mg/kg						0.002 U	0.002 U						
		Hexachlorobenzene	0.30	ca	--	mg/kg						0.0022 U	0.0022 U						
		Hexachlorobutadiene	6.2	ca	--	mg/kg						0.0041 U	0.0041 U						
		Hexachlorocyclopentadiene	37	nc	--	mg/kg						0.066 U	0.067 U						
		Hexachloroethane	35	ca	--	mg/kg						0.0041 U	0.0041 U						
		Indeno(1,2,3-cd)pyrene	0.62	ca	--	mg/kg						0.0026 U	0.0026 U						
		Isophorone	512	ca	--	mg/kg						0.003 U	0.003 U						
		Naphthalene	5.6	nc	--	mg/kg						0.0021 U	0.0021 U						
		n-Nitroso-di-n-propylamine	0.069	ca	--	mg/kg						0.0028 U	0.0028 U						
		n-Nitrosodiphenylamine	99	ca	--	mg/kg						0.0036 U*	0.0036 U						
		Pentachlorophenol	3.0	ca	--	mg/kg						0.12 U	0.12 U						
		Phenanthrene	--	--	--	mg/kg						0.0099 J	0.0012 U						
		Phenol	1833	nc	--	mg/kg						0.002 U	0.002 U						
		Pyrene	232	nc	--	mg/kg						0.021 J	0.0058 J						
TAL Metals 6010B	6010B	Aluminum	7614	nc	17700	mg/kg	**14000**	3300	**15000**	**18000**	**17000**	**10000**	**12000**	**14000**	**11000**	**13000**	**17000**	**13000**	**14000**
		Barium	538	nc	88.4	mg/kg	85	110	100	180	110	71	67	75	68	61	73	69	68
		Beryllium	15	nc	0.88	mg/kg	0.94	0.36 B	2.1	2.1	1	0.49	0.69	0.81	0.58	0.47	0.47	0.46	0.48
		Cadmium	3.7	nc	0.00	mg/kg	0.1 U	0.17 B	0.088 U	0.087 U	0.086 U	0.56	0.092 U	0.1 U	0.11 U	0.087 U	0.092 U	0.09 U	0.092 U
		Calcium	--	[n]	15800	mg/kg	1900	57000	53000	51000	21000	3800	5500	1800	450	16000	2600	5700	5500
		Chromium	30	ca	17.4	mg/kg	18	5.7	8.6	10	23	16	17	18	13	17	22	17	17
		Cobalt	902	ca	10.4	mg/kg	10	3.6	4	4.2	13	8.1	8.2	8.9	9	8.7	8.6	9.2	9.7
		Copper	313	nc	17.7	mg/kg	12	8.9	8.5	9.9	22	25	15	14	12	17	16	17	20
		Iron	2346	nc	23100	mg/kg	**31000** H	**10000** H	**11000** H	**12000** H	**28000** H	**24000** H	**22000** H	**23000** H	**16000** H	**23000**	**31000**	**23000**	**23000**
		Magnesium	--	[n]	3030	mg/kg	2600	910	8300	8800	7600	2800	3500	2800	1700	4700	3400	3600	3500
		Manganese	176	nc	1450	mg/kg	**940**	**820**	**810**	**1800**	**380**	**520**	**320**	**580**	**870**	**320**	**340**	**340**	**370**
		Nickel	156	nc	21.1	mg/kg	17	9.3	7.9	8.4	32	21	20	18	11	21	19	21	20
		Potassium	--	[n]	927	mg/kg	1100	600	1200	1500	2800	1100	1500	1300	860	1900	1800	1500	1600
		Selenium	39	nc	1.4	mg/kg	1.7	0.65 B	1.5	1.7	1.7	0.49 B	1.3	1.5	1 B	0.44 U	0.67 B	0.59 B	0.46 U
		Silver	39	nc	0.00	mg/kg	0.4 U	0.3 U	0.34 U	0.34 U	0.33 U	0.35 U	0.36 U	0.39 U	0.41 U	0.34 U	0.36 U	0.35 U	0.36 U
		Sodium	--	[n]	123	mg/kg	110 U	84 U	310	390	130	1100	100 U	110 U	110 U	1400	1300	1300	1400
		Vanadium	7.8	nc	31.1	mg/kg	**27**	6.7	**11**	**12**	**27**	**18**	**20**	**24**	**19**	**21**	**29**	**22**	**23**
		Zinc	2346	nc	61.8	mg/kg	57	58	28	33	58	96	58	61	59	61	55	55	56
	7041	Antimony	3.1	nc	0.96	mg/kg	0.56 U	0.28 B	0.39 B	0.22 B	0.46 U	0.36 B	0.082 B	0.22 B	0.31 B	0.49 U	0.49 U	0.5 U	0.49 U
	7060A	Arsenic	0.39	ca	15.4	mg/kg	**12**	**2.2**	**11**	**9.3**	**11**	**8.5**	**9.3**	**10**	**6.2**	**10**	**13**	**11**	**10**
	7421	Lead	400	pbk	26.1	mg/kg	11	14	15	21	8.1	180	14	18	21	13	23	13	16
	7471A	Mercury	2.3	nc	0.04	mg/kg	0.03	0.01 B	0.012 B	0.0081 B	0.0052 U	0.024	0.019 B	0.03	0.037	0.013 B	0.031	0.039 B	0.024
	7841	Thallium	0.52	nc	0.00	mg/kg	1.2 U	0.18 U	0.2 U	0.21 U	0.2 U	0.21 U	0.23 U	0.23 U	0.25 U	1.1 U	0.0089 U	0.22 U	0.0089 U

Table 4−1
Summary of Surface Soil Results (0−1 ft)

							LL6SS-030-0001-SO	LL6SS-031-0001-SO	LL6SS-032-0001-DUP	LL6SS-032-0001-SO	LL6SS-033-0001-SO	LL6SS-034-0001-SO	LL6SS-035-0001-SO	LL6SS-036-0001-SO	LL6SS-037-0001-SO	LL6SS-038-0001-SO	LL6SS-039-0001-SO	LL6SS-040-0001-DUP	LL6SS-040-0001-SO
						Sample Date	11/18/03	11/13/03	11/13/03	11/13/03	11/18/03	11/14/03	11/13/03	11/13/03	11/13/03	11/05/03	11/05/03	11/05/03	11/05/03
						Sample Depth	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.	0-1 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SS PRG Basis	RVAAP Surface Soil Background Criteria	Units													
VOCs TCL 8260B	8260B	1,1,1-Trichloroethane	1200	sat	--	mg/kg						0.00076 U	0.00076 U						
		1,1,2,2-Tetrachloroethane	0.41	ca	--	mg/kg						0.00079 U	0.0008 U						
		1,1,2-Trichloroethane	0.73	ca	--	mg/kg						0.00088 U	0.00088 U						
		1,1-Dichloroethane	51	nc	--	mg/kg						0.0011 U	0.0011 U						
		1,1-Dichloroethene	12	nc	--	mg/kg						0.0012 U	0.0012 U						
		1,2-Dichloroethane	0.28	ca	--	mg/kg						0.00072 U	0.00072 U						
		1,2-Dichloroethene (total)	6.9	nc	--	mg/kg						0.0024 U	0.0024 U						
		1,2-Dichloropropane	0.34	ca	--	mg/kg						0.0012 U	0.0012 U						
		2-Butanone (MEK)	2231	nc	--	mg/kg						0.0052 U	0.0052 U						
		2-Hexanone	530	nc	--	mg/kg						0.0021 U	0.0021 U						
		4-Methyl-2-pentanone (MIBK)	528	nc	--	mg/kg						0.0037 U	0.0037 U						
		Acetone	1412	nc	--	mg/kg						0.0051 U*	0.0051 U						
		Benzene	0.64	ca	--	mg/kg						0.00082 U	0.00082 U						
		Bromodichloromethane	0.82	ca	--	mg/kg						0.00084 U	0.00085 U						
		Bromoform	62	ca	--	mg/kg						0.0011 U	0.0011 U						
		Bromomethane	0.39	nc	--	mg/kg						0.0036 U*	0.0036 U						
		Carbon disulfide	36	nc	--	mg/kg						0.0025 U	0.0025 U						
		Carbon tetrachloride	0.25	ca	--	mg/kg						0.001 U	0.001 U						
		Chlorobenzene	15	nc	--	mg/kg						0.0011 U	0.0011 U						
		Chloroethane	3.0	ca	--	mg/kg						0.002 U	0.002 U						
		Chloroform	0.22	ca	--	mg/kg						0.00077 U	0.00077 U						
		Chloromethane	4.7	nc	--	mg/kg						0.0012 U*	0.0012 U						
		cis-1,3-Dichloropropene	0.78	ca	--	mg/kg						0.00098 U	0.00098 U						
		Dibromochloromethane	1.1	ca	--	mg/kg						0.00086 U*	0.00086 U						
		Ethylbenzene	395	sat	--	mg/kg						0.0014 U	0.0014 U						
		Methylene chloride	9.1	ca	--	mg/kg						0.0022 U	0.0022 U						
		Styrene	1700	sat	--	mg/kg						0.0012 U	0.0012 U						
		Tetrachloroethene	0.48	ca	--	mg/kg						0.00083 U	0.00083 U						
		Toluene	520	sat	--	mg/kg						0.0012 U	0.0012 U						
		trans-1,3-Dichloropropene	0.78	ca	--	mg/kg						0.001 U	0.001 U						
		Trichloroethene	0.053	ca	--	mg/kg						0.00073 U	0.00073 U						
		Vinyl chloride	0.079	ca	--	mg/kg						0.00092 U	0.00092 U						
		Xylenes (total)	27	nc	--	mg/kg						0.0036 U	0.0036 U						

Table 4-1
Summary of Surface Soil Results (0-1 ft)

Notes:
blank cells indicates that analysis was not performed
-- - no background/PRG value is available for this analyte
PRG - preliminary remediation goals
nc - non-cancer basis, value is 1/10th the published PRG
ca - cancer basis
pbk - based on PBK modeling
mcl - based on CWA maximum contaminant level
max - ceiling limit
sat - soil saturation
[n] - nutrient
If Result = or > Background, then the value is presented with a shaded/highlighted style
If Result = or > Background and PRG, then the value is presented with a bold + shaded/highlighted style
If Result = or > PRG, then the value is presented with a bold style
If Result < PRG and Background, then the value is presented with a normal style

Inorganic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is less than the RL, but greater than or equal to the MDL
B - result is less than the CRDL/RL, but greater than or equal to the IDL/MDL
InOrganic Flags
^ - instrument related QC exceed the upper or lower control limits
* - batch QC exceeds the upper or lower control limit
H - batch QC is greater than RL
Organic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is an estimated value below the RL
Organic Flags
B - Method Blank: batch QC is greater than RL
* - batch QC exceeds the upper or lower control limit
^ - batch QC is greater than RL
H - alternate peak selection upon analytical review

Table 4−2
Summary of Surface Soil Sample Results Collected During Azide Screening (0−1 ft)

ANALYTE**, UNITS, METHOD NO.	RVAAP Soil Background Criteria (0-1 ft) mg/kg	Region 9 PRG Data (Residential Soil) mg/kg		LL6SS-001-0001-SO	W-12S	D-12S	LL6SS-002-0001-SO	W-13S	D-13S	LL6SS-003-0001-SO	W-14S	D-14S
Sample Date				3/12/2002	3/15/2002	3/15/2002	3/12/2002	3/15/2002	3/15/2002	3/12/2002	3/15/2002	3/15/2002
Explosives 8330 mg/kg												
HMX	0.0	306	nc	0.25 U	0.25 U	0.24 U	0.25 U	0.25 U	0.25 U	0.19 J a	0.17 J a	0.2 J a
RDX	0.0	4.4	ca	0.1 U	0.099 U	0.098 U	0.099 U	0.099 U	0.099 U	0.1 U	0.099 U	0.1 U
1,3,5-Trinitrobenzene	0.0	183	nc	0.1 U	0.099 U	0.098 U	0.099 U	0.099 U	0.099 U	0.1 U	0.099 U	0.1 U
1,3-Dinitrobenzene	0.0	0.61	nc	0.1 U	0.099 U	0.098 U	0.099 U	0.099 U	0.099 U	0.1 U	0.099 U	0.1 U
Nitrobenzene	0.0	2	nc	0.1 U	0.099 U	0.098 U	0.099 U	0.099 U	0.099 U	0.1 U	0.099 U	0.1 U
2,4,6-Trinitrtoluene	0.0	16	ca	0.1 U	0.099 U	0.098 U	0.099 U	0.099 U	0.099 U	0.1 U	0.099 U	0.1 U
Tetryl	0.0	61	nc	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
2,4-Dinitrotoluene	0.0	12	nc	0.1 U	0.099 U	0.098 U	0.099 U	0.099 U	0.099 U	0.1 U	0.099 U	0.1 U
2,6-Dinitrotoluene	0.0	6.1	nc	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
2-Nitrotoluene	0.0	0.88	ca	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
4-Nitrtoluene	0.0	12	ca	0.5 U	0.5 U	0.49 U	0.49 U	0.49 U	0.49 U	0.5 U	0.49 U	0.5 U
3-Nitrotoluene	0.0	73	nc	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Metals 6010B mg/kg												
Antimony	0.96	3.1	nc	0.30	NT	NT	0.19 U	0.22 B	NT	0.21 U	NT	NT
Arsenic	15.4	0.39	ca	**3.2**	NT	NT	**3.3**	**3.8**	NT	**5.6**	NT	NT
Lead	26.1	400	pbk	17.8	NT	NT	33.8	40.4	NT	65.1	NT	NT
Thallium	0.0	0.52	nc	0.17 U	NT	NT	0.26 U	0.18 U	NT	0.28 U	NT	NT
Mercury	0.04	2.3	nc	0.039	NT	NT	0.063	0.063	NT	0.039	NT	NT
Aluminum	17700	7614	nc	6500	NT	NT	1990	2270	NT	4960	NT	NT
Barium	88.4	538	nc	95.9	NT	NT	150	89.9	NT	84.6	NT	NT
Beryllium	0.88	15	nc	0.44	NT	NT	0.20 B	0.25 B	NT	0.30 B	NT	NT
Cadmium	0.0	3.7	nc	0.22	NT	NT	**6.8**	**5.9**	NT	0.68	NT	NT
Calcium	15800	--	[n]	89100 H	NT	NT	184000 H	116000 H	NT	138000 H	NT	NT
Chromium	17.4	30	ca	9.2	NT	NT	5.8	6.9	NT	8.7	NT	NT
Cobalt	10.4	902	ca	5.8	NT	NT	3.6	3.9	NT	3.9	NT	NT
Copper	17.7	313	nc	17.8	NT	NT	**627**	145	NT	15.7	NT	NT
Iron	23100	2346	nc	**14100 H**	NT	NT	**9940 H**	**13900 H**	NT	**13000 H**	NT	NT
Magnesium	3030	--	[n]	2240	NT	NT	1650	1780	NT	1980	NT	NT
Manganese	1450	176	nc	**452**	NT	NT	**574**	**558**	NT	**451**	NT	NT
Nickel	21.1	156	nc	13.7	NT	NT	12	13.4	NT	11.1	NT	NT

Table 4−2
Summary of Surface Soil Sample Results Collected During Azide Screening (0−1 ft)

ANALYTE**, UNITS, METHOD NO.	RVAAP Soil Background Criteria (0-1 ft) mg/kg	Region 9 PRG Data (Residential Soil) mg/kg		LL6SS-001-0001-SO	W-12S	D-12S	LL6SS-002-0001-SO	W-13S	D-13S	LL6SS-003-0001-SO	W-14S	D-14S
Sample Date				3/12/2002	3/15/2002	3/15/2002	3/12/2002	3/15/2002	3/15/2002	3/12/2002	3/15/2002	3/15/2002
Metals 6010B mg/kg												
Potassium	927	--	[n]	1050	NT	NT	531	535	NT	930	NT	NT
Selenium	1.4	39	nc	0.82 U	NT	NT	0.98 U	0.85 U	NT	0.88 U	NT	NT
Silver	0.0	39	nc	0.41 U	NT	NT	0.49 U	0.43 U	NT	0.44 U	NT	NT
Sodium	123	--	[n]	196	NT	NT	119	152	NT	146	NT	NT
Vanadium	31.1	7.8	nc	**11.8**	NT	NT	5.6	6.7	NT	**11.1**	NT	NT
Zinc	61.8	2346	nc	46.0	NT	NT	160	180	NT	101	NT	NT

PRGs - Preliminary Remediation Goals

nc - non-cancer basis, value is 1/10 the published PRG

ca - cancer basis

pbk - based on PBK modeling

[n] - nutrient

NT - not tested

-- - no background/PRG value available for this analyte

If Result = or > Background, then the value is presented in a shaded cell.

If Result = or > Background & PRG, then the value is presented in a shaded cell in boldface.

If Result = or > PRG, then the value is presented in boldface.

If Result < PRG & Background, then the value is presented without shading or boldface.

Inorganic Qualifiers

U - analyte was not detected at or above the stated limit

B - result is less than the CRDL/RL, but greater than or equal to the IDL/MDL

InOrganic Flags

H - batch QC is greater than RL

Organic Qualifiers

U - analyte was not detected at or above the stated limit

Table 4−3
Summary of Surface Soil Exceedances (0-1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Surface Soil Background Criteria (mg/kg)	Surface Soil Region 9 Criteria (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
D-14S	3/15/2002	0-1ft	HMX	0.2	J	0.0	306.00	YES	NO
LL6SS-001-0001-SO	3/12/2002	0-1ft	Arsenic	3.2		15.4	0.39	NO	YES
LL6SS-001-0001-SO	3/12/2002	0-1ft	Barium	95.9		88.4	538.00	YES	NO
LL6SS-001-0001-SO	3/12/2002	0-1ft	Cadmium	0.22		0.0	3.70	YES	NO
LL6SS-001-0001-SO	3/12/2002	0-1ft	Calcium	89100	H	15800	--	YES	NO
LL6SS-001-0001-SO	3/12/2002	0-1ft	Copper	17.8		17.7	313.00	YES	NO
LL6SS-001-0001-SO	3/12/2002	0-1ft	Iron	14100	H	23100	2346.00	NO	YES
LL6SS-001-0001-SO	3/12/2002	0-1ft	Manganese	452		1450	176.00	NO	YES
LL6SS-001-0001-SO	3/12/2002	0-1ft	Potassium	1050		927	--	YES	NO
LL6SS-001-0001-SO	3/12/2002	0-1ft	Sodium	196		123	--	YES	NO
LL6SS-001-0001-SO	3/12/2002	0-1ft	Vanadium	11.8		31.1	7.80	NO	YES
LL6SS-002-0001-SO	3/12/2002	0-1ft	Arsenic	3.3		15.4	0.39	NO	YES
LL6SS-002-0001-SO	3/12/2002	0-1ft	Barium	150		88.4	538.00	YES	NO
LL6SS-002-0001-SO	3/12/2002	0-1ft	Cadmium	6.8		0.0	3.70	YES	YES
LL6SS-002-0001-SO	3/12/2002	0-1ft	Calcium	184000	H	15800	--	YES	NO
LL6SS-002-0001-SO	3/12/2002	0-1ft	Copper	627		17.7	313.00	YES	YES
LL6SS-002-0001-SO	3/12/2002	0-1ft	Iron	9940	H	23100	2346.00	NO	YES
LL6SS-002-0001-SO	3/12/2002	0-1ft	Lead	33.8		26.1	400.00	YES	NO
LL6SS-002-0001-SO	3/12/2002	0-1ft	Manganese	574		1450	176.00	NO	YES
LL6SS-002-0001-SO	3/12/2002	0-1ft	Mercury	0.063		0.04	2.30	YES	NO
LL6SS-002-0001-SO	3/12/2002	0-1ft	Zinc	160		61.8	2346.00	YES	NO
LL6SS-003-0001-SO	3/12/2002	0-1ft	Arsenic	5.6		15.4	0.39	NO	YES
LL6SS-003-0001-SO	3/12/2002	0-1ft	Cadmium	0.68		0.0	3.70	YES	NO
LL6SS-003-0001-SO	3/12/2002	0-1ft	Calcium	138000	H	15800	--	YES	NO
LL6SS-003-0001-SO	3/12/2002	0-1ft	HMX	0.19	J	0.0	306.00	YES	NO
LL6SS-003-0001-SO	3/12/2002	0-1ft	Iron	13000	H	23100	2346.00	NO	YES
LL6SS-003-0001-SO	3/12/2002	0-1ft	Lead	65.1		26.1	400.00	YES	NO
LL6SS-003-0001-SO	3/12/2002	0-1ft	Manganese	451		1450	176.00	NO	YES
LL6SS-003-0001-SO	3/12/2002	0-1ft	Potassium	930		927	--	YES	NO
LL6SS-003-0001-SO	3/12/2002	0-1ft	Sodium	146		123	--	YES	NO
LL6SS-003-0001-SO	3/12/2002	0-1ft	Vanadium	11.1		31.1	7.80	NO	YES
LL6SS-003-0001-SO	3/12/2002	0-1ft	Zinc	101		61.8	2346.00	YES	NO
LL6SS-004-0001-SO	11/25/03	0-0.5 ft.	Aluminum	17000		17700	7614	NO	YES
LL6SS-004-0001-SO	11/25/03	0-0.5 ft.	Arsenic	12		15.4	0.39	NO	YES
LL6SS-004-0001-SO	11/25/03	0-0.5 ft.	Chromium	21		17.4	30	YES	NO
LL6SS-004-0001-SO	11/25/03	0-0.5 ft.	Copper	21		17.7	313	YES	NO
LL6SS-004-0001-SO	11/25/03	0-0.5 ft.	Iron	28000		23100	2346	YES	YES
LL6SS-004-0001-SO	11/25/03	0-0.5 ft.	Lead	78		26.1	400	YES	NO
LL6SS-004-0001-SO	11/25/03	0-0.5 ft.	Magnesium	3500		3030	--[n]	YES	NO
LL6SS-004-0001-SO	11/25/03	0-0.5 ft.	Manganese	300		1450	176	NO	YES

Table 4−3
Summary of Surface Soil Exceedances (0-1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Surface Soil Background Criteria (mg/kg)	Surface Soil Region 9 Criteria (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SS-004-0001-SO	11/25/03	0-0.5 ft.	Nickel	22		21.1	156	YES	NO
LL6SS-004-0001-SO	11/25/03	0-0.5 ft.	Potassium	1700		927	--[n]	YES	NO
LL6SS-004-0001-SO	11/25/03	0-0.5 ft.	Sodium	1300		123	--[n]	YES	NO
LL6SS-004-0001-SO	11/25/03	0-0.5 ft.	Vanadium	27		31.1	7.8	NO	YES
LL6SS-004-0001-SO	11/25/03	0-0.5 ft.	Zinc	77		61.8	2346	YES	NO
LL6SS-005-0001-SO	11/19/03	0-1 ft.	Aluminum	13000		17700	7614	NO	YES
LL6SS-005-0001-SO	11/19/03	0-1 ft.	Arsenic	12		15.4	0.39	NO	YES
LL6SS-005-0001-SO	11/19/03	0-1 ft.	Copper	21		17.7	313	YES	NO
LL6SS-005-0001-SO	11/19/03	0-1 ft.	Iron	25000		23100	2346	YES	YES
LL6SS-005-0001-SO	11/19/03	0-1 ft.	Manganese	350		1450	176	NO	YES
LL6SS-005-0001-SO	11/19/03	0-1 ft.	Potassium	1100		927	--[n]	YES	NO
LL6SS-005-0001-SO	11/19/03	0-1 ft.	Vanadium	25	H	31.1	7.8	NO	YES
LL6SS-006-0001-SO	11/21/03	0-1 ft.	Aluminum	11000		17700	7614	NO	YES
LL6SS-006-0001-SO	11/21/03	0-1 ft.	Arsenic	12		15.4	0.39	NO	YES
LL6SS-006-0001-SO	11/21/03	0-1 ft.	Copper	21		17.7	313	YES	NO
LL6SS-006-0001-SO	11/21/03	0-1 ft.	Iron	27000		23100	2346	YES	YES
LL6SS-006-0001-SO	11/21/03	0-1 ft.	Lead	30		26.1	400	YES	NO
LL6SS-006-0001-SO	11/21/03	0-1 ft.	Manganese	700		1450	176	NO	YES
LL6SS-006-0001-SO	11/21/03	0-1 ft.	Vanadium	21		31.1	7.8	NO	YES
LL6SS-006-0001-SO	11/21/03	0-1 ft.	Zinc	71		61.8	2346	YES	NO
LL6SS-007-0001-SO	11/14/03	0-1 ft.	Arsenic	41		15.4	0.39	YES	YES
LL6SS-007-0001-SO	11/14/03	0-1 ft.	Cadmium	0.13	B	0	3.7	YES	NO
LL6SS-007-0001-SO	11/14/03	0-1 ft.	Copper	20		17.7	313	YES	NO
LL6SS-007-0001-SO	11/14/03	0-1 ft.	Iron	19000	H	23100	2346	NO	YES
LL6SS-007-0001-SO	11/14/03	0-1 ft.	Lead	53		26.1	400	YES	NO
LL6SS-007-0001-SO	11/14/03	0-1 ft.	Manganese	430		1450	176	NO	YES
LL6SS-007-0001-SO	11/14/03	0-1 ft.	Potassium	930		927	--[n]	YES	NO
LL6SS-007-0001-SO	11/14/03	0-1 ft.	Sodium	960		123	--[n]	YES	NO
LL6SS-007-0001-SO	11/14/03	0-1 ft.	Vanadium	14		31.1	7.8	NO	YES
LL6SS-007-0001-SO	11/14/03	0-1 ft.	Zinc	82		61.8	2346	YES	NO
LL6SS-008-0001-SO	11/14/03	0-1 ft.	Aluminum	12000		17700	7614	NO	YES
LL6SS-008-0001-SO	11/14/03	0-1 ft.	Arsenic	11		15.4	0.39	NO	YES
LL6SS-008-0001-SO	11/14/03	0-1 ft.	Iron	21000	H	23100	2346	NO	YES
LL6SS-008-0001-SO	11/14/03	0-1 ft.	Lead	32		26.1	400	YES	NO
LL6SS-008-0001-SO	11/14/03	0-1 ft.	Manganese	350		1450	176	NO	YES
LL6SS-008-0001-SO	11/14/03	0-1 ft.	Potassium	1300		927	--[n]	YES	NO
LL6SS-008-0001-SO	11/14/03	0-1 ft.	Sodium	1200		123	--[n]	YES	NO
LL6SS-008-0001-SO	11/14/03	0-1 ft.	Vanadium	19		31.1	7.8	NO	YES
LL6SS-008-0001-SO	11/14/03	0-1 ft.	Zinc	65		61.8	2346	YES	NO
LL6SS-009-0001-SO	11/20/03	0-1 ft.	Aluminum	12000		17700	7614	NO	YES

Table 4−3
Summary of Surface Soil Exceedances (0-1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Surface Soil Background Criteria (mg/kg)	Surface Soil Region 9 Criteria (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SS-009-0001-SO	11/20/03	0-1 ft.	Arsenic	10		15.4	0.39	NO	YES
LL6SS-009-0001-SO	11/20/03	0-1 ft.	Iron	22000		23100	2346	NO	YES
LL6SS-009-0001-SO	11/20/03	0-1 ft.	Manganese	480		1450	176	NO	YES
LL6SS-009-0001-SO	11/20/03	0-1 ft.	Potassium	980		927	--[n]	YES	NO
LL6SS-009-0001-SO	11/20/03	0-1 ft.	Vanadium	21	H	31.1	7.8	NO	YES
LL6SS-009-0001-SO	11/20/03	0-1 ft.	Zinc	68		61.8	2346	YES	NO
LL6SS-010-0001-SO	12/02/03	0-1 ft.	Aluminum	12000		17700	7614	NO	YES
LL6SS-010-0001-SO	12/02/03	0-1 ft.	Arsenic	16		15.4	0.39	YES	YES
LL6SS-010-0001-SO	12/02/03	0-1 ft.	Barium	100		88.4	538	YES	NO
LL6SS-010-0001-SO	12/02/03	0-1 ft.	Beryllium	0.95		0.88	15	YES	NO
LL6SS-010-0001-SO	12/02/03	0-1 ft.	Cobalt	12		10.4	30	YES	NO
LL6SS-010-0001-SO	12/02/03	0-1 ft.	Copper	20		17.7	313	YES	NO
LL6SS-010-0001-SO	12/02/03	0-1 ft.	Iron	23000		23100	2346	NO	YES
LL6SS-010-0001-SO	12/02/03	0-1 ft.	Magnesium	3400		3030	--[n]	YES	NO
LL6SS-010-0001-SO	12/02/03	0-1 ft.	Manganese	200		1450	176	NO	YES
LL6SS-010-0001-SO	12/02/03	0-1 ft.	Nickel	23		21.1	156	YES	NO
LL6SS-010-0001-SO	12/02/03	0-1 ft.	Nitrocellulose	10.1		0.00	--	YES	NO
LL6SS-010-0001-SO	12/02/03	0-1 ft.	Nitroglycerin	ND		0.00	35	YES	YES
LL6SS-010-0001-SO	12/02/03	0-1 ft.	Nitroguanidine	ND		0.00	611	YES	YES
LL6SS-010-0001-SO	12/02/03	0-1 ft.	Potassium	1100		927	--[n]	YES	NO
LL6SS-010-0001-SO	12/02/03	0-1 ft.	Vanadium	19		31.1	7.8	NO	YES
LL6SS-010-0001-SO	12/02/03	0-1 ft.	Zinc	62		61.8	2346	YES	NO
LL6SS-011-0001-SO	12/03/03	0-1 ft.	Aluminum	11000		17700	7614	NO	YES
LL6SS-011-0001-SO	12/03/03	0-1 ft.	Arsenic	13		15.4	0.39	NO	YES
LL6SS-011-0001-SO	12/03/03	0-1 ft.	Copper	19		17.7	313	YES	NO
LL6SS-011-0001-SO	12/03/03	0-1 ft.	Iron	21000		23100	2346	NO	YES
LL6SS-011-0001-SO	12/03/03	0-1 ft.	Lead	29		26.1	400	YES	NO
LL6SS-011-0001-SO	12/03/03	0-1 ft.	Manganese	400		1450	176	NO	YES
LL6SS-011-0001-SO	12/03/03	0-1 ft.	Mercury	0.082		0.04	2.3	YES	NO
LL6SS-011-0001-SO	12/03/03	0-1 ft.	Potassium	990		927	--[n]	YES	NO
LL6SS-011-0001-SO	12/03/03	0-1 ft.	Vanadium	20		31.1	7.8	NO	YES
LL6SS-012-0001-SO	11/25/03	0-1 ft.	Aluminum	14000		17700	7614	NO	YES
LL6SS-012-0001-SO	11/25/03	0-1 ft.	Arsenic	11		15.4	0.39	NO	YES
LL6SS-012-0001-SO	11/25/03	0-1 ft.	Chromium	18		17.4	30	YES	NO
LL6SS-012-0001-SO	11/25/03	0-1 ft.	Iron	24000		23100	2346	YES	YES
LL6SS-012-0001-SO	11/25/03	0-1 ft.	Magnesium	3100		3030	--[n]	YES	NO
LL6SS-012-0001-SO	11/25/03	0-1 ft.	Manganese	520		1450	176	NO	YES
LL6SS-012-0001-SO	11/25/03	0-1 ft.	Mercury	0.041		0.04	2.3	YES	NO
LL6SS-012-0001-SO	11/25/03	0-1 ft.	Potassium	1400		927	--[n]	YES	NO
LL6SS-012-0001-SO	11/25/03	0-1 ft.	Sodium	1400		123	--[n]	YES	NO

Table 4−3
Summary of Surface Soil Exceedances (0-1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Surface Soil Background Criteria (mg/kg)	Surface Soil Region 9 Criteria (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SS-012-0001-SO	11/25/03	0-1 ft.	Vanadium	24		31.1	7.8	NO	YES
LL6SS-013-0001-SO	11/21/03	0-1 ft.	Aluminum	13000		17700	7614	NO	YES
LL6SS-013-0001-SO	11/21/03	0-1 ft.	Arsenic	12		15.4	0.39	NO	YES
LL6SS-013-0001-SO	11/21/03	0-1 ft.	Cadmium	0.11	B	0	3.7	YES	NO
LL6SS-013-0001-SO	11/21/03	0-1 ft.	Iron	22000		23100	2346	NO	YES
LL6SS-013-0001-SO	11/21/03	0-1 ft.	Lead	40		26.1	400	YES	NO
LL6SS-013-0001-SO	11/21/03	0-1 ft.	Manganese	280		1450	176	NO	YES
LL6SS-013-0001-SO	11/21/03	0-1 ft.	Mercury	0.043		0.04	2.3	YES	NO
LL6SS-013-0001-SO	11/21/03	0-1 ft.	Potassium	940		927	--[n]	YES	NO
LL6SS-013-0001-SO	11/21/03	0-1 ft.	Vanadium	23		31.1	7.8	NO	YES
LL6SS-013-0001-SO	11/21/03	0-1 ft.	Zinc	63		61.8	2346	YES	NO
LL6SS-014-0001-SO	11/25/03	0-1 ft.	Arsenic	12		15.4	0.39	NO	YES
LL6SS-014-0001-SO	11/25/03	0-1 ft.	Copper	24		17.7	313	YES	NO
LL6SS-014-0001-SO	11/25/03	0-1 ft.	Iron	18000		23100	2346	NO	YES
LL6SS-014-0001-SO	11/25/03	0-1 ft.	Manganese	370		1450	176	NO	YES
LL6SS-014-0001-SO	11/25/03	0-1 ft.	Sodium	960		123	--[n]	YES	NO
LL6SS-014-0001-SO	11/25/03	0-1 ft.	Vanadium	12		31.1	7.8	NO	YES
LL6SS-014-0001-SO	11/25/03	0-1 ft.	Zinc	81		61.8	2346	YES	NO
LL6SS-015-0001-SO	11/25/03	0-1 ft.	Aluminum	10000		17700	7614	NO	YES
LL6SS-015-0001-SO	11/25/03	0-1 ft.	Arsenic	14		15.4	0.39	NO	YES
LL6SS-015-0001-SO	11/25/03	0-1 ft.	Chromium	20		17.4	30	YES	NO
LL6SS-015-0001-SO	11/25/03	0-1 ft.	Copper	35		17.7	313	YES	NO
LL6SS-015-0001-SO	11/25/03	0-1 ft.	Iron	24000		23100	2346	YES	YES
LL6SS-015-0001-SO	11/25/03	0-1 ft.	Lead	44		26.1	400	YES	NO
LL6SS-015-0001-SO	11/25/03	0-1 ft.	Magnesium	4100		3030	--[n]	YES	NO
LL6SS-015-0001-SO	11/25/03	0-1 ft.	Manganese	390		1450	176	NO	YES
LL6SS-015-0001-SO	11/25/03	0-1 ft.	Nickel	24		21.1	156	YES	NO
LL6SS-015-0001-SO	11/25/03	0-1 ft.	Potassium	1500		927	--[n]	YES	NO
LL6SS-015-0001-SO	11/25/03	0-1 ft.	Sodium	1400		123	--[n]	YES	NO
LL6SS-015-0001-SO	11/25/03	0-1 ft.	Vanadium	17		31.1	7.8	NO	YES
LL6SS-015-0001-SO	11/25/03	0-1 ft.	Zinc	93		61.8	2346	YES	NO
LL6SS-016-0001-SO	11/21/03	0-1 ft.	Aluminum	14000		17700	7614	NO	YES
LL6SS-016-0001-SO	11/21/03	0-1 ft.	Arsenic	12		15.4	0.39	NO	YES
LL6SS-016-0001-SO	11/21/03	0-1 ft.	Cadmium	0.25		0	3.7	YES	NO
LL6SS-016-0001-SO	11/21/03	0-1 ft.	Chromium	19		17.4	30	YES	NO
LL6SS-016-0001-SO	11/21/03	0-1 ft.	Cobalt	11		10.4	30	YES	NO
LL6SS-016-0001-SO	11/21/03	0-1 ft.	Copper	21		17.7	313	YES	NO
LL6SS-016-0001-SO	11/21/03	0-1 ft.	Iron	26000		23100	2346	YES	YES
LL6SS-016-0001-SO	11/21/03	0-1 ft.	Lead	48		26.1	400	YES	NO
LL6SS-016-0001-SO	11/21/03	0-1 ft.	Magnesium	3900		3030	--[n]	YES	NO

Table 4−3
Summary of Surface Soil Exceedances (0-1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Surface Soil Background Criteria (mg/kg)	Surface Soil Region 9 Criteria (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SS-016-0001-SO	11/21/03	0-1 ft.	Manganese	330		1450	176	NO	YES
LL6SS-016-0001-SO	11/21/03	0-1 ft.	Mercury	0.1		0.04	2.3	YES	NO
LL6SS-016-0001-SO	11/21/03	0-1 ft.	Nickel	23		21.1	156	YES	NO
LL6SS-016-0001-SO	11/21/03	0-1 ft.	Potassium	1400		927	--[n]	YES	NO
LL6SS-016-0001-SO	11/21/03	0-1 ft.	Vanadium	23		31.1	7.8	NO	YES
LL6SS-016-0001-SO	11/21/03	0-1 ft.	Zinc	78		61.8	2346	YES	NO
LL6SS-017-0001-SO	11/19/03	0-1 ft.	Aluminum	12000		17700	7614	NO	YES
LL6SS-017-0001-SO	11/19/03	0-1 ft.	Arsenic	11		15.4	0.39	NO	YES
LL6SS-017-0001-SO	11/19/03	0-1 ft.	Beryllium	1.2		0.88	15	YES	NO
LL6SS-017-0001-SO	11/19/03	0-1 ft.	Cadmium	0.92		0	3.7	YES	NO
LL6SS-017-0001-SO	11/19/03	0-1 ft.	Calcium	20000		15800	--[n]	YES	NO
LL6SS-017-0001-SO	11/19/03	0-1 ft.	Copper	26		17.7	313	YES	NO
LL6SS-017-0001-SO	11/19/03	0-1 ft.	Iron	19000		23100	2346	NO	YES
LL6SS-017-0001-SO	11/19/03	0-1 ft.	Lead	61		26.1	400	YES	NO
LL6SS-017-0001-SO	11/19/03	0-1 ft.	Magnesium	3600		3030	--[n]	YES	NO
LL6SS-017-0001-SO	11/19/03	0-1 ft.	Manganese	980		1450	176	NO	YES
LL6SS-017-0001-SO	11/19/03	0-1 ft.	Mercury	0.6		0.04	2.3	YES	NO
LL6SS-017-0001-SO	11/19/03	0-1 ft.	Potassium	1300		927	--[n]	YES	NO
LL6SS-017-0001-SO	11/19/03	0-1 ft.	Sodium	160		123	--[n]	YES	NO
LL6SS-017-0001-SO	11/19/03	0-1 ft.	Vanadium	16	H	31.1	7.8	NO	YES
LL6SS-017-0001-SO	11/19/03	0-1 ft.	Zinc	88		61.8	2346	YES	NO
LL6SS-018-0001-SO	12/02/03	0-1 ft.	Aluminum	11000		17700	7614	NO	YES
LL6SS-018-0001-SO	12/02/03	0-1 ft.	Arsenic	10		15.4	0.39	NO	YES
LL6SS-018-0001-SO	12/02/03	0-1 ft.	Iron	22000		23100	2346	NO	YES
LL6SS-018-0001-SO	12/02/03	0-1 ft.	Manganese	530		1450	176	NO	YES
LL6SS-018-0001-SO	12/02/03	0-1 ft.	Potassium	1100		927	--[n]	YES	NO
LL6SS-018-0001-SO	12/02/03	0-1 ft.	Vanadium	21		31.1	7.8	NO	YES
LL6SS-019-0001-SO	11/19/03	0-1 ft.	Aluminum	15000		17700	7614	NO	YES
LL6SS-019-0001-SO	11/19/03	0-1 ft.	Arsenic	12		15.4	0.39	NO	YES
LL6SS-019-0001-SO	11/19/03	0-1 ft.	Chromium	19		17.4	30	YES	NO
LL6SS-019-0001-SO	11/19/03	0-1 ft.	Cobalt	11		10.4	30	YES	NO
LL6SS-019-0001-SO	11/19/03	0-1 ft.	Copper	18		17.7	313	YES	NO
LL6SS-019-0001-SO	11/19/03	0-1 ft.	Iron	26000		23100	2346	YES	YES
LL6SS-019-0001-SO	11/19/03	0-1 ft.	Magnesium	4000		3030	--[n]	YES	NO
LL6SS-019-0001-SO	11/19/03	0-1 ft.	Manganese	370		1450	176	NO	YES
LL6SS-019-0001-SO	11/19/03	0-1 ft.	Nickel	25		21.1	156	YES	NO
LL6SS-019-0001-SO	11/19/03	0-1 ft.	Potassium	1600		927	--[n]	YES	NO
LL6SS-019-0001-SO	11/19/03	0-1 ft.	Vanadium	26	H	31.1	7.8	NO	YES
LL6SS-020-0001-DUP	12/02/03	0-1 ft.	Aluminum	13000		17700	7614	NO	YES
LL6SS-020-0001-DUP	12/02/03	0-1 ft.	Arsenic	14		15.4	0.39	NO	YES

Table 4−3
Summary of Surface Soil Exceedances (0-1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Surface Soil Background Criteria (mg/kg)	Surface Soil Region 9 Criteria (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SS-020-0001-DUP	12/02/03	0-1 ft.	Copper	18		17.7	313	YES	NO
LL6SS-020-0001-DUP	12/02/03	0-1 ft.	Iron	24000		23100	2346	YES	YES
LL6SS-020-0001-DUP	12/02/03	0-1 ft.	Magnesium	3200		3030	--[n]	YES	NO
LL6SS-020-0001-DUP	12/02/03	0-1 ft.	Manganese	270		1450	176	NO	YES
LL6SS-020-0001-DUP	12/02/03	0-1 ft.	Nitrocellulose	1.8	B J	0.00	--	YES	NO
LL6SS-020-0001-DUP	12/02/03	0-1 ft.	Nitroglycerin	ND		0.00	35	YES	YES
LL6SS-020-0001-DUP	12/02/03	0-1 ft.	Nitroguanidine	ND		0.00	611	YES	YES
LL6SS-020-0001-DUP	12/02/03	0-1 ft.	Potassium	1100		927	--[n]	YES	NO
LL6SS-020-0001-DUP	12/02/03	0-1 ft.	Vanadium	21		31.1	7.8	NO	YES
LL6SS-020-0001-SO	12/02/03	0-1 ft.	Aluminum	15000		17700	7614	NO	YES
LL6SS-020-0001-SO	12/02/03	0-1 ft.	Arsenic	12		15.4	0.39	NO	YES
LL6SS-020-0001-SO	12/02/03	0-1 ft.	Iron	22000		23100	2346	NO	YES
LL6SS-020-0001-SO	12/02/03	0-1 ft.	Nitrocellulose	1.1	B J	0.00	--	YES	NO
LL6SS-020-0001-SO	12/02/03	0-1 ft.	Nitroglycerin	ND		0.00	35	YES	YES
LL6SS-020-0001-SO	12/02/03	0-1 ft.	Nitroguanidine	ND		0.00	611	YES	YES
LL6SS-020-0001-SO	12/02/03	0-1 ft.	Potassium	1000		927	--[n]	YES	NO
LL6SS-020-0001-SO	12/02/03	0-1 ft.	Vanadium	21		31.1	7.8	NO	YES
LL6SS-021-0001-SO	11/19/03	0-1 ft.	Aluminum	11000		17700	7614	NO	YES
LL6SS-021-0001-SO	11/19/03	0-1 ft.	Arsenic	8.9		15.4	0.39	NO	YES
LL6SS-021-0001-SO	11/19/03	0-1 ft.	Iron	19000		23100	2346	NO	YES
LL6SS-021-0001-SO	11/19/03	0-1 ft.	Manganese	430		1450	176	NO	YES
LL6SS-021-0001-SO	11/19/03	0-1 ft.	Mercury	0.14		0.04	2.3	YES	NO
LL6SS-021-0001-SO	11/19/03	0-1 ft.	Potassium	1100		927	--[n]	YES	NO
LL6SS-021-0001-SO	11/19/03	0-1 ft.	Vanadium	19	H	31.1	7.8	NO	YES
LL6SS-022-0001-SO	11/14/03	0-1 ft.	Arsenic	12		15.4	0.39	NO	YES
LL6SS-022-0001-SO	11/14/03	0-1 ft.	Cadmium	1.5		0	3.7	YES	NO
LL6SS-022-0001-SO	11/14/03	0-1 ft.	Calcium	80000		15800	--[n]	YES	NO
LL6SS-022-0001-SO	11/14/03	0-1 ft.	Copper	30		17.7	313	YES	NO
LL6SS-022-0001-SO	11/14/03	0-1 ft.	Iron	19000	H	23100	2346	NO	YES
LL6SS-022-0001-SO	11/14/03	0-1 ft.	Lead	90		26.1	400	YES	NO
LL6SS-022-0001-SO	11/14/03	0-1 ft.	Manganese	440		1450	176	NO	YES
LL6SS-022-0001-SO	11/14/03	0-1 ft.	Potassium	1400		927	--[n]	YES	NO
LL6SS-022-0001-SO	11/14/03	0-1 ft.	Sodium	790		123	--[n]	YES	NO
LL6SS-022-0001-SO	11/14/03	0-1 ft.	Vanadium	12		31.1	7.8	NO	YES
LL6SS-022-0001-SO	11/14/03	0-1 ft.	Zinc	160		61.8	2346	YES	NO
LL6SS-023-0001-SO	11/19/03	0-1 ft.	Aluminum	12000		17700	7614	NO	YES
LL6SS-023-0001-SO	11/19/03	0-1 ft.	Arsenic	8.9		15.4	0.39	NO	YES
LL6SS-023-0001-SO	11/19/03	0-1 ft.	Copper	19		17.7	313	YES	NO
LL6SS-023-0001-SO	11/19/03	0-1 ft.	Iron	24000		23100	2346	YES	YES
LL6SS-023-0001-SO	11/19/03	0-1 ft.	Manganese	420		1450	176	NO	YES

Table 4−3
Summary of Surface Soil Exceedances (0-1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Surface Soil Background Criteria (mg/kg)	Surface Soil Region 9 Criteria (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SS-023-0001-SO	11/19/03	0-1 ft.	Nitrocellulose	2.4	B	0.00	--	YES	NO
LL6SS-023-0001-SO	11/19/03	0-1 ft.	Nitroglycerin	ND		0.00	35	YES	YES
LL6SS-023-0001-SO	11/19/03	0-1 ft.	Nitroguanidine	ND		0.00	611	YES	YES
LL6SS-023-0001-SO	11/19/03	0-1 ft.	Potassium	1300		927	--[n]	YES	NO
LL6SS-023-0001-SO	11/19/03	0-1 ft.	Vanadium	22	H	31.1	7.8	NO	YES
LL6SS-024-0001-SO	11/25/03	0-1 ft.	Aluminum	12000		17700	7614	NO	YES
LL6SS-024-0001-SO	11/25/03	0-1 ft.	Arsenic	11		15.4	0.39	NO	YES
LL6SS-024-0001-SO	11/25/03	0-1 ft.	Copper	21		17.7	313	YES	NO
LL6SS-024-0001-SO	11/25/03	0-1 ft.	Iron	22000		23100	2346	NO	YES
LL6SS-024-0001-SO	11/25/03	0-1 ft.	Manganese	310		1450	176	NO	YES
LL6SS-024-0001-SO	11/25/03	0-1 ft.	Potassium	1100		927	--[n]	YES	NO
LL6SS-024-0001-SO	11/25/03	0-1 ft.	Sodium	1100		123	--[n]	YES	NO
LL6SS-024-0001-SO	11/25/03	0-1 ft.	Vanadium	20		31.1	7.8	NO	YES
LL6SS-025-0001-SO	11/14/03	0-1 ft.	Aluminum	14000		17700	7614	NO	YES
LL6SS-025-0001-SO	11/14/03	0-1 ft.	Arsenic	9.7		15.4	0.39	NO	YES
LL6SS-025-0001-SO	11/14/03	0-1 ft.	Iron	20000	H	23100	2346	NO	YES
LL6SS-025-0001-SO	11/14/03	0-1 ft.	Manganese	540		1450	176	NO	YES
LL6SS-025-0001-SO	11/14/03	0-1 ft.	Potassium	1100		927	--[n]	YES	NO
LL6SS-025-0001-SO	11/14/03	0-1 ft.	Sodium	1300		123	--[n]	YES	NO
LL6SS-025-0001-SO	11/14/03	0-1 ft.	Vanadium	23		31.1	7.8	NO	YES
LL6SS-026-0001-SO	11/20/03	0-1 ft.	Aluminum	10000		17700	7614	NO	YES
LL6SS-026-0001-SO	11/20/03	0-1 ft.	Arsenic	13		15.4	0.39	NO	YES
LL6SS-026-0001-SO	11/20/03	0-1 ft.	Iron	23000		23100	2346	NO	YES
LL6SS-026-0001-SO	11/20/03	0-1 ft.	Manganese	510		1450	176	NO	YES
LL6SS-026-0001-SO	11/20/03	0-1 ft.	Vanadium	25	H	31.1	7.8	NO	YES
LL6SS-027-0001-SO	11/20/03	0-1 ft.	Aluminum	17000		17700	7614	NO	YES
LL6SS-027-0001-SO	11/20/03	0-1 ft.	Arsenic	11		15.4	0.39	NO	YES
LL6SS-027-0001-SO	11/20/03	0-1 ft.	Barium	95		88.4	538	YES	NO
LL6SS-027-0001-SO	11/20/03	0-1 ft.	Beryllium	0.96		0.88	15	YES	NO
LL6SS-027-0001-SO	11/20/03	0-1 ft.	Chromium	23		17.4	30	YES	NO
LL6SS-027-0001-SO	11/20/03	0-1 ft.	Cobalt	12		10.4	30	YES	NO
LL6SS-027-0001-SO	11/20/03	0-1 ft.	Copper	22		17.7	313	YES	NO
LL6SS-027-0001-SO	11/20/03	0-1 ft.	Iron	31000		23100	2346	YES	YES
LL6SS-027-0001-SO	11/20/03	0-1 ft.	Magnesium	4100		3030	--[n]	YES	NO
LL6SS-027-0001-SO	11/20/03	0-1 ft.	Manganese	460		1450	176	NO	YES
LL6SS-027-0001-SO	11/20/03	0-1 ft.	Nickel	27		21.1	156	YES	NO
LL6SS-027-0001-SO	11/20/03	0-1 ft.	Potassium	1700		927	--[n]	YES	NO
LL6SS-027-0001-SO	11/20/03	0-1 ft.	Vanadium	30	H	31.1	7.8	NO	YES
LL6SS-027-0001-SO	11/20/03	0-1 ft.	Zinc	66		61.8	2346	YES	NO
LL6SS-028-0001-SO	11/18/03	0-1 ft.	Aluminum	11000		17700	7614	NO	YES

Table 4−3
Summary of Surface Soil Exceedances (0-1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Surface Soil Background Criteria (mg/kg)	Surface Soil Region 9 Criteria (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SS-028-0001-SO	11/18/03	0-1 ft.	Arsenic	13		15.4	0.39	NO	YES
LL6SS-028-0001-SO	11/18/03	0-1 ft.	Iron	21000	H	23100	2346	NO	YES
LL6SS-028-0001-SO	11/18/03	0-1 ft.	Manganese	700		1450	176	NO	YES
LL6SS-028-0001-SO	11/18/03	0-1 ft.	Vanadium	23		31.1	7.8	NO	YES
LL6SS-029-0001-DUP	11/25/03	0-1 ft.	Aluminum	15000		17700	7614	NO	YES
LL6SS-029-0001-DUP	11/25/03	0-1 ft.	Arsenic	17		15.4	0.39	YES	YES
LL6SS-029-0001-DUP	11/25/03	0-1 ft.	Chromium	21		17.4	30	YES	NO
LL6SS-029-0001-DUP	11/25/03	0-1 ft.	Copper	18		17.7	313	YES	NO
LL6SS-029-0001-DUP	11/25/03	0-1 ft.	Iron	27000		23100	2346	YES	YES
LL6SS-029-0001-DUP	11/25/03	0-1 ft.	Manganese	200		1450	176	NO	YES
LL6SS-029-0001-DUP	11/25/03	0-1 ft.	Potassium	1400		927	--[n]	YES	NO
LL6SS-029-0001-DUP	11/25/03	0-1 ft.	Sodium	1100		123	--[n]	YES	NO
LL6SS-029-0001-DUP	11/25/03	0-1 ft.	Vanadium	26		31.1	7.8	NO	YES
LL6SS-029-0001-SO	11/25/03	0-1 ft.	Aluminum	18000		17700	7614	YES	YES
LL6SS-029-0001-SO	11/25/03	0-1 ft.	Arsenic	9.9		15.4	0.39	NO	YES
LL6SS-029-0001-SO	11/25/03	0-1 ft.	Chromium	25		17.4	30	YES	NO
LL6SS-029-0001-SO	11/25/03	0-1 ft.	Copper	23		17.7	313	YES	NO
LL6SS-029-0001-SO	11/25/03	0-1 ft.	Iron	35000		23100	2346	YES	YES
LL6SS-029-0001-SO	11/25/03	0-1 ft.	Magnesium	3900		3030	--[n]	YES	NO
LL6SS-029-0001-SO	11/25/03	0-1 ft.	Nickel	27		21.1	156	YES	NO
LL6SS-029-0001-SO	11/25/03	0-1 ft.	Potassium	1700		927	--[n]	YES	NO
LL6SS-029-0001-SO	11/25/03	0-1 ft.	Sodium	1200		123	--[n]	YES	NO
LL6SS-029-0001-SO	11/25/03	0-1 ft.	Vanadium	28		31.1	7.8	NO	YES
LL6SS-029-0001-SO	11/25/03	0-1 ft.	Zinc	78		61.8	2346	YES	NO
LL6SS-030-0001-SO	11/18/03	0-1 ft.	Aluminum	14000		17700	7614	NO	YES
LL6SS-030-0001-SO	11/18/03	0-1 ft.	Arsenic	12		15.4	0.39	NO	YES
LL6SS-030-0001-SO	11/18/03	0-1 ft.	Beryllium	0.94		0.88	15	YES	NO
LL6SS-030-0001-SO	11/18/03	0-1 ft.	Chromium	18		17.4	30	YES	NO
LL6SS-030-0001-SO	11/18/03	0-1 ft.	Iron	31000	H	23100	2346	YES	YES
LL6SS-030-0001-SO	11/18/03	0-1 ft.	Manganese	940		1450	176	NO	YES
LL6SS-030-0001-SO	11/18/03	0-1 ft.	Potassium	1100		927	--[n]	YES	NO
LL6SS-030-0001-SO	11/18/03	0-1 ft.	Selenium	1.7		1.4	39	YES	NO
LL6SS-030-0001-SO	11/18/03	0-1 ft.	Vanadium	27		31.1	7.8	NO	YES
LL6SS-031-0001-SO	11/13/03	0-1 ft.	Arsenic	2.2		15.4	0.39	NO	YES
LL6SS-031-0001-SO	11/13/03	0-1 ft.	Barium	110		88.4	538	YES	NO
LL6SS-031-0001-SO	11/13/03	0-1 ft.	Cadmium	0.17	B	0	3.7	YES	NO
LL6SS-031-0001-SO	11/13/03	0-1 ft.	Calcium	57000		15800	--[n]	YES	NO
LL6SS-031-0001-SO	11/13/03	0-1 ft.	Iron	10000	H	23100	2346	NO	YES
LL6SS-031-0001-SO	11/13/03	0-1 ft.	Manganese	820		1450	176	NO	YES
LL6SS-032-0001-DUP	11/13/03	0-1 ft.	Aluminum	15000		17700	7614	NO	YES

Table 4−3
Summary of Surface Soil Exceedances (0-1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Surface Soil Background Criteria (mg/kg)	Surface Soil Region 9 Criteria (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SS-032-0001-DUP	11/13/03	0-1 ft.	Arsenic	11		15.4	0.39	NO	YES
LL6SS-032-0001-DUP	11/13/03	0-1 ft.	Barium	100		88.4	538	YES	NO
LL6SS-032-0001-DUP	11/13/03	0-1 ft.	Beryllium	2.1		0.88	15	YES	NO
LL6SS-032-0001-DUP	11/13/03	0-1 ft.	Calcium	53000		15800	--[n]	YES	NO
LL6SS-032-0001-DUP	11/13/03	0-1 ft.	Iron	11000	H	23100	2346	NO	YES
LL6SS-032-0001-DUP	11/13/03	0-1 ft.	Magnesium	8300		3030	--[n]	YES	NO
LL6SS-032-0001-DUP	11/13/03	0-1 ft.	Manganese	810		1450	176	NO	YES
LL6SS-032-0001-DUP	11/13/03	0-1 ft.	Potassium	1200		927	--[n]	YES	NO
LL6SS-032-0001-DUP	11/13/03	0-1 ft.	Selenium	1.5		1.4	39	YES	NO
LL6SS-032-0001-DUP	11/13/03	0-1 ft.	Sodium	310		123	--[n]	YES	NO
LL6SS-032-0001-DUP	11/13/03	0-1 ft.	Vanadium	11		31.1	7.8	NO	YES
LL6SS-032-0001-SO	11/13/03	0-1 ft.	Aluminum	18000		17700	7614	YES	YES
LL6SS-032-0001-SO	11/13/03	0-1 ft.	Arsenic	9.3		15.4	0.39	NO	YES
LL6SS-032-0001-SO	11/13/03	0-1 ft.	Barium	180		88.4	538	YES	NO
LL6SS-032-0001-SO	11/13/03	0-1 ft.	Beryllium	2.1		0.88	15	YES	NO
LL6SS-032-0001-SO	11/13/03	0-1 ft.	Calcium	51000		15800	--[n]	YES	NO
LL6SS-032-0001-SO	11/13/03	0-1 ft.	Iron	12000	H	23100	2346	NO	YES
LL6SS-032-0001-SO	11/13/03	0-1 ft.	Magnesium	8800		3030	--[n]	YES	NO
LL6SS-032-0001-SO	11/13/03	0-1 ft.	Manganese	1800		1450	176	YES	YES
LL6SS-032-0001-SO	11/13/03	0-1 ft.	Potassium	1500		927	--[n]	YES	NO
LL6SS-032-0001-SO	11/13/03	0-1 ft.	Selenium	1.7		1.4	39	YES	NO
LL6SS-032-0001-SO	11/13/03	0-1 ft.	Sodium	390		123	--[n]	YES	NO
LL6SS-032-0001-SO	11/13/03	0-1 ft.	Vanadium	12		31.1	7.8	NO	YES
LL6SS-033-0001-SO	11/18/03	0-1 ft.	Aluminum	17000		17700	7614	NO	YES
LL6SS-033-0001-SO	11/18/03	0-1 ft.	Arsenic	11		15.4	0.39	NO	YES
LL6SS-033-0001-SO	11/18/03	0-1 ft.	Barium	110		88.4	538	YES	NO
LL6SS-033-0001-SO	11/18/03	0-1 ft.	Beryllium	1		0.88	15	YES	NO
LL6SS-033-0001-SO	11/18/03	0-1 ft.	Calcium	21000		15800	--[n]	YES	NO
LL6SS-033-0001-SO	11/18/03	0-1 ft.	Chromium	23		17.4	30	YES	NO
LL6SS-033-0001-SO	11/18/03	0-1 ft.	Cobalt	13		10.4	30	YES	NO
LL6SS-033-0001-SO	11/18/03	0-1 ft.	Copper	22		17.7	313	YES	NO
LL6SS-033-0001-SO	11/18/03	0-1 ft.	Iron	28000	H	23100	2346	YES	YES
LL6SS-033-0001-SO	11/18/03	0-1 ft.	Magnesium	7600		3030	--[n]	YES	NO
LL6SS-033-0001-SO	11/18/03	0-1 ft.	Manganese	380		1450	176	NO	YES
LL6SS-033-0001-SO	11/18/03	0-1 ft.	Nickel	32		21.1	156	YES	NO
LL6SS-033-0001-SO	11/18/03	0-1 ft.	Potassium	2800		927	--[n]	YES	NO
LL6SS-033-0001-SO	11/18/03	0-1 ft.	Selenium	1.7		1.4	39	YES	NO
LL6SS-033-0001-SO	11/18/03	0-1 ft.	Sodium	130		123	--[n]	YES	NO
LL6SS-033-0001-SO	11/18/03	0-1 ft.	Vanadium	27		31.1	7.8	NO	YES
LL6SS-034-0001-SO	11/14/03	0-1 ft.	Aluminum	10000		17700	7614	NO	YES

Table 4−3
Summary of Surface Soil Exceedances (0-1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Surface Soil Background Criteria (mg/kg)	Surface Soil Region 9 Criteria (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SS-034-0001-SO	11/14/03	0-1 ft.	Arsenic	8.5		15.4	0.39	NO	YES
LL6SS-034-0001-SO	11/14/03	0-1 ft.	Cadmium	0.56		0	3.7	YES	NO
LL6SS-034-0001-SO	11/14/03	0-1 ft.	Copper	25		17.7	313	YES	NO
LL6SS-034-0001-SO	11/14/03	0-1 ft.	Iron	24000	H	23100	2346	YES	YES
LL6SS-034-0001-SO	11/14/03	0-1 ft.	Lead	180		26.1	400	YES	NO
LL6SS-034-0001-SO	11/14/03	0-1 ft.	Manganese	520		1450	176	NO	YES
LL6SS-034-0001-SO	11/14/03	0-1 ft.	Nitrocellulose	3.1		0.00	--	YES	NO
LL6SS-034-0001-SO	11/14/03	0-1 ft.	Nitroglycerin	ND		0.00	35	YES	YES
LL6SS-034-0001-SO	11/14/03	0-1 ft.	Nitroguanidine	ND		0.00	611	YES	YES
LL6SS-034-0001-SO	11/14/03	0-1 ft.	Potassium	1100		927	--[n]	YES	NO
LL6SS-034-0001-SO	11/14/03	0-1 ft.	Sodium	1100		123	--[n]	YES	NO
LL6SS-034-0001-SO	11/14/03	0-1 ft.	Vanadium	18		31.1	7.8	NO	YES
LL6SS-034-0001-SO	11/14/03	0-1 ft.	Zinc	96		61.8	2346	YES	NO
LL6SS-035-0001-SO	11/13/03	0-1 ft.	Aluminum	12000		17700	7614	NO	YES
LL6SS-035-0001-SO	11/13/03	0-1 ft.	Arsenic	9.3		15.4	0.39	NO	YES
LL6SS-035-0001-SO	11/13/03	0-1 ft.	Iron	22000	H	23100	2346	NO	YES
LL6SS-035-0001-SO	11/13/03	0-1 ft.	Magnesium	3500		3030	--[n]	YES	NO
LL6SS-035-0001-SO	11/13/03	0-1 ft.	Manganese	320		1450	176	NO	YES
LL6SS-035-0001-SO	11/13/03	0-1 ft.	Nitrocellulose	0.72	B	0.00	--	YES	NO
LL6SS-035-0001-SO	11/13/03	0-1 ft.	Nitroglycerin	ND		0.00	35	YES	YES
LL6SS-035-0001-SO	11/13/03	0-1 ft.	Nitroguanidine	ND		0.00	611	YES	YES
LL6SS-035-0001-SO	11/13/03	0-1 ft.	Potassium	1500		927	--[n]	YES	NO
LL6SS-035-0001-SO	11/13/03	0-1 ft.	Vanadium	20		31.1	7.8	NO	YES
LL6SS-036-0001-SO	11/13/03	0-1 ft.	Aluminum	14000		17700	7614	NO	YES
LL6SS-036-0001-SO	11/13/03	0-1 ft.	Arsenic	10		15.4	0.39	NO	YES
LL6SS-036-0001-SO	11/13/03	0-1 ft.	Chromium	18		17.4	30	YES	NO
LL6SS-036-0001-SO	11/13/03	0-1 ft.	Iron	23000	H	23100	2346	NO	YES
LL6SS-036-0001-SO	11/13/03	0-1 ft.	Manganese	580		1450	176	NO	YES
LL6SS-036-0001-SO	11/13/03	0-1 ft.	Potassium	1300		927	--[n]	YES	NO
LL6SS-036-0001-SO	11/13/03	0-1 ft.	Selenium	1.5		1.4	39	YES	NO
LL6SS-036-0001-SO	11/13/03	0-1 ft.	Vanadium	24		31.1	7.8	NO	YES
LL6SS-037-0001-SO	11/13/03	0-1 ft.	Aluminum	11000		17700	7614	NO	YES
LL6SS-037-0001-SO	11/13/03	0-1 ft.	Arsenic	6.2		15.4	0.39	NO	YES
LL6SS-037-0001-SO	11/13/03	0-1 ft.	Iron	16000	H	23100	2346	NO	YES
LL6SS-037-0001-SO	11/13/03	0-1 ft.	Manganese	870		1450	176	NO	YES
LL6SS-037-0001-SO	11/13/03	0-1 ft.	Vanadium	19		31.1	7.8	NO	YES
LL6SS-038-0001-SO	11/05/03	0-1 ft.	Aluminum	13000		17700	7614	NO	YES
LL6SS-038-0001-SO	11/05/03	0-1 ft.	Arsenic	10		15.4	0.39	NO	YES
LL6SS-038-0001-SO	11/05/03	0-1 ft.	Calcium	16000		15800	--[n]	YES	NO
LL6SS-038-0001-SO	11/05/03	0-1 ft.	Iron	23000		23100	2346	NO	YES

Table 4−3
Summary of Surface Soil Exceedances (0-1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Surface Soil Background Criteria (mg/kg)	Surface Soil Region 9 Criteria (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SS-038-0001-SO	11/05/03	0-1 ft.	Magnesium	4700		3030	--[n]	YES	NO
LL6SS-038-0001-SO	11/05/03	0-1 ft.	Manganese	320		1450	176	NO	YES
LL6SS-038-0001-SO	11/05/03	0-1 ft.	Potassium	1900		927	--[n]	YES	NO
LL6SS-038-0001-SO	11/05/03	0-1 ft.	Sodium	1400		123	--[n]	YES	NO
LL6SS-038-0001-SO	11/05/03	0-1 ft.	Vanadium	21		31.1	7.8	NO	YES
LL6SS-039-0001-SO	11/05/03	0-1 ft.	Aluminum	17000		17700	7614	NO	YES
LL6SS-039-0001-SO	11/05/03	0-1 ft.	Arsenic	13		15.4	0.39	NO	YES
LL6SS-039-0001-SO	11/05/03	0-1 ft.	Chromium	22		17.4	30	YES	NO
LL6SS-039-0001-SO	11/05/03	0-1 ft.	Iron	31000		23100	2346	YES	YES
LL6SS-039-0001-SO	11/05/03	0-1 ft.	Magnesium	3400		3030	--[n]	YES	NO
LL6SS-039-0001-SO	11/05/03	0-1 ft.	Manganese	340		1450	176	NO	YES
LL6SS-039-0001-SO	11/05/03	0-1 ft.	Potassium	1800		927	--[n]	YES	NO
LL6SS-039-0001-SO	11/05/03	0-1 ft.	Sodium	1300		123	--[n]	YES	NO
LL6SS-039-0001-SO	11/05/03	0-1 ft.	Vanadium	29		31.1	7.8	NO	YES
LL6SS-040-0001-DUP	11/05/03	0-1 ft.	Aluminum	13000		17700	7614	NO	YES
LL6SS-040-0001-DUP	11/05/03	0-1 ft.	Arsenic	11		15.4	0.39	NO	YES
LL6SS-040-0001-DUP	11/05/03	0-1 ft.	Iron	23000		23100	2346	NO	YES
LL6SS-040-0001-DUP	11/05/03	0-1 ft.	Magnesium	3600		3030	--[n]	YES	NO
LL6SS-040-0001-DUP	11/05/03	0-1 ft.	Manganese	340		1450	176	NO	YES
LL6SS-040-0001-DUP	11/05/03	0-1 ft.	Potassium	1500		927	--[n]	YES	NO
LL6SS-040-0001-DUP	11/05/03	0-1 ft.	Sodium	1300		123	--[n]	YES	NO
LL6SS-040-0001-DUP	11/05/03	0-1 ft.	Vanadium	22		31.1	7.8	NO	YES
LL6SS-040-0001-SO	11/05/03	0-1 ft.	Aluminum	14000		17700	7614	NO	YES
LL6SS-040-0001-SO	11/05/03	0-1 ft.	Arsenic	10		15.4	0.39	NO	YES
LL6SS-040-0001-SO	11/05/03	0-1 ft.	Copper	20		17.7	313	YES	NO
LL6SS-040-0001-SO	11/05/03	0-1 ft.	Iron	23000		23100	2346	NO	YES
LL6SS-040-0001-SO	11/05/03	0-1 ft.	Magnesium	3500		3030	--[n]	YES	NO
LL6SS-040-0001-SO	11/05/03	0-1 ft.	Manganese	370		1450	176	NO	YES
LL6SS-040-0001-SO	11/05/03	0-1 ft.	Potassium	1600		927	--[n]	YES	NO
LL6SS-040-0001-SO	11/05/03	0-1 ft.	Sodium	1400		123	--[n]	YES	NO
LL6SS-040-0001-SO	11/05/03	0-1 ft.	Vanadium	23		31.1	7.8	NO	YES
LL6SS-056-0001-SO	11/18/03	0-1 ft.	Aluminum	11000		17700	7614	NO	YES
LL6SS-056-0001-SO	11/18/03	0-1 ft.	Arsenic	13		15.4	0.39	NO	YES
LL6SS-056-0001-SO	11/18/03	0-1 ft.	Iron	21000	H	23100	2346	NO	YES
LL6SS-056-0001-SO	11/18/03	0-1 ft.	Manganese	310		1450	176	NO	YES
LL6SS-056-0001-SO	11/18/03	0-1 ft.	Potassium	1200		927	--[n]	YES	NO
LL6SS-056-0001-SO	11/18/03	0-1 ft.	Selenium	1.6		1.4	39	YES	NO
LL6SS-056-0001-SO	11/18/03	0-1 ft.	Vanadium	18		31.1	7.8	NO	YES
W-13S	3/15/2002	0-1ft	Arsenic	3.8		15.4	0.39	NO	YES
W-13S	3/15/2002	0-1ft	Barium	89.9		88.4	538.00	YES	NO

Table 4−3
Summary of Surface Soil Exceedances (0-1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Surface Soil Background Criteria (mg/kg)	Surface Soil Region 9 Criteria (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
W-13S	3/15/2002	0-1ft	Cadmium	5.9		0.0	3.70	YES	YES
W-13S	3/15/2002	0-1ft	Calcium	116000	H	15800	--	YES	NO
W-13S	3/15/2002	0-1ft	Copper	145		17.7	313.00	YES	NO
W-13S	3/15/2002	0-1ft	Iron	13900	H	23100	2346.00	NO	YES
W-13S	3/15/2002	0-1ft	Lead	40.4		26.1	400.00	YES	NO
W-13S	3/15/2002	0-1ft	Manganese	558		1450	176.00	NO	YES
W-13S	3/15/2002	0-1ft	Mercury	0.063		0.04	2.30	YES	NO
W-13S	3/15/2002	0-1ft	Sodium	152		123	--	YES	NO
W-13S	3/15/2002	0-1ft	Zinc	180		61.8	2346.00	YES	NO
W-14S	3/15/2002	0-1ft	HMX	0.17	J	0.0	306.00	YES	NO

Notes:
-- - no background/PRG value is available for this analyte
blank cell indicates that the analyte was a non-detect (with a "U" qualifier) or analysis was not performed
PRG - preliminary remediation goals; the PRG for lead is the Maximum Contaminant Level (MCL)
nc - non-cancer basis
ca - cancer basis
pbk - based on PBK modeling
mcl - based on CWA maximum contaminant level
max - ceiling limit
sat - soil saturation
[n] - nutrient
UC - unconsolidated

Inorganic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is less than the RL, but greater than or equal to the MDL
B - result is less than the CRDL/RL, but greater than or equal to the IDL/MDL

InOrganic Flags
^ - instrument related QC exceed the upper or lower control limits
* - batch QC exceeds the upper or lower control limit
H - batch QC is greater than RL

Organic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is an estimated value below the RL

Organic Flags
B - Method Blank: batch QC is greater than RL
* - batch QC exceeds the upper or lower control limit
^ - batch QC is greater than RL
H - alternate peak selection upon analytical review

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-001-0001-SO	LL6SB-002-0001-SO	LL6SB-003-0001-SO	LL6SB-004-0001-SO	LL6SB-005-0001-SO	LL6SB-006-0001-DUP	LL6SB-006-0001-SO	LL6SB-007-0001-SO	LL6SB-008-0001-SO
					Sample Date		12/03/03	12/03/03	12/03/03	11/25/03	11/19/03	11/21/03	11/21/03	11/14/03	11/14/03
					Sample Depth		1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units									
Cyanide 9012A	9014/9010B	Cyanide, Total	122	nc	0.00	mg/Kg			0.21 U			0.12 U	0.13 U		
Explosives 8330	8330	1,3,5-Trinitrobenzene	183	nc	0.00	mg/Kg			0.017 U			0.017 U	0.017 U		
		1,3-Dinitrobenzene	0.61	nc	0.00	mg/Kg			0.018 U			0.018 U	0.018 U		
		2,4,6-TNT	16	ca	0.00	mg/Kg			0.034 U			0.033 U	0.034 U		
		2,4-Dinitrotoluene	12	nc	0.00	mg/Kg			0.035 U			0.035 U	0.035 U		
		2,6-Dinitrotoluene	6.1	nc	0.00	mg/Kg			0.047 U			0.047 U	0.047 U		
		2-Nitrotoluene	0.88	ca	0.00	mg/Kg			0.033 U			0.033 U	0.033 U		
		3-Nitrotoluene	73	nc	0.00	mg/Kg			0.05 U			0.049 U	0.05 U		
		4-Nitrotoluene	12	ca	0.00	mg/Kg			0.046 U			0.046 U	0.046 U		
		HMX	306	nc	0.00	mg/Kg			0.11 U			0.11 Ua	0.11 U		
		Nitrobenzene	2	nc	0.00	mg/Kg			0.022 U			0.022 U	0.022 U		
		RDX	4.4	ca	0.00	mg/Kg			0.058 U			0.058 U	0.058 U		
		Tetryl	61	nc	0.00	mg/Kg			0.043 U			0.043 U	0.043 U		
Others	8015B MDRO	Diesel Range Organics (DRO)	--	--	--	mg/Kg									
	8015B MGRO	Gasoline Range Organics (GRO)	--	--	--	mg/Kg									
	8081A	Toxaphene	0.44	ca	--	mg/Kg			0.0053 U			0.0055 U	0.0056 U		
	8270C	Phenanthrene	--	--	--	mg/Kg			0.0012 U			0.0062 Ja	0.0012 U		
PCB TCL 8082	8082	Aroclor 1016	0.39	nc	--	mg/Kg			0.0022 U			0.0023 U	0.0023 U		
		Aroclor 1221	0.22	ca	--	mg/Kg			0.0023 U			0.0024 U	0.0024 U		
		Aroclor 1232	0.22	ca	--	mg/Kg			0.0023 U			0.0024 U	0.0024 U		
		Aroclor 1242	0.22	ca	--	mg/Kg			0.0023 U			0.0024 U	0.0024 U		
		Aroclor 1248	0.22	ca	--	mg/Kg			0.0023 U			0.0024 U	0.0024 U		
		Aroclor 1254	0.22	ca	--	mg/Kg			0.0023 U			0.0024 U	0.0024 U		
		Aroclor 1260	0.22	ca	--	mg/Kg			0.0016 U			0.0017 U	0.0017 U		
Pesticides 8081A	8081A	4,4'-DDD	2.4	ca	--	mg/Kg			0.00041 U			0.00043 U	0.00044 U		
		4,4'-DDE	1.7	ca	--	mg/Kg			0.00075 U			0.00078 U	0.00079 U		
		4,4'-DDT	1.7	ca	--	mg/Kg			0.00043 U			0.00044 U	0.00045 U		
		Aldrin	0.029	ca	--	mg/Kg			0.00015 U			0.00016 U	0.00016 U		
		alpha-BHC	0.09	sat	--	mg/Kg			0.00018 U			0.00019 U	0.00019 U		
		alpha-Chlordane	1.6	ca	--	mg/Kg			0.00014 U			0.00014 U	0.00015 U		
		beta-BHC	0.32	ca	--	mg/Kg			0.00017 U			0.00018 U	0.00018 U		
		delta-BHC	--	--	--	mg/Kg			0.00013 U			0.00013 U	0.00013 U		
		Dieldrin	0.030	ca	--	mg/Kg			0.00039 U			0.00041 U	0.00041 U		
		Endosulfan I	37	nc	--	mg/Kg			0.00031 U			0.00032 U	0.00033 U		
		Endosulfan II	37	nc	--	mg/Kg			0.00032 U			0.00034 U	0.00034 U		
		Endosulfan sulfate	37	nc	--	mg/Kg			0.00033 U			0.00035 U	0.00035 U		
		Endrin	1.8	nc	--	mg/Kg			0.0005 U			0.00052 U	0.00052 U		
		Endrin aldehyde	--	--	--	mg/Kg			0.00038 U			0.0004 U	0.0004 U		
		Endrin ketone	--	--	--	mg/Kg			0.00033 U			0.00035 U	0.00035 U		
		gamma-BHC (Lindane)	0.44	ca	--	mg/Kg			0.00027 U			0.00028 U	0.00028 U		
		gamma-Chlordane	1.6	ca	--	mg/Kg			0.00017 U			0.00018 U	0.00018 U		
		Heptachlor	0.11	ca	--	mg/Kg			0.00021 U			0.00022 U	0.00022 U		
		Heptachlor epoxide	0.053	ca	--	mg/Kg			0.00016 U			0.00017 U	0.00017 U		

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units	LL6SB-001-0001-SO	LL6SB-002-0001-SO	LL6SB-003-0001-SO	LL6SB-004-0001-SO	LL6SB-005-0001-SO	LL6SB-006-0001-DUP	LL6SB-006-0001-SO	LL6SB-007-0001-SO	LL6SB-008-0001-SO
		Sample Date					12/03/03	12/03/03	12/03/03	11/25/03	11/19/03	11/21/03	11/21/03	11/14/03	11/14/03
		Sample Depth					1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.
		Methoxychlor	31	nc	--	mg/Kg			0.0027 U			0.0028 U	0.0028 U		
Propellants 8330	353.2	Nitrocellulose	--	--	0.00	mg/Kg			1.3 BJ			2.4 U	0.88 B		
	8330	Nitroglycerin	35	--	0.00	mg/Kg			0.5 U			0.5 U	0.5 U		
	UV/HPLC per SOP	Nitroguanidine	611	nc	0.00	mg/Kg			0.25 U			0.25 U	0.25 U		
SVOCs TCL 8270 C	8270C	1,2,4-Trichlorobenzene	6.2	nc	--	mg/Kg			0.069 U			0.071 U	0.071 U		
		1,2-Dichlorobenzene	600	sat	--	mg/Kg			0.092 U			0.095 U	0.095 U		
		1,3-Dichlorobenzene	53	nc	--	mg/Kg			0.092 U			0.095 U	0.095 U		
		1,4-Dichlorobenzene	3.4	ca	--	mg/Kg			0.083 U			0.086 U	0.085 U		
		2,2-oxybis (1-chloropropane)	2.9	ca	--	mg/Kg			0.088 U			0.09 U	0.09 U		
		2,4,5-Trichlorophenol	611	nc	--	mg/Kg			0.044 U			0.046 U*	0.046 U*		
		2,4,6-Trichlorophenol	0.61	nc	--	mg/Kg			0.055 U			0.057 U	0.057 U		
		2,4-Dichlorophenol	18	nc	--	mg/Kg			0.056 U			0.058 U	0.058 U		
		2,4-Dimethylphenol	122	nc	--	mg/Kg			0.07 U			0.072 U	0.072 U		
		2,4-Dinitrophenol	12	nc	--	mg/Kg			0.13 U			0.14 U	0.14 U		
		2-Chloronaphthalene	494	nc	--	mg/Kg			0.056 U			0.058 U	0.058 U		
		2-Chlorophenol	6.3	nc	--	mg/Kg			0.069 U			0.071 U	0.071 U		
		2-Methylnaphthalene	--	--	--	mg/Kg			0.0018 U			0.0018 U	0.0018 U		
		2-Methylphenol (o-cresol)	306	nc	--	mg/Kg			0.0098 U			0.01 U	0.01 U		
		2-Nitroaniline	18.3	nc	--	mg/Kg			0.04 U			0.041 U	0.041 U		
		2-Nitrophenol	--	--	--	mg/Kg			0.074 U			0.076 U	0.076 U		
		3,3-Dichlorobenzidine	1.1	ca	--	mg/Kg			0.021 U			0.022 U	0.022 U		
		3-Nitroaniline	1.8	nc	--	mg/Kg			0.13 U			0.13 U	0.13 U		
		4,6-Dinitro-2-methylphenol	0.61	nc	--	mg/Kg			0.11 U			0.11 U	0.11 U		
		4-Bromophenyl phenyl ether	--	--	--	mg/Kg			0.0036 U			0.0037 U*	0.0037 U*		
		4-Chloro-3-methylphenol	--	--	--	mg/Kg			0.044 U			0.046 U	0.046 U		
		4-Chloroaniline	24	nc	--	mg/Kg			0.12 U			0.12 U	0.12 U		
		4-Chlorophenyl phenyl ether	--	--	--	mg/Kg			0.0042 U			0.0043 U	0.0043 U		
		4-Methylphenol (m/p-cresol)	31	nc	--	mg/Kg			0.0068 U			0.007 U	0.007 U		
		4-Nitroaniline	23	ca	--	mg/Kg			0.046 U			0.047 U	0.047 U		
		4-Nitrophenol	--	--	--	mg/Kg			0.096 U			0.099 U	0.099 U		
		Acenaphthene	368	nc	--	mg/Kg			0.0016 U			0.0017 U	0.0017 U		
		Acenaphthylene	--	--	--	mg/Kg			0.0011 U			0.0011 U	0.0011 U		
		Anthracene	2189	nc	--	mg/Kg			0.001 U			0.001 U	0.001 U		
		Benzo(a)anthracene	0.62	ca	--	mg/Kg			0.0013 U			0.012 Ja*	0.0013 U*		
		Benzo(a)pyrene	0.062	ca	--	mg/Kg			0.0026 U			0.012 Ja	0.0026 U		
		Benzo(b)fluoranthene	0.62	ca	--	mg/Kg			0.0025 U			0.013 Ja	0.0025 U		
		Benzo(ghi)perylene	--	--	--	mg/Kg			0.0022 U			0.0072 Ja	0.0023 U		
		Benzo(k)fluoranthene	6.2	ca	--	mg/Kg			0.0033 U			0.0093 Ja	0.0034 U		
		Bis(2-chloroethoxy)methane	--	--	--	mg/Kg			0.0034 U			0.0035 U	0.0035 U		
		Bis(2-chloroethyl)ether	0.22	ca	--	mg/Kg			0.0023 U			0.0024 U	0.0024 U		
		Bis(2-ethylhexyl)phthalate	35	ca	--	mg/Kg			0.047 Ja			0.061 Ja	0.016 Ja		
		Butyl benzyl phthalate	1222	nc	--	mg/Kg			0.0048 U			0.0049 U	0.0049 U		
		Carbazole	24	ca	--	mg/Kg			0.041 U			0.042 U*	0.042 U*		
		Chrysene	62	ca	--	mg/Kg			0.0021 U			0.013 Ja	0.0022 U		
		Dibenzo(a,h)anthracene	0.062	ca	--	mg/Kg			0.0026 U			0.0048 Ja	0.0026 U		

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-001-0001-SO		LL6SB-002-0001-SO		LL6SB-003-0001-SO		LL6SB-004-0001-SO		LL6SB-005-0001-SO		LL6SB-006-0001-DUP		LL6SB-006-0001-SO		LL6SB-007-0001-SO		LL6SB-008-0001-SO	
						Sample Date	12/03/03		12/03/03		12/03/03		11/25/03		11/19/03		11/21/03		11/21/03		11/14/03		11/14/03	
						Sample Depth	1-3 ft.		1-3 ft.		1-3 ft.		1-3 ft.		1-3 ft.		1-3 ft.		1-3 ft.		1-3 ft.		1-3 ft.	
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units																		
		Dibenzofuran	15	nc	--	mg/Kg					0.0032	U					0.0033	U	0.0032	U				
		Diethyl phthalate	4888	nc	--	mg/Kg					0.0043	U					0.0045	U*	0.0044	U*				
		Dimethyl phthalate	100000	max	--	mg/Kg					0.0042	U					0.0043	U*	0.0043	U*				
		Di-n-butyl phthalate	611	nc	--	mg/Kg					0.023	U					0.024	U	0.024	U				
		Di-n-octyl phthalate	244	nc	--	mg/Kg					0.01	U					0.01	U	0.01	U				
		Fluoranthene	229	nc	--	mg/Kg					0.0013	U					0.027	Ja	0.0068	Ja				
		Fluorene	275	nc	--	mg/Kg					0.0019	U					0.0019	U*	0.0019	U*				
		Hexachlorobenzene	0.30	ca	--	mg/Kg					0.0021	U					0.0022	U*	0.0022	U*				
		Hexachlorobutadiene	6.2	ca	--	mg/Kg					0.0039	U					0.004	U	0.004	U				
		Hexachlorocyclopentadiene	37	nc	--	mg/Kg					0.063	U					0.065	U	0.065	U				
		Hexachloroethane	35	ca	--	mg/Kg					0.0039	U					0.004	U	0.004	U				
		Indeno(1,2,3-cd)pyrene	0.62	ca	--	mg/Kg					0.0025	U					0.0078	Ja	0.0025	U				
		Isophorone	512	ca	--	mg/Kg					0.0028	U					0.0029	U	0.0029	U				
		Naphthalene	5.6	nc	--	mg/Kg					0.002	U					0.002	U	0.002	U				
		n-Nitroso-di-n-propylamine	0.069	ca	--	mg/Kg					0.0027	U					0.0028	U	0.0028	U				
		n-Nitrosodiphenylamine	99	ca	--	mg/Kg					0.0034	U					0.0035	U	0.0035	U				
		Pentachlorophenol	3.0	ca	--	mg/Kg					0.12	U					0.12	U	0.12	U				
		Phenol	1833	nc	--	mg/Kg					0.0019	U					0.0019	U	0.0019	U				
		Pyrene	232	nc	--	mg/Kg					0.0023	U					0.016	Ja	0.005	Ja				
TAL Metals 6010B	6010B	Aluminum	7614	nc	19500	mg/Kg	**11000**		**10000**		7300		**14000**		**13000**		**13000**		**13000**		**15000**		**16000**	
		Barium	538	nc	124	mg/Kg	60		47		39		94		75		67		68		89		89	
		Beryllium	15	nc	0.88	mg/Kg	0.42	B	0.35	B	0.21	B	0.75		0.88		0.64		0.57		0.55		0.69	
		Cadmium	3.7	nc	0.00	mg/Kg	0.086	U	0.092	U	0.092	U	0.09	U	0.091	U	0.09	U	0.091	U	0.67		0.092	U
		Calcium	--	[n]	35500	mg/Kg	4900		4000		760		4400		4300		1300		1400		6900		3500	
		Chromium	30	ca	27.2	mg/Kg	15		14		9.4		20		17		16		16		22		20	
		Cobalt	902	ca	23.2	mg/Kg	10		6.9		5.3		12		11		12		9		8.5		11	
		Copper	313	nc	32.3	mg/Kg	17		17		7.4		22		20		11		11		28		19	
		Iron	2346	nc	35200	mg/Kg	**22000**		**21000**		**13000**		**28000**		**23000**		**27000**		**24000**		**28000**	H	**27000**	H
		Magnesium	--	[n]	8790	mg/Kg	3800		2500		1400		4900		3100		2200		2300		4400		3900	
		Manganese	176	nc	3030	mg/Kg	**380**		**300**		**300**		**290**		**700**		**1100**		**660**		**500**		**230**	
		Nickel	156	nc	60.7	mg/Kg	20		16		9.2		30		18		13		15		27		26	
		Potassium	--	[n]	3350	mg/Kg	1200		1000		580		1900		1300		800		880		1800		1700	
		Selenium	39	nc	1.5	mg/Kg	0.56	B	0.53	B	0.46	U	0.45	U	0.45	U	0.89	B	0.7	B	0.56	B	0.46	U
		Silver	39	nc	0.00	mg/Kg	0.33	U	0.36	U	0.36	U	0.35	U	0.35	U	0.35	U	0.35	U	0.36	U	0.36	U
		Sodium	--	[n]	145	mg/Kg	93	U	100	U	100	U	1800		99	U	97	U	98	U	1400		1600	
		Vanadium	7.8	nc	37.6	mg/Kg	**18**		**17**		**12**		**23**		**24**	H	**27**		**25**		**24**		**24**	
		Zinc	2346	nc	93.3	mg/Kg	51		52		31		65		54		52		55		190		64	
	7041	Antimony	3.1	nc	0.96	mg/Kg	0.5	U	0.5	U	0.49	U	0.5	U	0.45	U	0.45	U	0.51	U	0.074	B	0.15	B
	7060A	Arsenic	0.39	ca	19.8	mg/Kg	**17**		**13**		**13**		**13**		**15**		**11**		**14**		**17**		**11**	
	7421	Lead	400	pbk	19.1	mg/Kg	12		20		9.1		12		20		15		24		150		17	
	7471A	Mercury	2.3	nc	0.04	mg/Kg	0.022		0.022		0.023		0.013	B	0.02	B	0.035		0.044		0.032		0.024	
	7841	Thallium	0.52	nc	0.91	mg/Kg	0.31		0.22	U	0.21	U	0.22	U	0.19	U	0.19	U	0.22	U	0.22	U	0.21	U

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-001-0001-SO	LL6SB-002-0001-SO	LL6SB-003-0001-SO	LL6SB-004-0001-SO	LL6SB-005-0001-SO	LL6SB-006-0001-DUP	LL6SB-006-0001-SO	LL6SB-007-0001-SO	LL6SB-008-0001-SO
					Sample Date		12/03/03	12/03/03	12/03/03	11/25/03	11/19/03	11/21/03	11/21/03	11/14/03	11/14/03
					Sample Depth		1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units									
VOCs TCL 8260B	8260B	1,1,1-Trichloroethane	1200	sat	--	mg/Kg			0.0013 U			0.00075 U	0.00074 U		
		1,1,2,2-Tetrachloroethane	0.41	ca	--	mg/Kg			0.0011 U			0.00078 U	0.00078 U		
		1,1,2-Trichloroethane	0.73	ca	--	mg/Kg			0.0013 U			0.00087 U	0.00087 U		
		1,1-Dichloroethane	51	nc	--	mg/Kg			0.0012 U			0.0011 U	0.0011 U		
		1,1-Dichloroethene	12	nc	--	mg/Kg			0.0016 U			0.0012 U	0.0012 U		
		1,2-Dichloroethane	0.28	ca	--	mg/Kg			0.0011 U			0.00071 U	0.00071 U		
		1,2-Dichloroethene (total)	6.9	nc	--	mg/Kg			0.0025 U			0.0023 U	0.0023 U		
		1,2-Dichloropropane	0.34	ca	--	mg/Kg			0.0012 U			0.0012 U	0.0012 U		
		2-Butanone (MEK)	2231	nc	--	mg/Kg			0.0047 U			0.0051 U	0.0051 U		
		2-Hexanone	530	nc	--	mg/Kg			0.0013 U			0.0021 U	0.0021 U		
		4-Methyl-2-pentanone (MIBK)	528	nc	--	mg/Kg			0.0012 U			0.0037 U	0.0037 U		
		Acetone	1412	nc	--	mg/Kg			0.0055 U			0.005 U	0.005 U		
		Benzene	0.64	ca	--	mg/Kg			0.0013 U			0.00081 U	0.00081 U		
		Bromodichloromethane	0.82	ca	--	mg/Kg			0.0011 U			0.00083 U	0.00083 U		
		Bromoform	62	ca	--	mg/Kg			0.00089 U			0.0011 U	0.0011 U		
		Bromomethane	0.39	nc	--	mg/Kg			0.0016 U			0.0036 U	0.0035 U		
		Carbon disulfide	36	nc	--	mg/Kg			0.0014 U			0.0025 U	0.0024 U		
		Carbon tetrachloride	0.25	ca	--	mg/Kg			0.0013 U			0.001 U	0.001 U		
		Chlorobenzene	15	nc	--	mg/Kg			0.0013 U			0.0011 U	0.0011 U		
		Chloroethane	3.0	ca	--	mg/Kg			0.0012 U			0.002 U	0.002 U		
		Chloroform	0.22	ca	--	mg/Kg			0.0013 U			0.00076 U	0.00076 U		
		Chloromethane	4.7	nc	--	mg/Kg			0.0013 U			0.0012 U	0.0011 U		
		cis-1,3-Dichloropropene	0.78	ca	--	mg/Kg			0.0011 U			0.00097 U	0.00096 U		
		Dibromochloromethane	1.1	ca	--	mg/Kg			0.00094 U			0.00085 U	0.00084 U		
		Ethylbenzene	395	sat	--	mg/Kg			0.0013 U			0.0013 U	0.0013 U		
		Methylene chloride	9.1	ca	--	mg/Kg			0.0035 U			0.0022 U	0.0022 U		
		Styrene	1700	sat	--	mg/Kg			0.0013 U			0.0012 U	0.0012 U		
		Tetrachloroethene	0.48	ca	--	mg/Kg			0.0014 U			0.00082 U	0.00082 U		
		Toluene	520	sat	--	mg/Kg			0.0013 U			0.0012 U	0.0012 U		
		trans-1,3-Dichloropropene	0.78	ca	--	mg/Kg			0.00094 U			0.001 U	0.001 U		
		Trichloroethene	0.053	ca	--	mg/Kg			0.0013 U			0.00072 U	0.00072 U		
		Vinyl chloride	0.079	ca	--	mg/Kg			0.0013 U			0.00091 U	0.0009 U		
		Xylenes (total)	0.079	ca	--	mg/Kg			0.0041 U			0.0036 U	0.0035 U		

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units	LL6SB-009-0001-SO	LL6SB-010-0001-SO	LL6SB-011-0001-SO	LL6SB-012-0001-DUP	LL6SB-012-0001-SO	LL6SB-013-0001-SO	LL6SB-014-0001-SO	LL6SB-015-0001-DUP	LL6SB-015-0001-SO
		Sample Date					11/20/03	12/02/03	12/03/03	11/25/03	11/25/03	11/21/03	11/25/03	11/25/03	11/25/03
		Sample Depth					1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.
Cyanide 9012A	9014/9010B	Cyanide, Total	122	nc	0.00	mg/Kg							0.13 U		
Explosives 8330	8330	1,3,5-Trinitrobenzene	183	nc	0.00	mg/Kg							0.018 U	0.017 U	0.017 U
		1,3-Dinitrobenzene	0.61	nc	0.00	mg/Kg							0.018 U	0.018 U	0.018 U
		2,4,6-TNT	16	ca	0.00	mg/Kg							0.034 U	0.034 U	0.033 U
		2,4-Dinitrotoluene	12	nc	0.00	mg/Kg							0.036 U	0.035 U	0.035 U
		2,6-Dinitrotoluene	6.1	nc	0.00	mg/Kg							0.048 U*	0.047 U*	0.047 U*
		2-Nitrotoluene	0.88	ca	0.00	mg/Kg							0.033 U	0.033 U	0.033 U
		3-Nitrotoluene	73	nc	0.00	mg/Kg							0.05 U	0.05 U	0.05 U
		4-Nitrotoluene	12	ca	0.00	mg/Kg							0.047 U	0.046 U	0.046 U
		HMX	306	nc	0.00	mg/Kg							0.11 U	0.11 U	0.11 U
		Nitrobenzene	2	nc	0.00	mg/Kg							0.022 U	0.022 U	0.022 U
		RDX	4.4	ca	0.00	mg/Kg							0.059 U	0.058 U	0.058 U
		Tetryl	61	nc	0.00	mg/Kg							0.043 U	0.043 U	0.043 U
Others	8015B MDRO	Diesel Range Organics (DRO)	--	--	--	mg/Kg									
	8015B MGRO	Gasoline Range Organics (GRO)	--	--	--	mg/Kg									
	8081A	Toxaphene	0.44	ca	--	mg/Kg							0.0052 U		
	8270C	Phenanthrene	--	--	--	mg/Kg							0.0011 U		
PCB TCL 8082	8082	Aroclor 1016	0.39	nc	--	mg/Kg							0.0021 U		
		Aroclor 1221	0.22	ca	--	mg/Kg							0.0023 U		
		Aroclor 1232	0.22	ca	--	mg/Kg							0.0023 U		
		Aroclor 1242	0.22	ca	--	mg/Kg							0.0023 U		
		Aroclor 1248	0.22	ca	--	mg/Kg							0.0023 U		
		Aroclor 1254	0.22	ca	--	mg/Kg							0.0023 U		
		Aroclor 1260	0.22	ca	--	mg/Kg							0.0016 U		
Pesticides 8081A	8081A	4,4'-DDD	2.4	ca	--	mg/Kg							0.00041 U		
		4,4'-DDE	1.7	ca	--	mg/Kg							0.00073 U		
		4,4'-DDT	1.7	ca	--	mg/Kg							0.00042 U		
		Aldrin	0.029	ca	--	mg/Kg							0.00015 U		
		alpha-BHC	0.09	sat	--	mg/Kg							0.00018 U		
		alpha-Chlordane	1.6	ca	--	mg/Kg							0.00014 U		
		beta-BHC	0.32	ca	--	mg/Kg							0.00017 U		
		delta-BHC	--	--	--	mg/Kg							0.00012 U		
		Dieldrin	0.030	ca	--	mg/Kg							0.00038 U		
		Endosulfan I	37	nc	--	mg/Kg							0.0003 U		
		Endosulfan II	37	nc	--	mg/Kg							0.00032 U		
		Endosulfan sulfate	37	nc	--	mg/Kg							0.00033 U		
		Endrin	1.8	nc	--	mg/Kg							0.00048 U		
		Endrin aldehyde	--	--	--	mg/Kg							0.00037 U		
		Endrin ketone	--	--	--	mg/Kg							0.00033 U		
		gamma-BHC (Lindane)	0.44	ca	--	mg/Kg							0.00026 U		
		gamma-Chlordane	1.6	ca	--	mg/Kg							0.00017 U		
		Heptachlor	0.11	ca	--	mg/Kg							0.0002 U		
		Heptachlor epoxide	0.053	ca	--	mg/Kg							0.00016 U		

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-009-0001-SO	LL6SB-010-0001-SO	LL6SB-011-0001-SO	LL6SB-012-0001-DUP	LL6SB-012-0001-SO	LL6SB-013-0001-SO	LL6SB-014-0001-SO	LL6SB-015-0001-DUP	LL6SB-015-0001-SO
					Sample Date		11/20/03	12/02/03	12/03/03	11/25/03	11/25/03	11/21/03	11/25/03	11/25/03	11/25/03
					Sample Depth		1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units									
		Methoxychlor	31	nc	--	mg/Kg							0.0026 U		
Propellants 8330	353.2	Nitrocellulose	--	--	0.00	mg/Kg							2.1 B		
	8330	Nitroglycerin	35	--	0.00	mg/Kg							0.5 U		
	UV/HPLC per SOP	Nitroguanidine	611	nc	0.00	mg/Kg							0.25 U		
SVOCs TCL 8270 C	8270C	1,2,4-Trichlorobenzene	6.2	nc	--	mg/Kg							0.067 U		
		1,2-Dichlorobenzene	600	sat	--	mg/Kg							0.09 U		
		1,3-Dichlorobenzene	53	nc	--	mg/Kg							0.09 U		
		1,4-Dichlorobenzene	3.4	ca	--	mg/Kg							0.081 U		
		2,2-oxybis (1-chloropropane)	2.9	ca	--	mg/Kg							0.086 U		
		2,4,5-Trichlorophenol	611	nc	--	mg/Kg							0.043 U		
		2,4,6-Trichlorophenol	0.61	nc	--	mg/Kg							0.054 U		
		2,4-Dichlorophenol	18	nc	--	mg/Kg							0.055 U		
		2,4-Dimethylphenol	122	nc	--	mg/Kg							0.069 U		
		2,4-Dinitrophenol	12	nc	--	mg/Kg							0.13 U		
		2-Chloronaphthalene	494	nc	--	mg/Kg							0.055 U		
		2-Chlorophenol	6.3	nc	--	mg/Kg							0.067 U		
		2-Methylnaphthalene	--	--	--	mg/Kg							0.0017 U		
		2-Methylphenol (o-cresol)	306	nc	--	mg/Kg							0.0096 U		
		2-Nitroaniline	18.3	nc	--	mg/Kg							0.039 U		
		2-Nitrophenol	--	--	--	mg/Kg							0.072 U		
		3,3-Dichlorobenzidine	1.1	ca	--	mg/Kg							0.021 U		
		3-Nitroaniline	1.8	nc	--	mg/Kg							0.13 U		
		4,6-Dinitro-2-methylphenol	0.61	nc	--	mg/Kg							0.11 U		
		4-Bromophenyl phenyl ether	--	--	--	mg/Kg							0.0035 U		
		4-Chloro-3-methylphenol	--	--	--	mg/Kg							0.043 U		
		4-Chloroaniline	24	nc	--	mg/Kg							0.11 U		
		4-Chlorophenyl phenyl ether	--	--	--	mg/Kg							0.0041 U		
		4-Methylphenol (m/p-cresol)	31	nc	--	mg/Kg							0.0066 U		
		4-Nitroaniline	23	ca	--	mg/Kg							0.045 U		
		4-Nitrophenol	--	--	--	mg/Kg							0.094 U		
		Acenaphthene	368	nc	--	mg/Kg							0.0016 U		
		Acenaphthylene	--	--	--	mg/Kg							0.001 U		
		Anthracene	2189	nc	--	mg/Kg							0.00098 U		
		Benzo(a)anthracene	0.62	ca	--	mg/Kg							0.0013 U		
		Benzo(a)pyrene	0.062	ca	--	mg/Kg							0.0025 U		
		Benzo(b)fluoranthene	0.62	ca	--	mg/Kg							0.0024 U		
		Benzo(ghi)perylene	--	--	--	mg/Kg							0.0022 U		
		Benzo(k)fluoranthene	6.2	ca	--	mg/Kg							0.0032 U		
		Bis(2-chloroethoxy)methane	--	--	--	mg/Kg							0.0033 U		
		Bis(2-chloroethyl)ether	0.22	ca	--	mg/Kg							0.0023 U		
		Bis(2-ethylhexyl)phthalate	35	ca	--	mg/Kg							0.011 U		
		Butyl benzyl phthalate	1222	nc	--	mg/Kg							0.0047 U		
		Carbazole	24	ca	--	mg/Kg							0.04 U		
		Chrysene	62	ca	--	mg/Kg							0.0021 U		
		Dibenzo(a,h)anthracene	0.062	ca	--	mg/Kg							0.0025 U		

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units	LL6SB-009-0001-SO	LL6SB-010-0001-SO	LL6SB-011-0001-SO	LL6SB-012-0001-DUP	LL6SB-012-0001-SO	LL6SB-013-0001-SO	LL6SB-014-0001-SO	LL6SB-015-0001-DUP	LL6SB-015-0001-SO
		Sample Date					11/20/03	12/02/03	12/03/03	11/25/03	11/25/03	11/21/03	11/25/03	11/25/03	11/25/03
		Sample Depth					1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.
		Dibenzofuran	15	nc	--	mg/Kg							0.0031 U		
		Diethyl phthalate	4888	nc	--	mg/Kg							0.0042 U		
		Dimethyl phthalate	100000	max	--	mg/Kg							0.0041 U		
		Di-n-butyl phthalate	611	nc	--	mg/Kg							0.023 U		
		Di-n-octyl phthalate	244	nc	--	mg/Kg							0.0099 U		
		Fluoranthene	229	nc	--	mg/Kg							0.0013 U		
		Fluorene	275	nc	--	mg/Kg							0.0018 U		
		Hexachlorobenzene	0.30	ca	--	mg/Kg							0.0021 U		
		Hexachlorobutadiene	6.2	ca	--	mg/Kg							0.0038 U		
		Hexachlorocyclopentadiene	37	nc	--	mg/Kg							0.062 U		
		Hexachloroethane	35	ca	--	mg/Kg							0.0038 U		
		Indeno(1,2,3-cd)pyrene	0.62	ca	--	mg/Kg							0.0024 U		
		Isophorone	512	ca	--	mg/Kg							0.0027 U		
		Naphthalene	5.6	nc	--	mg/Kg							0.0019 U		
		n-Nitroso-di-n-propylamine	0.069	ca	--	mg/Kg							0.0026 U		
		n-Nitrosodiphenylamine	99	ca	--	mg/Kg							0.0033 U		
		Pentachlorophenol	3.0	ca	--	mg/Kg							0.11 U		
		Phenol	1833	nc	--	mg/Kg							0.0018 U		
		Pyrene	232	nc	--	mg/Kg							0.0023 U		
TAL Metals 6010B	6010B	Aluminum	7614	nc	19500	mg/Kg	**11000**	**13000**	**13000**	**21000**	**19000**	**14000**	**9300**	**13000**	**7800**
		Barium	538	nc	124	mg/Kg	100	86	70	81	87	56	62	120	63
		Beryllium	15	nc	0.88	mg/Kg	1.1	0.84	0.46 B	0.68 B	0.63	0.48	0.4 B	0.76	0.37 B
		Cadmium	3.7	nc	0.00	mg/Kg	0.088 U	0.085 U	0.096 U	0.089 U	0.093 U	0.091 U	0.088 U	0.12 B	0.088 U
		Calcium	--	[n]	35500	mg/Kg	1100	32000	2500	2100	3000	820	2200	19000	16000
		Chromium	30	ca	27.2	mg/Kg	16	18	17	26	24	19	14	28	29
		Cobalt	902	ca	23.2	mg/Kg	11	11	10	8.6	12	11	9.4	10	8.5
		Copper	313	nc	32.3	mg/Kg	20	22	15	23	20	19	30	120	110
		Iron	2346	nc	35200	mg/Kg	**27000**	**26000**	**23000**	**32000**	**30000**	**28000**	**22000**	**29000**	**34000**
		Magnesium	--	[n]	8790	mg/Kg	3500	7600	3300	5300	5100	3100	2600	5600	4700
		Manganese	176	nc	3030	mg/Kg	**810**	**350**	**360**	160	**340**	**200**	**390**	**610**	**530**
		Nickel	156	nc	60.7	mg/Kg	32	27	19	32	30	21	21	31	36
		Potassium	--	[n]	3350	mg/Kg	1100	2200	1100	2200	2000	1300	960	1800	1700
		Selenium	39	nc	1.5	mg/Kg	0.44 U	0.43 U	0.48 U	0.45 U	0.46 U	0.45 U	0.44 U	0.48 U	0.44 U
		Silver	39	nc	0.00	mg/Kg	0.34 U	0.33 U	0.37 U	0.34 U	0.36 U	0.35 U	0.34 U	0.37 U	0.34 U
		Sodium	--	[n]	145	mg/Kg	95 U	93 B	100 U	1500	1600	98 U	1200	1700	970
		Vanadium	7.8	nc	37.6	mg/Kg	**19** H	**22**	**22**	**30**	**29**	**23**	**15**	**20**	**14**
		Zinc	2346	nc	93.3	mg/Kg	63	66	49	64	60	53	97	280	160
	7041	Antimony	3.1	nc	0.96	mg/Kg	0.52 U	0.49 U	0.52 U	0.52 U	0.5 U	0.49 U	0.47 U	0.54 U	0.52 U
	7060A	Arsenic	0.39	ca	19.8	mg/Kg	**16**	**13**	**9.9**	**11**	**12**	**20**	**12**	**18**	**15**
	7421	Lead	400	pbk	19.1	mg/Kg	8.5	14	15	13	16	18	17	250	130
	7471A	Mercury	2.3	nc	0.04	mg/Kg	0.029	0.012 B	0.024	0.036	0.022	0.028	0.023	0.049	0.03
	7841	Thallium	0.52	nc	0.91	mg/Kg	1.1 U	0.21 U	0.28	1.1 U	0.22 U	0.21 U	1 U	0.23 U	0.23 U

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-009-0001-SO	LL6SB-010-0001-SO	LL6SB-011-0001-SO	LL6SB-012-0001-DUP	LL6SB-012-0001-SO	LL6SB-013-0001-SO	LL6SB-014-0001-SO	LL6SB-015-0001-DUP	LL6SB-015-0001-SO
						Sample Date	11/20/03	12/02/03	12/03/03	11/25/03	11/25/03	11/21/03	11/25/03	11/25/03	11/25/03
						Sample Depth	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units									
VOCs TCL 8260B	8260B	1,1,1-Trichloroethane	1200	sat	--	mg/Kg							0.0013 U		
		1,1,2,2-Tetrachloroethane	0.41	ca	--	mg/Kg							0.0011 U		
		1,1,2-Trichloroethane	0.73	ca	--	mg/Kg							0.0013 U		
		1,1-Dichloroethane	51	nc	--	mg/Kg							0.0012 U		
		1,1-Dichloroethene	12	nc	--	mg/Kg							0.0015 U		
		1,2-Dichloroethane	0.28	ca	--	mg/Kg							0.0011 U		
		1,2-Dichloroethene (total)	6.9	nc	--	mg/Kg							0.0024 U		
		1,2-Dichloropropane	0.34	ca	--	mg/Kg							0.0012 U		
		2-Butanone (MEK)	2231	nc	--	mg/Kg							0.0045 U		
		2-Hexanone	530	nc	--	mg/Kg							0.0013 U		
		4-Methyl-2-pentanone (MIBK)	528	nc	--	mg/Kg							0.0012 U		
		Acetone	1412	nc	--	mg/Kg							0.0053 U		
		Benzene	0.64	ca	--	mg/Kg							0.0013 U		
		Bromodichloromethane	0.82	ca	--	mg/Kg							0.0011 U		
		Bromoform	62	ca	--	mg/Kg							0.00087 U		
		Bromomethane	0.39	nc	--	mg/Kg							0.0015 U		
		Carbon disulfide	36	nc	--	mg/Kg							0.0014 U		
		Carbon tetrachloride	0.25	ca	--	mg/Kg							0.0013 U		
		Chlorobenzene	15	nc	--	mg/Kg							0.0013 U		
		Chloroethane	3.0	ca	--	mg/Kg							0.0012 U		
		Chloroform	0.22	ca	--	mg/Kg							0.0013 U		
		Chloromethane	4.7	nc	--	mg/Kg							0.0013 U		
		cis-1,3-Dichloropropene	0.78	ca	--	mg/Kg							0.0011 U		
		Dibromochloromethane	1.1	ca	--	mg/Kg							0.00092 U		
		Ethylbenzene	395	sat	--	mg/Kg							0.0013 U		
		Methylene chloride	9.1	ca	--	mg/Kg							0.0034 U		
		Styrene	1700	sat	--	mg/Kg							0.0013 U		
		Tetrachloroethene	0.48	ca	--	mg/Kg							0.0014 U		
		Toluene	520	sat	--	mg/Kg							0.0013 U		
		trans-1,3-Dichloropropene	0.78	ca	--	mg/Kg							0.00092 U		
		Trichloroethene	0.053	ca	--	mg/Kg							0.0013 U		
		Vinyl chloride	0.079	ca	--	mg/Kg							0.0013 U		
		Xylenes (total)	0.079	ca	--	mg/Kg							0.0039 U		

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-016-0001-SO	LL6SB-017-0001-SO	LL6SB-018-0001-DUP	LL6SB-018-0001-SO	LL6SB-019-0001-SO	LL6SB-020-0001-SO	LL6SB-021-0001-SO	LL6SB-023-0001-SO	LL6SB-024-0001-SO
						Sample Date	11/21/03	11/19/03	12/02/03	12/02/03	11/19/03	12/02/03	11/19/03	11/19/03	11/25/03
						Sample Depth	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units									
Cyanide 9012A	9014/9010B	Cyanide, Total	122	nc	0.00	mg/Kg									0.22 U
Explosives 8330	8330	1,3,5-Trinitrobenzene	183	nc	0.00	mg/Kg			0.017 U	0.018 U					0.017 U
		1,3-Dinitrobenzene	0.61	nc	0.00	mg/Kg			0.017 U	0.018 U					0.018 U
		2,4,6-TNT	16	ca	0.00	mg/Kg			0.033 U	0.034 U					0.034 U
		2,4-Dinitrotoluene	12	nc	0.00	mg/Kg			0.035 U	0.036 U					0.035 U
		2,6-Dinitrotoluene	6.1	nc	0.00	mg/Kg			0.047 U	0.048 U					0.047 U*
		2-Nitrotoluene	0.88	ca	0.00	mg/Kg			0.033 U	0.033 U					0.033 U
		3-Nitrotoluene	73	nc	0.00	mg/Kg			0.049 U	0.05 U					0.05 U
		4-Nitrotoluene	12	ca	0.00	mg/Kg			0.046 U	0.047 U					0.046 U
		HMX	306	nc	0.00	mg/Kg			0.11 U	0.11 U					0.11 U
		Nitrobenzene	2	nc	0.00	mg/Kg			0.022 U	0.022 U					0.022 U
		RDX	4.4	ca	0.00	mg/Kg			0.057 U	0.059 U					0.058 U
		Tetryl	61	nc	0.00	mg/Kg			0.043 U	0.043 U					0.043 U
Others	8015B MDRO	Diesel Range Organics (DRO)	--	--	--	mg/Kg									
	8015B MGRO	Gasoline Range Organics (GRO)	--	--	--	mg/Kg									
	8081A	Toxaphene	0.44	ca	--	mg/Kg									0.0055 U
	8270C	Phenanthrene	--	--	--	mg/Kg									0.51
PCB TCL 8082	8082	Aroclor 1016	0.39	nc	--	mg/Kg									0.0023 U
		Aroclor 1221	0.22	ca	--	mg/Kg									0.0024 U
		Aroclor 1232	0.22	ca	--	mg/Kg									0.0024 U
		Aroclor 1242	0.22	ca	--	mg/Kg									0.0024 U
		Aroclor 1248	0.22	ca	--	mg/Kg									0.0024 U
		Aroclor 1254	0.22	ca	--	mg/Kg									0.0024 U
		Aroclor 1260	0.22	ca	--	mg/Kg									0.0017 U
Pesticides 8081A	8081A	4,4'-DDD	2.4	ca	--	mg/Kg									0.00043 U
		4,4'-DDE	1.7	ca	--	mg/Kg									0.00078 U
		4,4'-DDT	1.7	ca	--	mg/Kg									0.00044 U
		Aldrin	0.029	ca	--	mg/Kg									0.00016 U
		alpha-BHC	0.09	sat	--	mg/Kg									0.00019 U
		alpha-Chlordane	1.6	ca	--	mg/Kg									0.00014 U
		beta-BHC	0.32	ca	--	mg/Kg									0.00018 U
		delta-BHC	--	--	--	mg/Kg									0.00013 U
		Dieldrin	0.030	ca	--	mg/Kg									0.00041 U
		Endosulfan I	37	nc	--	mg/Kg									0.00032 U
		Endosulfan II	37	nc	--	mg/Kg									0.00033 U
		Endosulfan sulfate	37	nc	--	mg/Kg									0.00035 U
		Endrin	1.8	nc	--	mg/Kg									0.00051 U
		Endrin aldehyde	--	--	--	mg/Kg									0.00039 U
		Endrin ketone	--	--	--	mg/Kg									0.00035 U
		gamma-BHC (Lindane)	0.44	ca	--	mg/Kg									0.00027 U
		gamma-Chlordane	1.6	ca	--	mg/Kg									0.00018 U
		Heptachlor	0.11	ca	--	mg/Kg									0.00022 U
		Heptachlor epoxide	0.053	ca	--	mg/Kg									0.00017 U

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units	LL6SB-016-0001-SO		LL6SB-017-0001-SO		LL6SB-018-0001-DUP		LL6SB-018-0001-SO		LL6SB-019-0001-SO		LL6SB-020-0001-SO		LL6SB-021-0001-SO		LL6SB-023-0001-SO		LL6SB-024-0001-SO	
		Sample Date					11/21/03		11/19/03		12/02/03		12/02/03		11/19/03		12/02/03		11/19/03		11/19/03		11/25/03	
		Sample Depth					1-3 ft.		1-3 ft.		1-3 ft.		1-3 ft.		1-3 ft.		1-3 ft.		1-3 ft.		1-3 ft.		1-3 ft.	
		Methoxychlor	31	nc	--	mg/Kg																	0.0027	U
Propellants 8330	353.2	Nitrocellulose	--	--	0.00	mg/Kg																	1.1	B
	8330	Nitroglycerin	35	--	0.00	mg/Kg																	0.5	U
	UV/HPLC per SOP	Nitroguanidine	611	nc	0.00	mg/Kg																	0.25	U
SVOCs TCL 8270 C	8270C	1,2,4-Trichlorobenzene	6.2	nc	--	mg/Kg																	0.071	U
		1,2-Dichlorobenzene	600	sat	--	mg/Kg																	0.095	U
		1,3-Dichlorobenzene	53	nc	--	mg/Kg																	0.095	U
		1,4-Dichlorobenzene	3.4	ca	--	mg/Kg																	0.086	U
		2,2-oxybis (1-chloropropane)	2.9	ca	--	mg/Kg																	0.09	U
		2,4,5-Trichlorophenol	611	nc	--	mg/Kg																	0.046	U
		2,4,6-Trichlorophenol	0.61	nc	--	mg/Kg																	0.057	U
		2,4-Dichlorophenol	18	nc	--	mg/Kg																	0.058	U
		2,4-Dimethylphenol	122	nc	--	mg/Kg																	0.072	U
		2,4-Dinitrophenol	12	nc	--	mg/Kg																	0.14	U
		2-Chloronaphthalene	494	nc	--	mg/Kg																	0.058	U
		2-Chlorophenol	6.3	nc	--	mg/Kg																	0.071	U
		2-Methylnaphthalene	--	--	--	mg/Kg																	0.022	Ja
		2-Methylphenol (o-cresol)	306	nc	--	mg/Kg																	0.01	U
		2-Nitroaniline	18.3	nc	--	mg/Kg																	0.041	U
		2-Nitrophenol	--	--	--	mg/Kg																	0.076	U
		3,3-Dichlorobenzidine	1.1	ca	--	mg/Kg																	0.022	U
		3-Nitroaniline	1.8	nc	--	mg/Kg																	0.13	U
		4,6-Dinitro-2-methylphenol	0.61	nc	--	mg/Kg																	0.11	U
		4-Bromophenyl phenyl ether	--	--	--	mg/Kg																	0.0037	U
		4-Chloro-3-methylphenol	--	--	--	mg/Kg																	0.046	U
		4-Chloroaniline	24	nc	--	mg/Kg																	0.12	U
		4-Chlorophenyl phenyl ether	--	--	--	mg/Kg																	0.0043	U
		4-Methylphenol (m/p-cresol)	31	nc	--	mg/Kg																	0.007	U
		4-Nitroaniline	23	ca	--	mg/Kg																	0.047	U
		4-Nitrophenol	--	--	--	mg/Kg																	0.099	U
		Acenaphthene	368	nc	--	mg/Kg																	0.069	
		Acenaphthylene	--	--	--	mg/Kg																	0.0011	U
		Anthracene	2189	nc	--	mg/Kg																	0.13	
		Benzo(a)anthracene	0.62	ca	--	mg/Kg																	0.29	
		Benzo(a)pyrene	0.062	ca	--	mg/Kg																	**0.2**	
		Benzo(b)fluoranthene	0.62	ca	--	mg/Kg																	0.23	H
		Benzo(ghi)perylene	--	--	--	mg/Kg																	0.083	
		Benzo(k)fluoranthene	6.2	ca	--	mg/Kg																	0.16	
		Bis(2-chloroethoxy)methane	--	--	--	mg/Kg																	0.0035	U
		Bis(2-chloroethyl)ether	0.22	ca	--	mg/Kg																	0.0024	U
		Bis(2-ethylhexyl)phthalate	35	ca	--	mg/Kg																	0.034	Ja
		Butyl benzyl phthalate	1222	nc	--	mg/Kg																	0.0049	U
		Carbazole	24	ca	--	mg/Kg																	0.14	Ja
		Chrysene	62	ca	--	mg/Kg																	0.3	
		Dibenzo(a,h)anthracene	0.062	ca	--	mg/Kg																	0.052	

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units	LL6SB-016-0001-SO	LL6SB-017-0001-SO	LL6SB-018-0001-DUP	LL6SB-018-0001-SO	LL6SB-019-0001-SO	LL6SB-020-0001-SO	LL6SB-021-0001-SO	LL6SB-023-0001-SO	LL6SB-024-0001-SO
		Sample Date					11/21/03	11/19/03	12/02/03	12/02/03	11/19/03	12/02/03	11/19/03	11/19/03	11/25/03
		Sample Depth					1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.
		Dibenzofuran	15	nc	--	mg/Kg									0.045 Ja
		Diethyl phthalate	4888	nc	--	mg/Kg									0.0045 U
		Dimethyl phthalate	100000	max	--	mg/Kg									0.0043 U
		Di-n-butyl phthalate	611	nc	--	mg/Kg									0.024 U
		Di-n-octyl phthalate	244	nc	--	mg/Kg									0.01 U
		Fluoranthene	229	nc	--	mg/Kg									0.76
		Fluorene	275	nc	--	mg/Kg									0.057
		Hexachlorobenzene	0.30	ca	--	mg/Kg									0.0022 U
		Hexachlorobutadiene	6.2	ca	--	mg/Kg									0.004 U
		Hexachlorocyclopentadiene	37	nc	--	mg/Kg									0.065 U
		Hexachloroethane	35	ca	--	mg/Kg									0.004 U
		Indeno(1,2,3-cd)pyrene	0.62	ca	--	mg/Kg									0.088
		Isophorone	512	ca	--	mg/Kg									0.0029 U
		Naphthalene	5.6	nc	--	mg/Kg									0.078
		n-Nitroso-di-n-propylamine	0.069	ca	--	mg/Kg									0.0028 U
		n-Nitrosodiphenylamine	99	ca	--	mg/Kg									0.0035 U
		Pentachlorophenol	3.0	ca	--	mg/Kg									0.12 U
		Phenol	1833	nc	--	mg/Kg									0.0019 U
		Pyrene	232	nc	--	mg/Kg									0.51
TAL Metals 6010B	6010B	Aluminum	7614	nc	19500	mg/Kg	**14000**	**11000**	**12000**	**13000**	**18000**	**13000**	**11000**	**16000**	**14000**
		Barium	538	nc	124	mg/Kg	90	83	79	63	86	110	69	67	92
		Beryllium	15	nc	0.88	mg/Kg	0.81	0.9	0.75	0.61	0.82	1	0.43 B	0.72	0.63
		Cadmium	3.7	nc	0.00	mg/Kg	0.09 U	0.45	0.091 U	0.095 U	0.096 U	0.086 U	0.097 U	0.1 U	0.09 U
		Calcium	--	[n]	35500	mg/Kg	1300	9100	830	650	4900	2600	1600	2100	30000
		Chromium	30	ca	27.2	mg/Kg	19	13	15	16	23	19	12	20	18
		Cobalt	902	ca	23.2	mg/Kg	33	9.9	33	5	10	19	2.3	7.8	9.9
		Copper	313	nc	32.3	mg/Kg	22	16	9.3	9.7	19	22	5.2	17	20
		Iron	2346	nc	35200	mg/Kg	**28000**	**17000**	**24000**	**25000**	**30000**	**27000**	**10000**	**25000**	**22000**
		Magnesium	--	[n]	8790	mg/Kg	4000	2700	2000	1800	4600	4000	1300	3300	5000
		Manganese	176	nc	3030	mg/Kg	**570**	**820**	**1600**	**260**	**270**	**390**	45	**320**	**550**
		Nickel	156	nc	60.7	mg/Kg	31	13	13	9.7	25	32	8	20	24
		Potassium	--	[n]	3350	mg/Kg	1500	900	830	810	1800	1300	910	1500	2100
		Selenium	39	nc	1.5	mg/Kg	0.46 B	0.49 U	0.45 U	0.48 U	0.48 U	0.43 U	0.49 U	0.5 U	0.69 B
		Silver	39	nc	0.00	mg/Kg	0.35 U	0.38 U	0.35 U	0.37 U	0.37 U	0.33 U	0.38 U	0.39 U	0.35 U
		Sodium	--	[n]	145	mg/Kg	97 U	110 U	99 U	100 U	100 U	93 U	110 U	110 U	1400
		Vanadium	7.8	nc	37.6	mg/Kg	**20**	**20** H	**26**	**32**	**31** H	**22**	**15** H	**26** H	**21**
		Zinc	2346	nc	93.3	mg/Kg	65	69	43	38	59	57	29	50	60
	7041	Antimony	3.1	nc	0.96	mg/Kg	0.47 U	0.46 U	0.53 U	0.5 U	0.46 U	0.48 U	0.49 U	0.48 U	0.5 U
	7060A	Arsenic	0.39	ca	19.8	mg/Kg	**13**	**5**	**11**	**13**	**15**	**19**	**2.6**	**9.7**	**11**
	7421	Lead	400	pbk	19.1	mg/Kg	20	47	14	15	19	18	9.2	16	22
	7471A	Mercury	2.3	nc	0.04	mg/Kg	0.041	0.29	0.032	0.024	0.02 B	0.021	0.027	0.037	0.039
	7841	Thallium	0.52	nc	0.91	mg/Kg	0.2 U	0.2 U	0.23 U	0.22 U	0.2 U	0.21 U	0.21 U	0.21 U	1.1 U

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-016-0001-SO	LL6SB-017-0001-SO	LL6SB-018-0001-DUP	LL6SB-018-0001-SO	LL6SB-019-0001-SO	LL6SB-020-0001-SO	LL6SB-021-0001-SO	LL6SB-023-0001-SO	LL6SB-024-0001-SO
						Sample Date	11/21/03	11/19/03	12/02/03	12/02/03	11/19/03	12/02/03	11/19/03	11/19/03	11/25/03
						Sample Depth	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units									
VOCs TCL 8260B	8260B	1,1,1-Trichloroethane	1200	sat	--	mg/Kg									0.0014 U
		1,1,2,2-Tetrachloroethane	0.41	ca	--	mg/Kg									0.0012 U
		1,1,2-Trichloroethane	0.73	ca	--	mg/Kg									0.0014 U
		1,1-Dichloroethane	51	nc	--	mg/Kg									0.0012 U
		1,1-Dichloroethene	12	nc	--	mg/Kg									0.0016 U
		1,2-Dichloroethane	0.28	ca	--	mg/Kg									0.0012 U
		1,2-Dichloroethene (total)	6.9	nc	--	mg/Kg									0.0026 U
		1,2-Dichloropropane	0.34	ca	--	mg/Kg									0.0012 U
		2-Butanone (MEK)	2231	nc	--	mg/Kg									0.0048 U
		2-Hexanone	530	nc	--	mg/Kg									0.0014 U
		4-Methyl-2-pentanone (MIBK)	528	nc	--	mg/Kg									0.0012 U
		Acetone	1412	nc	--	mg/Kg									0.0057 U
		Benzene	0.64	ca	--	mg/Kg									0.0014 U
		Bromodichloromethane	0.82	ca	--	mg/Kg									0.0012 U
		Bromoform	62	ca	--	mg/Kg									0.00092 U
		Bromomethane	0.39	nc	--	mg/Kg									0.0016 U
		Carbon disulfide	36	nc	--	mg/Kg									0.0015 U
		Carbon tetrachloride	0.25	ca	--	mg/Kg									0.0014 U
		Chlorobenzene	15	nc	--	mg/Kg									0.0014 U
		Chloroethane	3.0	ca	--	mg/Kg									0.0012 U
		Chloroform	0.22	ca	--	mg/Kg									0.0014 U
		Chloromethane	4.7	nc	--	mg/Kg									0.0014 U
		cis-1,3-Dichloropropene	0.78	ca	--	mg/Kg									0.0011 U
		Dibromochloromethane	1.1	ca	--	mg/Kg									0.00097 U
		Ethylbenzene	395	sat	--	mg/Kg									0.0014 U
		Methylene chloride	9.1	ca	--	mg/Kg									0.0036 U
		Styrene	1700	sat	--	mg/Kg									0.0014 U
		Tetrachloroethene	0.48	ca	--	mg/Kg									0.0015 U
		Toluene	520	sat	--	mg/Kg									0.0014 U
		trans-1,3-Dichloropropene	0.78	ca	--	mg/Kg									0.00097 U
		Trichloroethene	0.053	ca	--	mg/Kg									0.0014 U
		Vinyl chloride	0.079	ca	--	mg/Kg									0.0014 U
		Xylenes (total)	0.079	ca	--	mg/Kg									0.0042 U

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units	LL6SB-025-0001-SO	LL6SB-026-0001-SO	LL6SB-027-0001-SO	LL6SB-028-0001-SO	LL6SB-030-0001-SO	LL6SB-031-0001-SO	LL6SB-032-0001-SO	LL6SB-033-0001-DUP	LL6SB-033-0001-SO
		Sample Date					11/14/03	11/20/03	11/20/03	11/18/03	11/18/03	11/18/03	11/13/03	11/18/03	11/18/03
		Sample Depth					1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	6-8 ft.	14-15 ft.	14-15 ft.	6-8 ft.
Cyanide 9012A	9014/9010B	Cyanide, Total	122	nc	0.00	mg/Kg									
Explosives 8330	8330	1,3,5-Trinitrobenzene	183	nc	0.00	mg/Kg								0.017 U	0.018 U
		1,3-Dinitrobenzene	0.61	nc	0.00	mg/Kg								0.018 U	0.018 U
		2,4,6-TNT	16	ca	0.00	mg/Kg								0.033 U	0.034 U
		2,4-Dinitrotoluene	12	nc	0.00	mg/Kg								0.035 U	0.036 U
		2,6-Dinitrotoluene	6.1	nc	0.00	mg/Kg								0.047 U*	0.048 U*
		2-Nitrotoluene	0.88	ca	0.00	mg/Kg								0.033 U	0.033 U
		3-Nitrotoluene	73	nc	0.00	mg/Kg								0.5 U	0.05 U
		4-Nitrotoluene	12	ca	0.00	mg/Kg								0.046 U	0.047 U
		HMX	306	nc	0.00	mg/Kg								0.11 U	0.11 U
		Nitrobenzene	2	nc	0.00	mg/Kg								0.022 U	0.022 U
		RDX	4.4	ca	0.00	mg/Kg								0.58 U	0.059 U
		Tetryl	61	nc	0.00	mg/Kg								0.043 U	0.043 U
Others	8015B MDRO	Diesel Range Organics (DRO)	--	--	--	mg/Kg									
	8015B MGRO	Gasoline Range Organics (GRO)	--	--	--	mg/Kg									
	8081A	Toxaphene	0.44	ca	--	mg/Kg									
	8270C	Phenanthrene	--	--	--	mg/Kg									
PCB TCL 8082	8082	Aroclor 1016	0.39	nc	--	mg/Kg									
		Aroclor 1221	0.22	ca	--	mg/Kg									
		Aroclor 1232	0.22	ca	--	mg/Kg									
		Aroclor 1242	0.22	ca	--	mg/Kg									
		Aroclor 1248	0.22	ca	--	mg/Kg									
		Aroclor 1254	0.22	ca	--	mg/Kg									
		Aroclor 1260	0.22	ca	--	mg/Kg									
Pesticides 8081A	8081A	4,4'-DDD	2.4	ca	--	mg/Kg									
		4,4'-DDE	1.7	ca	--	mg/Kg									
		4,4'-DDT	1.7	ca	--	mg/Kg									
		Aldrin	0.029	ca	--	mg/Kg									
		alpha-BHC	0.09	sat	--	mg/Kg									
		alpha-Chlordane	1.6	ca	--	mg/Kg									
		beta-BHC	0.32	ca	--	mg/Kg									
		delta-BHC	--	--	--	mg/Kg									
		Dieldrin	0.030	ca	--	mg/Kg									
		Endosulfan I	37	nc	--	mg/Kg									
		Endosulfan II	37	nc	--	mg/Kg									
		Endosulfan sulfate	37	nc	--	mg/Kg									
		Endrin	1.8	nc	--	mg/Kg									
		Endrin aldehyde	--	--	--	mg/Kg									
		Endrin ketone	--	--	--	mg/Kg									
		gamma-BHC (Lindane)	0.44	ca	--	mg/Kg									
		gamma-Chlordane	1.6	ca	--	mg/Kg									
		Heptachlor	0.11	ca	--	mg/Kg									
		Heptachlor epoxide	0.053	ca	--	mg/Kg									

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-025-0001-SO	LL6SB-026-0001-SO	LL6SB-027-0001-SO	LL6SB-028-0001-SO	LL6SB-030-0001-SO	LL6SB-031-0001-SO	LL6SB-032-0001-SO	LL6SB-033-0001-DUP	LL6SB-033-0001-SO
					Sample Date		11/14/03	11/20/03	11/20/03	11/18/03	11/18/03	11/18/03	11/13/03	11/18/03	11/18/03
					Sample Depth		1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	6-8 ft.	14-15 ft.	14-15 ft.	6-8 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units									
		Methoxychlor	31	nc	--	mg/Kg									
Propellants 8330	353.2	Nitrocellulose	--	--	0.00	mg/Kg									
	8330	Nitroglycerin	35	--	0.00	mg/Kg									
	UV/HPLC per SOP	Nitroguanidine	611	nc	0.00	mg/Kg									
SVOCs TCL 8270 C	8270C	1,2,4-Trichlorobenzene	6.2	nc	--	mg/Kg									
		1,2-Dichlorobenzene	600	sat	--	mg/Kg									
		1,3-Dichlorobenzene	53	nc	--	mg/Kg									
		1,4-Dichlorobenzene	3.4	ca	--	mg/Kg									
		2,2-oxybis (1-chloropropane)	2.9	ca	--	mg/Kg									
		2,4,5-Trichlorophenol	611	nc	--	mg/Kg									
		2,4,6-Trichlorophenol	0.61	nc	--	mg/Kg									
		2,4-Dichlorophenol	18	nc	--	mg/Kg									
		2,4-Dimethylphenol	122	nc	--	mg/Kg									
		2,4-Dinitrophenol	12	nc	--	mg/Kg									
		2-Chloronaphthalene	494	nc	--	mg/Kg									
		2-Chlorophenol	6.3	nc	--	mg/Kg									
		2-Methylnaphthalene	--	--	--	mg/Kg									
		2-Methylphenol (o-cresol)	306	nc	--	mg/Kg									
		2-Nitroaniline	18.3	nc	--	mg/Kg									
		2-Nitrophenol	--	--	--	mg/Kg									
		3,3-Dichlorobenzidine	1.1	ca	--	mg/Kg									
		3-Nitroaniline	1.8	nc	--	mg/Kg									
		4,6-Dinitro-2-methylphenol	0.61	nc	--	mg/Kg									
		4-Bromophenyl phenyl ether	--	--	--	mg/Kg									
		4-Chloro-3-methylphenol	--	--	--	mg/Kg									
		4-Chloroaniline	24	nc	--	mg/Kg									
		4-Chlorophenyl phenyl ether	--	--	--	mg/Kg									
		4-Methylphenol (m/p-cresol)	31	nc	--	mg/Kg									
		4-Nitroaniline	23	ca	--	mg/Kg									
		4-Nitrophenol	--	--	--	mg/Kg									
		Acenaphthene	368	nc	--	mg/Kg									
		Acenaphthylene	--	--	--	mg/Kg									
		Anthracene	2189	nc	--	mg/Kg									
		Benzo(a)anthracene	0.62	ca	--	mg/Kg									
		Benzo(a)pyrene	0.062	ca	--	mg/Kg									
		Benzo(b)fluoranthene	0.62	ca	--	mg/Kg									
		Benzo(ghi)perylene	--	--	--	mg/Kg									
		Benzo(k)fluoranthene	6.2	ca	--	mg/Kg									
		Bis(2-chloroethoxy)methane	--	--	--	mg/Kg									
		Bis(2-chloroethyl)ether	0.22	ca	--	mg/Kg									
		Bis(2-ethylhexyl)phthalate	35	ca	--	mg/Kg									
		Butyl benzyl phthalate	1222	nc	--	mg/Kg									
		Carbazole	24	ca	--	mg/Kg									
		Chrysene	62	ca	--	mg/Kg									
		Dibenzo(a,h)anthracene	0.062	ca	--	mg/Kg									

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-025-0001-SO		LL6SB-026-0001-SO		LL6SB-027-0001-SO		LL6SB-028-0001-SO		LL6SB-030-0001-SO		LL6SB-031-0001-SO		LL6SB-032-0001-SO		LL6SB-033-0001-DUP		LL6SB-033-0001-SO	
						Sample Date	11/14/03		11/20/03		11/20/03		11/18/03		11/18/03		11/18/03		11/13/03		11/18/03		11/18/03	
						Sample Depth	1-3 ft.		1-3 ft.		1-3 ft.		1-3 ft.		1-3 ft.		6-8 ft.		14-15 ft.		14-15 ft.		6-8 ft.	
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units																		
		Dibenzofuran	15	nc	--	mg/Kg																		
		Diethyl phthalate	4888	nc	--	mg/Kg																		
		Dimethyl phthalate	100000	max	--	mg/Kg																		
		Di-n-butyl phthalate	611	nc	--	mg/Kg																		
		Di-n-octyl phthalate	244	nc	--	mg/Kg																		
		Fluoranthene	229	nc	--	mg/Kg																		
		Fluorene	275	nc	--	mg/Kg																		
		Hexachlorobenzene	0.30	ca	--	mg/Kg																		
		Hexachlorobutadiene	6.2	ca	--	mg/Kg																		
		Hexachlorocyclopentadiene	37	nc	--	mg/Kg																		
		Hexachloroethane	35	ca	--	mg/Kg																		
		Indeno(1,2,3-cd)pyrene	0.62	ca	--	mg/Kg																		
		Isophorone	512	ca	--	mg/Kg																		
		Naphthalene	5.6	nc	--	mg/Kg																		
		n-Nitroso-di-n-propylamine	0.069	ca	--	mg/Kg																		
		n-Nitrosodiphenylamine	99	ca	--	mg/Kg																		
		Pentachlorophenol	3.0	ca	--	mg/Kg																		
		Phenol	1833	nc	--	mg/Kg																		
		Pyrene	232	nc	--	mg/Kg																		
TAL Metals 6010B	6010B	Aluminum	7614	nc	19500	mg/Kg	**14000**		**19000**		**15000**		**19000**		**19000**		**15000**		6100		**9200**		**8400**	
		Barium	538	nc	124	mg/Kg	42		70		63		160		83		86		24		39		36	
		Beryllium	15	nc	0.88	mg/Kg	0.2	B	0.75		0.76		0.93		0.76		0.9		0.39	B	0.56		0.49	
		Cadmium	3.7	nc	0.00	mg/Kg	0.095	U	0.091	U	0.092	U	0.09	U	0.1	U	0.09	U	0.086	U	0.089	U	0.08	U
		Calcium	--	[n]	35500	mg/Kg	300		1300		1300		2100		1300		39000		11000		5200		6600	
		Chromium	30	ca	27.2	mg/Kg	15		24		18		24		25		21		9.4		14		13	
		Cobalt	902	ca	23.2	mg/Kg	4.3		7.1		9.1		9.6		6.6		11		7.6		9.9		9.1	
		Copper	313	nc	32.3	mg/Kg	6.3		21		14		21		18		21		18		20		20	
		Iron	2346	nc	35200	mg/Kg	**21000**	H	**32000**		**29000**		**28000**	H	**45000**	H	**27000**	H	**20000**	H	**25000**	H	**24000**	H
		Magnesium	--	[n]	8790	mg/Kg	1900		3700		2400		4800		2700		9200		3800		4300		4100	
		Manganese	176	nc	3030	mg/Kg	120		140		**460**		**340**		**440**		**380**		**400**		**290**		**290**	
		Nickel	156	nc	60.7	mg/Kg	9.2		22		14		32		15		30		17		23		22	
		Potassium	--	[n]	3350	mg/Kg	760		1500		900		1700		1500		3200		1100		1400		1200	
		Selenium	39	nc	1.5	mg/Kg	0.48	U	0.45	U	0.46	U	1.5		2.5		1.4		1	B	1.2		1.4	
		Silver	39	nc	0.00	mg/Kg	0.37	U	0.35	U	0.36	U	0.35	U	0.4	U	0.35	U	0.33	U	0.35	U	0.31	U
		Sodium	--	[n]	145	mg/Kg	1300		99	U	100	U	98	U	110	U	140		93	U	97	U	87	U
		Vanadium	7.8	nc	37.6	mg/Kg	**27**		**30**	H	**31**	H	**27**		**31**		**25**		**11**		**15**		**13**	
		Zinc	2346	nc	93.3	mg/Kg	40		57		48		59		49		55		50		58		54	
	7041	Antimony	3.1	nc	0.96	mg/Kg	0.45	U*H^	0.47	U	0.52	U	0.5	U	0.53	U	0.51	U	0.27	B	0.43	U	0.42	U
	7060A	Arsenic	0.39	ca	19.8	mg/Kg	**6.8**		**16**		**10**		**16**		**11**		**10**		**20**		**26**		**26**	
	7421	Lead	400	pbk	19.1	mg/Kg	13		9.5		12		18		17		13		16		14		10	
	7471A	Mercury	2.3	nc	0.04	mg/Kg	0.025		0.038		0.042		0.016	B	0.026		0.0064	B	0.0049	U	0.005	U	0.0047	U
	7841	Thallium	0.52	nc	0.91	mg/Kg	0.2	U	1	U	1.1	U	1.1	U	1.1	U	0.22	U	0.2	U	0.92	U	0.91	U

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-025-0001-SO	LL6SB-026-0001-SO	LL6SB-027-0001-SO	LL6SB-028-0001-SO	LL6SB-030-0001-SO	LL6SB-031-0001-SO	LL6SB-032-0001-SO	LL6SB-033-0001-DUP	LL6SB-033-0001-SO
						Sample Date	11/14/03	11/20/03	11/20/03	11/18/03	11/18/03	11/18/03	11/13/03	11/18/03	11/18/03
						Sample Depth	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	1-3 ft.	6-8 ft.	14-15 ft.	14-15 ft.	6-8 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units									
VOCs TCL 8260B	8260B	1,1,1-Trichloroethane	1200	sat	--	mg/Kg									
		1,1,2,2-Tetrachloroethane	0.41	ca	--	mg/Kg									
		1,1,2-Trichloroethane	0.73	ca	--	mg/Kg									
		1,1-Dichloroethane	51	nc	--	mg/Kg									
		1,1-Dichloroethene	12	nc	--	mg/Kg									
		1,2-Dichloroethane	0.28	ca	--	mg/Kg									
		1,2-Dichloroethene (total)	6.9	nc	--	mg/Kg									
		1,2-Dichloropropane	0.34	ca	--	mg/Kg									
		2-Butanone (MEK)	2231	nc	--	mg/Kg									
		2-Hexanone	530	nc	--	mg/Kg									
		4-Methyl-2-pentanone (MIBK)	528	nc	--	mg/Kg									
		Acetone	1412	nc	--	mg/Kg									
		Benzene	0.64	ca	--	mg/Kg									
		Bromodichloromethane	0.82	ca	--	mg/Kg									
		Bromoform	62	ca	--	mg/Kg									
		Bromomethane	0.39	nc	--	mg/Kg									
		Carbon disulfide	36	nc	--	mg/Kg									
		Carbon tetrachloride	0.25	ca	--	mg/Kg									
		Chlorobenzene	15	nc	--	mg/Kg									
		Chloroethane	3.0	ca	--	mg/Kg									
		Chloroform	0.22	ca	--	mg/Kg									
		Chloromethane	4.7	nc	--	mg/Kg									
		cis-1,3-Dichloropropene	0.78	ca	--	mg/Kg									
		Dibromochloromethane	1.1	ca	--	mg/Kg									
		Ethylbenzene	395	sat	--	mg/Kg									
		Methylene chloride	9.1	ca	--	mg/Kg									
		Styrene	1700	sat	--	mg/Kg									
		Tetrachloroethene	0.48	ca	--	mg/Kg									
		Toluene	520	sat	--	mg/Kg									
		trans-1,3-Dichloropropene	0.78	ca	--	mg/Kg									
		Trichloroethene	0.053	ca	--	mg/Kg									
		Vinyl chloride	0.079	ca	--	mg/Kg									
		Xylenes (total)	0.079	ca	--	mg/Kg									

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-034-0001-SO	LL6SB-035-0001-SO	LL6SB-036-0001-SO	LL6SB-037-0001-SO	LL6SB-038-0001-SO	LL6SB-039-0001-SO	LL6SB-040-0001-SO	LL6SB-041-0001-SO	LL6SB-042-0001-SO
						Sample Date	11/14/03	11/14/03	11/18/03	11/14/03	11/05/03	11/05/03	11/05/03	10/27/03	12/03/03
						Sample Depth	15-17 ft.	11-13 ft.	6-8 ft.	12-14 ft.	8-10 ft.	8-10 ft.	4-6 ft.	5-7 ft.	1-3 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units									
Cyanide 9012A	9014/9010B	Cyanide, Total	122	nc	0.00	mg/Kg									
Explosives 8330	8330	1,3,5-Trinitrobenzene	183	nc	0.00	mg/Kg						0.017 U			
		1,3-Dinitrobenzene	0.61	nc	0.00	mg/Kg						0.018 U			
		2,4,6-TNT	16	ca	0.00	mg/Kg						0.034 U			
		2,4-Dinitrotoluene	12	nc	0.00	mg/Kg						0.035 U			
		2,6-Dinitrotoluene	6.1	nc	0.00	mg/Kg						0.047 U			
		2-Nitrotoluene	0.88	ca	0.00	mg/Kg						0.033 U			
		3-Nitrotoluene	73	nc	0.00	mg/Kg						0.05 U			
		4-Nitrotoluene	12	ca	0.00	mg/Kg						0.046 U			
		HMX	306	nc	0.00	mg/Kg						0.11 U			
		Nitrobenzene	2	nc	0.00	mg/Kg						0.022 U			
		RDX	4.4	ca	0.00	mg/Kg						0.058 U			
		Tetryl	61	nc	0.00	mg/Kg						0.043 U			
Others	8015B MDRO	Diesel Range Organics (DRO)	--	--	--	mg/Kg									
	8015B MGRO	Gasoline Range Organics (GRO)	--	--	--	mg/Kg									
	8081A	Toxaphene	0.44	ca	--	mg/Kg									
	8270C	Phenanthrene	--	--	--	mg/Kg									
PCB TCL 8082	8082	Aroclor 1016	0.39	nc	--	mg/Kg									
		Aroclor 1221	0.22	ca	--	mg/Kg									
		Aroclor 1232	0.22	ca	--	mg/Kg									
		Aroclor 1242	0.22	ca	--	mg/Kg									
		Aroclor 1248	0.22	ca	--	mg/Kg									
		Aroclor 1254	0.22	ca	--	mg/Kg									
		Aroclor 1260	0.22	ca	--	mg/Kg									
Pesticides 8081A	8081A	4,4'-DDD	2.4	ca	--	mg/Kg									
		4,4'-DDE	1.7	ca	--	mg/Kg									
		4,4'-DDT	1.7	ca	--	mg/Kg									
		Aldrin	0.029	ca	--	mg/Kg									
		alpha-BHC	0.09	sat	--	mg/Kg									
		alpha-Chlordane	1.6	ca	--	mg/Kg									
		beta-BHC	0.32	ca	--	mg/Kg									
		delta-BHC	--	--	--	mg/Kg									
		Dieldrin	0.030	ca	--	mg/Kg									
		Endosulfan I	37	nc	--	mg/Kg									
		Endosulfan II	37	nc	--	mg/Kg									
		Endosulfan sulfate	37	nc	--	mg/Kg									
		Endrin	1.8	nc	--	mg/Kg									
		Endrin aldehyde	--	--	--	mg/Kg									
		Endrin ketone	--	--	--	mg/Kg									
		gamma-BHC (Lindane)	0.44	ca	--	mg/Kg									
		gamma-Chlordane	1.6	ca	--	mg/Kg									
		Heptachlor	0.11	ca	--	mg/Kg									
		Heptachlor epoxide	0.053	ca	--	mg/Kg									

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-034-0001-SO	LL6SB-035-0001-SO	LL6SB-036-0001-SO	LL6SB-037-0001-SO	LL6SB-038-0001-SO	LL6SB-039-0001-SO	LL6SB-040-0001-SO	LL6SB-041-0001-SO	LL6SB-042-0001-SO
						Sample Date	11/14/03	11/14/03	11/18/03	11/14/03	11/05/03	11/05/03	11/05/03	10/27/03	12/03/03
						Sample Depth	15-17 ft.	11-13 ft.	6-8 ft.	12-14 ft.	8-10 ft.	8-10 ft.	4-6 ft.	5-7 ft.	1-3 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units									
		Methoxychlor	31	nc	--	mg/Kg									
Propellants 8330	353.2	Nitrocellulose	--	--	0.00	mg/Kg									
	8330	Nitroglycerin	35	--	0.00	mg/Kg									
	UV/HPLC per SOP	Nitroguanidine	611	nc	0.00	mg/Kg									
SVOCs TCL 8270 C	8270C	1,2,4-Trichlorobenzene	6.2	nc	--	mg/Kg									
		1,2-Dichlorobenzene	600	sat	--	mg/Kg									
		1,3-Dichlorobenzene	53	nc	--	mg/Kg									
		1,4-Dichlorobenzene	3.4	ca	--	mg/Kg									
		2,2-oxybis (1-chloropropane)	2.9	ca	--	mg/Kg									
		2,4,5-Trichlorophenol	611	nc	--	mg/Kg									
		2,4,6-Trichlorophenol	0.61	nc	--	mg/Kg									
		2,4-Dichlorophenol	18	nc	--	mg/Kg									
		2,4-Dimethylphenol	122	nc	--	mg/Kg									
		2,4-Dinitrophenol	12	nc	--	mg/Kg									
		2-Chloronaphthalene	494	nc	--	mg/Kg									
		2-Chlorophenol	6.3	nc	--	mg/Kg									
		2-Methylnaphthalene	--	--	--	mg/Kg									
		2-Methylphenol (o-cresol)	306	nc	--	mg/Kg									
		2-Nitroaniline	18.3	nc	--	mg/Kg									
		2-Nitrophenol	--	--	--	mg/Kg									
		3,3-Dichlorobenzidine	1.1	ca	--	mg/Kg									
		3-Nitroaniline	1.8	nc	--	mg/Kg									
		4,6-Dinitro-2-methylphenol	0.61	nc	--	mg/Kg									
		4-Bromophenyl phenyl ether	--	--	--	mg/Kg									
		4-Chloro-3-methylphenol	--	--	--	mg/Kg									
		4-Chloroaniline	24	nc	--	mg/Kg									
		4-Chlorophenyl phenyl ether	--	--	--	mg/Kg									
		4-Methylphenol (m/p-cresol)	31	nc	--	mg/Kg									
		4-Nitroaniline	23	ca	--	mg/Kg									
		4-Nitrophenol	--	--	--	mg/Kg									
		Acenaphthene	368	nc	--	mg/Kg									
		Acenaphthylene	--	--	--	mg/Kg									
		Anthracene	2189	nc	--	mg/Kg									
		Benzo(a)anthracene	0.62	ca	--	mg/Kg									
		Benzo(a)pyrene	0.062	ca	--	mg/Kg									
		Benzo(b)fluoranthene	0.62	ca	--	mg/Kg									
		Benzo(ghi)perylene	--	--	--	mg/Kg									
		Benzo(k)fluoranthene	6.2	ca	--	mg/Kg									
		Bis(2-chloroethoxy)methane	--	--	--	mg/Kg									
		Bis(2-chloroethyl)ether	0.22	ca	--	mg/Kg									
		Bis(2-ethylhexyl)phthalate	35	ca	--	mg/Kg									
		Butyl benzyl phthalate	1222	nc	--	mg/Kg									
		Carbazole	24	ca	--	mg/Kg									
		Chrysene	62	ca	--	mg/Kg									
		Dibenzo(a,h)anthracene	0.062	ca	--	mg/Kg									

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-034-0001-SO		LL6SB-035-0001-SO		LL6SB-036-0001-SO		LL6SB-037-0001-SO		LL6SB-038-0001-SO		LL6SB-039-0001-SO		LL6SB-040-0001-SO		LL6SB-041-0001-SO		LL6SB-042-0001-SO	
						Sample Date	11/14/03		11/14/03		11/18/03		11/14/03		11/05/03		11/05/03		11/05/03		10/27/03		12/03/03	
						Sample Depth	15-17 ft.		11-13 ft.		6-8 ft.		12-14 ft.		8-10 ft.		8-10 ft.		4-6 ft.		5-7 ft.		1-3 ft.	
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units																		
		Dibenzofuran	15	nc	--	mg/Kg																		
		Diethyl phthalate	4888	nc	--	mg/Kg																		
		Dimethyl phthalate	100000	max	--	mg/Kg																		
		Di-n-butyl phthalate	611	nc	--	mg/Kg																		
		Di-n-octyl phthalate	244	nc	--	mg/Kg																		
		Fluoranthene	229	nc	--	mg/Kg																		
		Fluorene	275	nc	--	mg/Kg																		
		Hexachlorobenzene	0.30	ca	--	mg/Kg																		
		Hexachlorobutadiene	6.2	ca	--	mg/Kg																		
		Hexachlorocyclopentadiene	37	nc	--	mg/Kg																		
		Hexachloroethane	35	ca	--	mg/Kg																		
		Indeno(1,2,3-cd)pyrene	0.62	ca	--	mg/Kg																		
		Isophorone	512	ca	--	mg/Kg																		
		Naphthalene	5.6	nc	--	mg/Kg																		
		n-Nitroso-di-n-propylamine	0.069	ca	--	mg/Kg																		
		n-Nitrosodiphenylamine	99	ca	--	mg/Kg																		
		Pentachlorophenol	3.0	ca	--	mg/Kg																		
		Phenol	1833	nc	--	mg/Kg																		
		Pyrene	232	nc	--	mg/Kg																		
TAL Metals 6010B	6010B	Aluminum	7614	nc	19500	mg/Kg	**8200**		**8300**		**9400**		6900		**15000**		**13000**		5900		**13000**		**13000**	
		Barium	538	nc	124	mg/Kg	36		49		29		25		75		59		20		74		89	
		Beryllium	15	nc	0.88	mg/Kg	0.39	B	0.35	B	0.54		0.29	B	0.56		0.47	B	0.19	B	0.55		0.53	
		Cadmium	3.7	nc	0.00	mg/Kg	0.089	U	0.083	U	0.084	U	0.087	U	0.092	U	0.094	U	0.085	U	0.085	U	0.088	U
		Calcium	--	[n]	35500	mg/Kg	5500		8500		8000		6900		24000		8400		270		20000	H	36000	
		Chromium	30	ca	27.2	mg/Kg	13		13		14		10		20		17		8.2		19		21	
		Cobalt	902	ca	23.2	mg/Kg	9.2		8.7		9.2		7.6		11		9.9		3.5		13		12	
		Copper	313	nc	32.3	mg/Kg	20		20		19		16		20		17		5.9		23		21	
		Iron	2346	nc	35200	mg/Kg	**26000**	H	**22000**	H	**23000**	H	**20000**	H	**29000**		**25000**		**11000**		**29000**	*H	**27000**	
		Magnesium	--	[n]	8790	mg/Kg	3800		3500		4700		4700		7200		4200		1500		6300		8500	
		Manganese	176	nc	3030	mg/Kg	**330**		**480**		**220**		**220**		**280**		**400**		79		**540**		**370**	
		Nickel	156	nc	60.7	mg/Kg	21		21		21		18		27		22		9.1		31		29	
		Potassium	--	[n]	3350	mg/Kg	1500		1500		1600		1400		2900		1800		640		2200		2500	
		Selenium	39	nc	1.5	mg/Kg	0.45	U	0.42	U	1		0.43	U	0.46	U	0.59	B	0.67	B	0.42	U	0.55	B
		Silver	39	nc	0.00	mg/Kg	0.35	U	0.32	U	0.33	U	0.34	U	0.36	U	0.36	U	0.33	U	0.33	U	0.34	U
		Sodium	--	[n]	145	mg/Kg	1200		1200		91	U	1000		1500		1400		740		92	U	150	
		Vanadium	7.8	nc	37.6	mg/Kg	**14**		**14**		**15**		**11**		**24**		**22**		**11**		**21**		**23**	
		Zinc	2346	nc	93.3	mg/Kg	62		56		52		53		60		76		22		69	H	58	
	7041	Antimony	3.1	nc	0.96	mg/Kg	0.019	B	0.14	B	0.41	U	0.58	B	0.5	U	0.49	U	0.48	U	0.23	B	0.49	U
	7060A	Arsenic	0.39	ca	19.8	mg/Kg	**16**		**15**		**15**		**16**		**13**		**11**		**13**		**12**		**15**	
	7421	Lead	400	pbk	19.1	mg/Kg	11		12		11		12		10		15		7.8		14		12	
	7471A	Mercury	2.3	nc	0.04	mg/Kg	0.0086	B	0.011	B	0.0049	U	0.0081	B	0.014	B	0.021		0.016	B	0.018	B	0.011	B
	7841	Thallium	0.52	nc	0.91	mg/Kg	0.21	U	0.21	U	0.18	U	0.19	U	0.22	U	0.0089	U	0.072	B	0.21	U	0.22	B

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-034-0001-SO	LL6SB-035-0001-SO	LL6SB-036-0001-SO	LL6SB-037-0001-SO	LL6SB-038-0001-SO	LL6SB-039-0001-SO	LL6SB-040-0001-SO	LL6SB-041-0001-SO	LL6SB-042-0001-SO
						Sample Date	11/14/03	11/14/03	11/18/03	11/14/03	11/05/03	11/05/03	11/05/03	10/27/03	12/03/03
						Sample Depth	15-17 ft.	11-13 ft.	6-8 ft.	12-14 ft.	8-10 ft.	8-10 ft.	4-6 ft.	5-7 ft.	1-3 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units									
VOCs TCL 8260B	8260B	1,1,1-Trichloroethane	1200	sat	--	mg/Kg									
		1,1,2,2-Tetrachloroethane	0.41	ca	--	mg/Kg									
		1,1,2-Trichloroethane	0.73	ca	--	mg/Kg									
		1,1-Dichloroethane	51	nc	--	mg/Kg									
		1,1-Dichloroethene	12	nc	--	mg/Kg									
		1,2-Dichloroethane	0.28	ca	--	mg/Kg									
		1,2-Dichloroethene (total)	6.9	nc	--	mg/Kg									
		1,2-Dichloropropane	0.34	ca	--	mg/Kg									
		2-Butanone (MEK)	2231	nc	--	mg/Kg									
		2-Hexanone	530	nc	--	mg/Kg									
		4-Methyl-2-pentanone (MIBK)	528	nc	--	mg/Kg									
		Acetone	1412	nc	--	mg/Kg									
		Benzene	0.64	ca	--	mg/Kg									
		Bromodichloromethane	0.82	ca	--	mg/Kg									
		Bromoform	62	ca	--	mg/Kg									
		Bromomethane	0.39	nc	--	mg/Kg									
		Carbon disulfide	36	nc	--	mg/Kg									
		Carbon tetrachloride	0.25	ca	--	mg/Kg									
		Chlorobenzene	15	nc	--	mg/Kg									
		Chloroethane	3.0	ca	--	mg/Kg									
		Chloroform	0.22	ca	--	mg/Kg									
		Chloromethane	4.7	nc	--	mg/Kg									
		cis-1,3-Dichloropropene	0.78	ca	--	mg/Kg									
		Dibromochloromethane	1.1	ca	--	mg/Kg									
		Ethylbenzene	395	sat	--	mg/Kg									
		Methylene chloride	9.1	ca	--	mg/Kg									
		Styrene	1700	sat	--	mg/Kg									
		Tetrachloroethene	0.48	ca	--	mg/Kg									
		Toluene	520	sat	--	mg/Kg									
		trans-1,3-Dichloropropene	0.78	ca	--	mg/Kg									
		Trichloroethene	0.053	ca	--	mg/Kg									
		Vinyl chloride	0.079	ca	--	mg/Kg									
		Xylenes (total)	0.079	ca	--	mg/Kg									

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-044-0001-DUP		LL6SB-044-0001-SO		LL6SB-045-0001-SO		LL6SB-049-0001-SO		LL6SB-050-0001-SO		LL6SB-051-0001-SO		LL6SB-055-0001-SO		LL6SB-056-0001-SO	
						Sample Date	12/02/03		12/02/03		12/02/03		11/04/03		11/04/03		11/04/03		11/04/03		11/18/03	
						Sample Depth	1-3 ft.		1-3 ft.		1-3 ft.		4-6 ft.		6-8 ft.		6-8 ft.		3-5 ft.		1-3 ft.	
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units																
Cyanide 9012A	9014/9010B	Cyanide, Total	122	nc	0.00	mg/Kg	0.22	U	0.15	U												
Explosives 8330	8330	1,3,5-Trinitrobenzene	183	nc	0.00	mg/Kg	0.018	U	0.017	U												
		1,3-Dinitrobenzene	0.61	nc	0.00	mg/Kg	0.018	U	0.018	U												
		2,4,6-TNT	16	ca	0.00	mg/Kg	0.034	U	0.033	U												
		2,4-Dinitrotoluene	12	nc	0.00	mg/Kg	0.036	U	0.035	U												
		2,6-Dinitrotoluene	6.1	nc	0.00	mg/Kg	0.048	U	0.047	U												
		2-Nitrotoluene	0.88	ca	0.00	mg/Kg	0.033	U	0.033	U												
		3-Nitrotoluene	73	nc	0.00	mg/Kg	0.05	U	0.05	U												
		4-Nitrotoluene	12	ca	0.00	mg/Kg	0.047	U	0.046	U												
		HMX	306	nc	0.00	mg/Kg	0.11	U	0.11	U												
		Nitrobenzene	2	nc	0.00	mg/Kg	0.022	U	0.022	U												
		RDX	4.4	ca	0.00	mg/Kg	0.059	U	0.058	U												
		Tetryl	61	nc	0.00	mg/Kg	0.043	U	0.043	U												
Others	8015B MDRO	Diesel Range Organics (DRO)	--	--	--	mg/Kg							3	U	2.9	U	3	U	2.9	U		
	8015B MGRO	Gasoline Range Organics (GRO)	--	--	--	mg/Kg							0.11	U	0.011	U	0.011	U	0.011	U		
	8081A	Toxaphene	0.44	ca	--	mg/Kg	0.0054	U	0.0053	U												
	8270C	Phenanthrene	--	--	--	mg/Kg	0.0012	U	0.0012	U			0.0011	U	0.0012	U	0.0012	U	0.0011	U		
PCB TCL 8082	8082	Aroclor 1016	0.39	nc	--	mg/Kg	0.0022	U	0.0022	U												
		Aroclor 1221	0.22	ca	--	mg/Kg	0.0023	U	0.0023	U												
		Aroclor 1232	0.22	ca	--	mg/Kg	0.0023	U	0.0023	U												
		Aroclor 1242	0.22	ca	--	mg/Kg	0.0023	U	0.0023	U												
		Aroclor 1248	0.22	ca	--	mg/Kg	0.0023	U	0.0023	U												
		Aroclor 1254	0.22	ca	--	mg/Kg	0.0023	U	0.0023	U												
		Aroclor 1260	0.22	ca	--	mg/Kg	0.0016	U	0.0016	U												
Pesticides 8081A	8081A	4,4'-DDD	2.4	ca	--	mg/Kg	0.00042	U	0.00041	U												
		4,4'-DDE	1.7	ca	--	mg/Kg	0.00076	U	0.00075	U												
		4,4'-DDT	1.7	ca	--	mg/Kg	0.00043	U	0.00042	U												
		Aldrin	0.029	ca	--	mg/Kg	0.00015	U	0.00015	U												
		alpha-BHC	0.09	sat	--	mg/Kg	0.00019	U	0.00018	U												
		alpha-Chlordane	1.6	ca	--	mg/Kg	0.00014	U	0.00014	U												
		beta-BHC	0.32	ca	--	mg/Kg	0.00018	U	0.00017	U												
		delta-BHC	--	--	--	mg/Kg	0.00013	U	0.00013	U												
		Dieldrin	0.030	ca	--	mg/Kg	0.0004	U	0.00039	U												
		Endosulfan I	37	nc	--	mg/Kg	0.00032	U	0.00031	U												
		Endosulfan II	37	nc	--	mg/Kg	0.00033	U	0.00032	U												
		Endosulfan sulfate	37	nc	--	mg/Kg	0.00034	U	0.00033	U												
		Endrin	1.8	nc	--	mg/Kg	0.0005	U	0.00049	U												
		Endrin aldehyde	--	--	--	mg/Kg	0.00039	U	0.00038	U												
		Endrin ketone	--	--	--	mg/Kg	0.00034	U	0.00033	U												
		gamma-BHC (Lindane)	0.44	ca	--	mg/Kg	0.00027	U	0.00026	U												
		gamma-Chlordane	1.6	ca	--	mg/Kg	0.00018	U	0.00017	U												
		Heptachlor	0.11	ca	--	mg/Kg	0.00021	U	0.00021	U												
		Heptachlor epoxide	0.053	ca	--	mg/Kg	0.00016	U	0.00016	U												

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-044-0001-DUP		LL6SB-044-0001-SO		LL6SB-045-0001-SO	LL6SB-049-0001-SO		LL6SB-050-0001-SO		LL6SB-051-0001-SO		LL6SB-055-0001-SO		LL6SB-056-0001-SO
						Sample Date	12/02/03		12/02/03		12/02/03	11/04/03		11/04/03		11/04/03		11/04/03		11/18/03
						Sample Depth	1-3 ft.		1-3 ft.		1-3 ft.	4-6 ft.		6-8 ft.		6-8 ft.		3-5 ft.		1-3 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units														
		Methoxychlor	31	nc	--	mg/Kg	0.0027	U	0.0026	U										
Propellants 8330	353.2	Nitrocellulose	--	--	0.00	mg/Kg	2.8	J	0.85	B J										
	8330	Nitroglycerin	35	--	0.00	mg/Kg	0.5	U	0.5	U										
	UV/HPLC per SOP	Nitroguanidine	611	nc	0.00	mg/Kg	0.25	U	0.25	U										
SVOCs TCL 8270 C	8270C	1,2,4-Trichlorobenzene	6.2	nc	--	mg/Kg	0.07	U	0.069	U		0.067	U	0.069	U	0.069	U	0.067	U	
		1,2-Dichlorobenzene	600	sat	--	mg/Kg	0.094	U	0.092	U		0.089	U	0.092	U	0.092	U	0.09	U	
		1,3-Dichlorobenzene	53	nc	--	mg/Kg	0.094	U	0.092	U		0.089	U	0.092	U	0.092	U	0.09	U	
		1,4-Dichlorobenzene	3.4	ca	--	mg/Kg	0.084	U	0.083	U		0.08	U	0.083	U	0.083	U	0.08	U	
		2,2-oxybis (1-chloropropane)	2.9	ca	--	mg/Kg	0.089	U	0.087	U		0.085	U	0.087	U	0.087	U	0.085	U	
		2,4,5-Trichlorophenol	611	nc	--	mg/Kg	0.045	U	0.044	U		0.043	U	0.044	U	0.044	U	0.043	U	
		2,4,6-Trichlorophenol	0.61	nc	--	mg/Kg	0.056	U	0.055	U		0.053	U	0.055	U	0.055	U	0.053	U	
		2,4-Dichlorophenol	18	nc	--	mg/Kg	0.057	U	0.056	U		0.054	U	0.056	U	0.056	U	0.054	U	
		2,4-Dimethylphenol	122	nc	--	mg/Kg	0.071	U	0.07	U		0.068	U	0.07	U	0.07	U	0.068	U	
		2,4-Dinitrophenol	12	nc	--	mg/Kg	0.14	U	0.13	U		0.13	U	0.13	U	0.13	U	0.13	U	
		2-Chloronaphthalene	494	nc	--	mg/Kg	0.057	U	0.056	U		0.054	U	0.056	U	0.056	U	0.054	U	
		2-Chlorophenol	6.3	nc	--	mg/Kg	0.07	U	0.069	U		0.067	U	0.069	U	0.069	U	0.067	U	
		2-Methylnaphthalene	--	--	--	mg/Kg	0.0018	U	0.0017	U		0.0017	U	0.0017	U	0.0017	U	0.0017	U	
		2-Methylphenol (o-cresol)	306	nc	--	mg/Kg	0.01	U	0.0098	U		0.0095	U	0.0098	U	0.0098	U	0.0095	U	
		2-Nitroaniline	18.3	nc	--	mg/Kg	0.04	U	0.04	U		0.038	U*	0.04	U*	0.04	U*	0.039	U*	
		2-Nitrophenol	--	--	--	mg/Kg	0.075	U	0.073	U		0.071	U	0.073	U	0.073	U	0.071	U	
		3,3-Dichlorobenzidine	1.1	ca	--	mg/Kg	0.021	U	0.021	U		0.02	U	0.021	U	0.021	U	0.02	U	
		3-Nitroaniline	1.8	nc	--	mg/Kg	0.13	U*	0.13	U*		0.13	U	0.13	U	0.13	U	0.13	U	
		4,6-Dinitro-2-methylphenol	0.61	nc	--	mg/Kg	0.11	U*	0.11	U*		0.11	U*	0.11	U*	0.11	U*	0.11	U*	
		4-Bromophenyl phenyl ether	--	--	--	mg/Kg	0.0037	U	0.0036	U		0.0035	U*	0.0036	U*	0.0036	U*	0.0035	U*	
		4-Chloro-3-methylphenol	--	--	--	mg/Kg	0.045	U	0.044	U		0.043	U	0.044	U	0.044	U	0.043	U	
		4-Chloroaniline	24	nc	--	mg/Kg	0.12	U	0.12	U		0.11	U	0.12	U	0.12	U	0.11	U	
		4-Chlorophenyl phenyl ether	--	--	--	mg/Kg	0.0043	U	0.0042	U		0.0041	U*	0.0042	U*	0.0042	U*	0.0041	U*	
		4-Methylphenol (m/p-cresol)	31	nc	--	mg/Kg	0.0069	U	0.0068	U		0.0065	U	0.0068	U	0.0068	U	0.0066	U	
		4-Nitroaniline	23	ca	--	mg/Kg	0.046	U	0.045	U		0.044	U	0.045	U	0.045	U	0.044	U	
		4-Nitrophenol	--	--	--	mg/Kg	0.097	U	0.096	U		0.092	U	0.096	U	0.095	U	0.093	U	
		Acenaphthene	368	nc	--	mg/Kg	0.0017	U	0.0016	U		0.0016	U	0.0016	U	0.0016	U	0.0016	U	
		Acenaphthylene	--	--	--	mg/Kg	0.0011	U	0.0011	U		0.001	U*	0.0011	U*	0.0011	U*	0.001	U*	
		Anthracene	2189	nc	--	mg/Kg	0.001	U	0.001	U		0.00097	U	0.001	U	0.001	U	0.00097	U	
		Benzo(a)anthracene	0.62	ca	--	mg/Kg	0.0013	U	0.0013	U		0.0012	U	0.0013	U	0.0013	U	0.0012	U	
		Benzo(a)pyrene	0.062	ca	--	mg/Kg	0.0026	U	0.0026	U		0.0025	U	0.0026	U	0.0026	U	0.0025	U	
		Benzo(b)fluoranthene	0.62	ca	--	mg/Kg	0.0025	U	0.0024	U		0.0024	U	0.0024	U	0.0024	U	0.0024	U	
		Benzo(ghi)perylene	--	--	--	mg/Kg	0.0023	U	0.0022	U		0.0021	U	0.0022	U	0.0022	U	0.0022	U	
		Benzo(k)fluoranthene	6.2	ca	--	mg/Kg	0.0033	U	0.0033	U		0.0032	U	0.0033	U	0.0033	U	0.0032	U	
		Bis(2-chloroethoxy)methane	--	--	--	mg/Kg	0.0034	U	0.0034	U		0.0033	U	0.0034	U	0.0034	U	0.0033	U	
		Bis(2-chloroethyl)ether	0.22	ca	--	mg/Kg	0.0024	U	0.0023	U		0.0023	U	0.0023	U	0.0023	U	0.0023	U	
		Bis(2-ethylhexyl)phthalate	35	ca	--	mg/Kg	0.06	Ja	0.16	Ja		0.011	U	0.011	U	0.011	U	0.011	U	
		Butyl benzyl phthalate	1222	nc	--	mg/Kg	0.0049	U	0.0048	U		0.0046	U	0.0048	U	0.0048	U	0.0046	U	
		Carbazole	24	ca	--	mg/Kg	0.042	U	0.041	U		0.039	U	0.041	U	0.041	U	0.04	U	
		Chrysene	62	ca	--	mg/Kg	0.0021	U	0.0021	U		0.002	U	0.0021	U	0.0021	U	0.002	U	
		Dibenzo(a,h)anthracene	0.062	ca	--	mg/Kg	0.0026	U	0.0026	U		0.0025	U	0.0026	U	0.0026	U	0.0025	U	

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-044-0001-DUP		LL6SB-044-0001-SO		LL6SB-045-0001-SO		LL6SB-049-0001-SO		LL6SB-050-0001-SO		LL6SB-051-0001-SO		LL6SB-055-0001-SO		LL6SB-056-0001-SO	
						Sample Date	12/02/03		12/02/03		12/02/03		11/04/03		11/04/03		11/04/03		11/04/03		11/18/03	
						Sample Depth	1-3 ft.		1-3 ft.		1-3 ft.		4-6 ft.		6-8 ft.		6-8 ft.		3-5 ft.		1-3 ft.	
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units																
		Dibenzofuran	15	nc	--	mg/Kg	0.0032	U	0.0031	U			0.003	U	0.0031	U	0.0031	U	0.0031	U		
		Diethyl phthalate	4888	nc	--	mg/Kg	0.0044	U	0.0043	U			0.0042	U*	0.0043	U*	0.0043	U*	0.0042	U*		
		Dimethyl phthalate	100000	max	--	mg/Kg	0.0043	U	0.0042	U			0.0041	U*	0.0042	U*	0.0042	U*	0.0041	U*		
		Di-n-butyl phthalate	611	nc	--	mg/Kg	0.024	U	0.023	U			0.023	U	0.023	U	0.023	U	0.023	U		
		Di-n-octyl phthalate	244	nc	--	mg/Kg	0.01	U	0.01	U			0.02	J	0.01	U	0.01	U	0.0099	U		
		Fluoranthene	229	nc	--	mg/Kg	0.0013	U	0.0013	U			0.0012	U	0.0013	U	0.0013	U	0.0012	U		
		Fluorene	275	nc	--	mg/Kg	0.0019	U	0.0019	U			0.0018	U	0.0019	U	0.0019	U	0.0018	U		
		Hexachlorobenzene	0.30	ca	--	mg/Kg	0.0021	U	0.0021	U			0.002	U*	0.0021	U*	0.0021	U*	0.002	U*		
		Hexachlorobutadiene	6.2	ca	--	mg/Kg	0.0039	U	0.0038	U			0.0037	U	0.0038	U	0.0038	U	0.0037	U		
		Hexachlorocyclopentadiene	37	nc	--	mg/Kg	0.064	U	0.063	U			0.061	U	0.063	U	0.063	U	0.061	U		
		Hexachloroethane	35	ca	--	mg/Kg	0.0039	U	0.0038	U			0.0037	U	0.0038	U	0.0038	U	0.0037	U		
		Indeno(1,2,3-cd)pyrene	0.62	ca	--	mg/Kg	0.0025	U	0.0024	U			0.0024	U	0.0024	U	0.0024	U	0.0024	U		
		Isophorone	512	ca	--	mg/Kg	0.0028	U	0.0028	U			0.0027	U	0.0028	U	0.0028	U	0.0027	U		
		Naphthalene	5.6	nc	--	mg/Kg	0.002	U	0.002	U			0.0019	U	0.002	U	0.002	U	0.0019	U		
		n-Nitroso-di-n-propylamine	0.069	ca	--	mg/Kg	0.0027	U	0.0027	U			0.0026	U	0.0027	U	0.0027	U	0.0026	U		
		n-Nitrosodiphenylamine	99	ca	--	mg/Kg	0.0034	U	0.0034	U			0.0033	U	0.0034	U	0.0034	U	0.0033	U		
		Pentachlorophenol	3.0	ca	--	mg/Kg	0.12	U	0.12	U			0.11	U	0.12	U	0.12	U	0.11	U		
		Phenol	1833	nc	--	mg/Kg	0.0019	U	0.0019	U			0.0018	U	0.0019	U	0.0019	U	0.0018	U		
		Pyrene	232	nc	--	mg/Kg	0.0024	U	0.0023	U			0.0023	U	0.0023	U	0.0023	U	0.0023	U		
TAL Metals 6010B	6010B	Aluminum	7614	nc	19500	mg/Kg	**8500**		**9100**		**16000**										**16000**	
		Barium	538	nc	124	mg/Kg	43		47		87										63	
		Beryllium	15	nc	0.88	mg/Kg	0.45		0.51		0.94										0.6	
		Cadmium	3.7	nc	0.00	mg/Kg	0.088	U	0.083	U	0.083	U									0.091	U
		Calcium	--	[n]	35500	mg/Kg	660		410		3800										3400	
		Chromium	30	ca	27.2	mg/Kg	10		11		21										19	
		Cobalt	902	ca	23.2	mg/Kg	3.4		3.7		12										5.5	
		Copper	313	nc	32.3	mg/Kg	5		5.6		23										15	
		Iron	2346	nc	35200	mg/Kg	**15000**		**16000**		**29000**										**26000**	H
		Magnesium	--	[n]	8790	mg/Kg	1400		1500		4600										2600	
		Manganese	176	nc	3030	mg/Kg	**210**		110		**300**										150	
		Nickel	156	nc	60.7	mg/Kg	7.8		8.4		30										14	
		Potassium	--	[n]	3350	mg/Kg	610		620		1700										1300	
		Selenium	39	nc	1.5	mg/Kg	0.44	U	0.41	U	0.41	U									1.5	
		Silver	39	nc	0.00	mg/Kg	0.34	U	0.32	U	0.32	U									0.35	U
		Sodium	--	[n]	145	mg/Kg	96	U	90	U	100	B									98	U
		Vanadium	7.8	nc	37.6	mg/Kg	**17**		**18**		**24**										**27**	
		Zinc	2346	nc	93.3	mg/Kg	29		31		61										45	
	7041	Antimony	3.1	nc	0.96	mg/Kg	0.51	U	0.5	U	0.51	U									0.49	U
	7060A	Arsenic	0.39	ca	19.8	mg/Kg	**5.2**		**4.3**		**15**										**13**	
	7421	Lead	400	pbk	19.1	mg/Kg	7.5		8.5		17										14	
	7471A	Mercury	2.3	nc	0.04	mg/Kg	0.013	B	0.013	B	0.017	B									0.022	
	7841	Thallium	0.52	nc	0.91	mg/Kg	0.22	U	0.21	U	0.22	U									1.1	U

Table 4−4
Summary of Subsurface Soil Results (>1 ft)

							LL6SB-044-0001-DUP		LL6SB-044-0001-SO		LL6SB-045-0001-SO		LL6SB-049-0001-SO		LL6SB-050-0001-SO		LL6SB-051-0001-SO		LL6SB-055-0001-SO		LL6SB-056-0001-SO	
						Sample Date	12/02/03		12/02/03		12/02/03		11/04/03		11/04/03		11/04/03		11/04/03		11/18/03	
						Sample Depth	1-3 ft.		1-3 ft.		1-3 ft.		4-6 ft.		6-8 ft.		6-8 ft.		3-5 ft.		1-3 ft.	
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SB PRG Basis	RVAAP Subsurface Soil Background Criteria	Units																
VOCs TCL 8260B	8260B	1,1,1-Trichloroethane	1200	sat	--	mg/Kg	0.0013	U	0.0013	U			0.00069	U	0.00071	U	0.00071	U	0.00071	U		
		1,1,2,2-Tetrachloroethane	0.41	ca	--	mg/Kg	0.0012	U	0.0011	U			0.00073	U	0.00075	U	0.00075	U	0.00075	U		
		1,1,2-Trichloroethane	0.73	ca	--	mg/Kg	0.0013	U	0.0013	U			0.00081	U	0.00083	U	0.00083	U	0.00083	U		
		1,1-Dichloroethane	51	nc	--	mg/Kg	0.0012	U	0.0012	U			0.001	U	0.001	U	0.001	U	0.001	U		
		1,1-Dichloroethene	12	nc	--	mg/Kg	0.0016	U	0.0016	U			0.0011	U	0.0012	U	0.0012	U	0.0012	U		
		1,2-Dichloroethane	0.28	ca	--	mg/Kg	0.0011	U	0.0011	U			0.00066	U	0.00068	U	0.00068	U	0.00068	U		
		1,2-Dichloroethene (total)	6.9	nc	--	mg/Kg	0.0026	U	0.0025	U			0.0022	U	0.0022	U	0.0022	U	0.0022	U		
		1,2-Dichloropropane	0.34	ca	--	mg/Kg	0.0012	U	0.0012	U			0.0011	U	0.0011	U	0.0011	U	0.0011	U		
		2-Butanone (MEK)	2231	nc	--	mg/Kg	0.0047	U	0.0047	U			0.0048	U	0.0049	U	0.0049	U	0.0049	U		
		2-Hexanone	530	nc	--	mg/Kg	0.0013	U	0.0013	U			0.0019	U*	0.002	U*	0.002	U*	0.002	U*		
		4-Methyl-2-pentanone (MIBK)	528	nc	--	mg/Kg	0.0012	U	0.0012	U			0.0034	U*	0.0035	U*	0.0035	U*	0.0035	U*		
		Acetone	1412	nc	--	mg/Kg	0.012		0.0055	U			0.0047	U	0.0048	U	0.0048	U	0.0048	U		
		Benzene	0.64	ca	--	mg/Kg	0.0013	U	0.0013	U			0.00075	U	0.00077	U	0.00077	U	0.00077	U		
		Bromodichloromethane	0.82	ca	--	mg/Kg	0.0012	U	0.0011	U			0.00077	U	0.0008	U	0.00079	U	0.0008	U		
		Bromoform	62	ca	--	mg/Kg	0.00091	U	0.0009	U			0.001	U*	0.0011	U*	0.0011	U*	0.0011	U*		
		Bromomethane	0.39	nc	--	mg/Kg	0.0016	U	0.0016	U			0.0033	U*	0.0034	U*	0.0034	U*	0.0034	U*		
		Carbon disulfide	36	nc	--	mg/Kg	0.0015	U	0.0014	U			0.0023	U	0.0023	U	0.0023	U	0.0023	U		
		Carbon tetrachloride	0.25	ca	--	mg/Kg	0.0013	U	0.0013	UM			0.00095	U	0.00097	U	0.00097	U	0.00097	U		
		Chlorobenzene	15	nc	--	mg/Kg	0.0013	U	0.0013	U			0.001	U	0.0011	U	0.0011	U	0.0011	U		
		Chloroethane	3.0	ca	--	mg/Kg	0.0012	U	0.0012	U*			0.0018	U	0.0019	U	0.0019	U	0.0019	U		
		Chloroform	0.22	ca	--	mg/Kg	0.0013	U	0.0013	U			0.00071	U	0.00073	U	0.00072	U	0.00073	U		
		Chloromethane	4.7	nc	--	mg/Kg	0.0013	U	0.0013	U			0.0011	U	0.0011	U	0.0011	U	0.0011	U		
		cis-1,3-Dichloropropene	0.78	ca	--	mg/Kg	0.0011	U	0.0011	U			0.0009	U	0.00092	U	0.00092	U	0.00092	U		
		Dibromochloromethane	1.1	ca	--	mg/Kg	0.00096	U	0.00094	U			0.00079	U	0.00081	U	0.0008	U	0.00081	U		
		Ethylbenzene	395	sat	--	mg/Kg	0.0013	U	0.0013	U			0.0013	U	0.0013	U	0.0013	U	0.0013	U		
		Methylene chloride	9.1	ca	--	mg/Kg	0.0048	Ja	0.0035	U			0.0021	U	0.0021	U	0.0021	U	0.0021	U		
		Styrene	1700	sat	--	mg/Kg	0.0013	U	0.0013	U			0.0011	U	0.0012	U	0.0012	U	0.0012	U		
		Tetrachloroethene	0.48	ca	--	mg/Kg	0.0015	U	0.0014	U			0.00076	U	0.00078	U	0.00078	U	0.00078	U		
		Toluene	520	sat	--	mg/Kg	0.0013	U	0.0013	U			0.0011	U	0.0012	U	0.0012	U	0.0012	U		
		trans-1,3-Dichloropropene	0.78	ca	--	mg/Kg	0.00096	U	0.00094	U			0.00096	U	0.00098	U	0.00098	U	0.00098	U		
		Trichloroethene	0.053	ca	--	mg/Kg	0.0013	U	0.0013	U			0.00067	U	0.00069	U	0.00069	U	0.00069	U		
		Vinyl chloride	0.079	ca	--	mg/Kg	0.0013	U	0.0013	U			0.00084	U	0.00087	U	0.00086	U	0.00087	U		
		Xylenes (total)	0.079	ca	--	mg/Kg	0.0041	U	0.0041	U			0.0033	U	0.0034	U	0.0034	U	0.0034	U		

Table 4-4
Summary of Subsurface Soil Results (>1ft)

Notes:
blank cells indicates that analysis was not performed
-- - no background/PRG value is available for this analyte
PRG - preliminary remediation goals
nc - non-cancer basis, value is 1/10th the published PRG
ca - cancer basis
pbk - based on PBK modeling
mcl - based on CWA maximum contaminant level
max - ceiling limit
sat - soil saturation
[n] - nutrient
If Result = or > Background, then the value is presented with a shaded/highlighted style
If Result = or > Background and PRG, then the value is presented with a bold + shaded/highlighted style
If Result = or > PRG, then the value is presented with a bold style
If Result < PRG and Background, then the value is presented with a normal style
Inorganic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is less than the RL, but greater than or equal to the MDL
B - result is less than the CRDL/RL, but greater than or equal to the IDL/MDL
InOrganic Flags
^ - instrument related QC exceed the upper or lower control limits
* - batch QC exceeds the upper or lower control limit
H - batch QC is greater than RL
Organic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is an estimated value below the RL
Organic Flags
B - Method Blank: batch QC is greater than RL
* - batch QC exceeds the upper or lower control limit
^ - batch QC is greater than RL
H - alternate peak selection upon analytical review

Table 4−5
Summary of Subsurface Soil Exceedances (>1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Subsurface Soil Background Criteria (mg/kg)	Subsurface Soil Region 9 PRGs (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SB-001-0001-SO	12/03/03	1-3 ft	Aluminum	11000		19500	7614	NO	YES
LL6SB-001-0001-SO	12/03/03	1-3 ft	Arsenic	17		19.8	0.39	NO	YES
LL6SB-001-0001-SO	12/03/03	1-3 ft	Iron	22000		35200	2346	NO	YES
LL6SB-001-0001-SO	12/03/03	1-3 ft	Manganese	380		3030	176	NO	YES
LL6SB-001-0001-SO	12/03/03	1-3 ft	Vanadium	18		37.6	7.8	NO	YES
LL6SB-002-0001-SO	12/03/03	1-3 ft	Aluminum	10000		19500	7614	NO	YES
LL6SB-002-0001-SO	12/03/03	1-3 ft	Arsenic	13		19.8	0.39	NO	YES
LL6SB-002-0001-SO	12/03/03	1-3 ft	Iron	21000		35200	2346	NO	YES
LL6SB-002-0001-SO	12/03/03	1-3 ft	Lead	20		19.1	400	YES	NO
LL6SB-002-0001-SO	12/03/03	1-3 ft	Manganese	300		3030	176	NO	YES
LL6SB-002-0001-SO	12/03/03	1-3 ft	Vanadium	17		37.6	7.8	NO	YES
LL6SB-003-0001-SO	12/03/03	1-3 ft	Arsenic	13		19.8	0.39	NO	YES
LL6SB-003-0001-SO	12/03/03	1-3 ft	Iron	13000		35200	2346	NO	YES
LL6SB-003-0001-SO	12/03/03	1-3 ft	Manganese	300		3030	176	NO	YES
LL6SB-003-0001-SO	12/03/03	1-3 ft	Vanadium	12		37.6	7.8	NO	YES
LL6SB-003-001-SO	12/03/03	1-3 ft	Nitrocellulose	1.3	B J	0.00	--	YES	NO
LL6SB-004-0001-SO	11/25/03	1-3 ft	Aluminum	14000		19500	7614	NO	YES
LL6SB-004-0001-SO	11/25/03	1-3 ft	Arsenic	13		19.8	0.39	NO	YES
LL6SB-004-0001-SO	11/25/03	1-3 ft	Iron	28000		35200	2346	NO	YES
LL6SB-004-0001-SO	11/25/03	1-3 ft	Manganese	290		3030	176	NO	YES
LL6SB-004-0001-SO	11/25/03	1-3 ft	Sodium	1800		145	--[n]	YES	NO
LL6SB-004-0001-SO	11/25/03	1-3 ft	Vanadium	23		37.6	7.8	NO	YES
LL6SB-005-0001-SO	11/19/03	1-3 ft	Aluminum	13000		19500	7614	NO	YES
LL6SB-005-0001-SO	11/19/03	1-3 ft	Arsenic	15		19.8	0.39	NO	YES
LL6SB-005-0001-SO	11/19/03	1-3 ft	Iron	23000		35200	2346	NO	YES
LL6SB-005-0001-SO	11/19/03	1-3 ft	Lead	20		19.1	400	YES	NO
LL6SB-005-0001-SO	11/19/03	1-3 ft	Manganese	700		3030	176	NO	YES
LL6SB-005-0001-SO	11/19/03	1-3 ft	Vanadium	24	H	37.6	7.8	NO	YES
LL6SB-006-0001-DUP	11/21/03	1-3 ft	Aluminum	13000		19500	7614	NO	YES
LL6SB-006-0001-DUP	11/21/03	1-3 ft	Arsenic	11		19.8	0.39	NO	YES
LL6SB-006-0001-DUP	11/21/03	1-3 ft	Iron	27000		35200	2346	NO	YES
LL6SB-006-0001-DUP	11/21/03	1-3 ft	Manganese	1100		3030	176	NO	YES
LL6SB-006-0001-DUP	11/21/03	1-3 ft	Vanadium	27		37.6	7.8	NO	YES
LL6SB-006-0001-SO	11/21/03	1-3 ft	Aluminum	13000		19500	7614	NO	YES
LL6SB-006-0001-SO	11/21/03	1-3 ft	Arsenic	14		19.8	0.39	NO	YES
LL6SB-006-0001-SO	11/21/03	1-3 ft	Iron	24000		35200	2346	NO	YES
LL6SB-006-0001-SO	11/21/03	1-3 ft	Lead	24		19.1	400	YES	NO
LL6SB-006-0001-SO	11/21/03	1-3 ft	Manganese	660		3030	176	NO	YES
LL6SB-006-0001-SO	11/21/03	1-3 ft	Mercury	0.044		0.04	2.3	YES	NO
LL6SB-006-0001-SO	11/21/03	1-3 ft	Nitrocellulose	0.88	B	0.00	--	YES	NO
LL6SB-006-0001-SO	11/21/03	1-3 ft	Vanadium	25		37.6	7.8	NO	YES
LL6SB-007-0001-SO	11/14/03	1-3 ft	Aluminum	15000		19500	7614	NO	YES
LL6SB-007-0001-SO	11/14/03	1-3 ft	Arsenic	17		19.8	0.39	NO	YES
LL6SB-007-0001-SO	11/14/03	1-3 ft	Cadmium	0.67		0	3.7	YES	NO
LL6SB-007-0001-SO	11/14/03	1-3 ft	Iron	28000	H	35200	2346	NO	YES
LL6SB-007-0001-SO	11/14/03	1-3 ft	Lead	150		19.1	400	YES	NO
LL6SB-007-0001-SO	11/14/03	1-3 ft	Manganese	500		3030	176	NO	YES

Table 4−5
Summary of Subsurface Soil Exceedances (>1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Subsurface Soil Background Criteria (mg/kg)	Subsurface Soil Region 9 PRGs (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SB-007-0001-SO	11/14/03	1-3 ft	Sodium	1400		145	--[n]	YES	NO
LL6SB-007-0001-SO	11/14/03	1-3 ft	Vanadium	24		37.6	7.8	NO	YES
LL6SB-007-0001-SO	11/14/03	1-3 ft	Zinc	190		93.3	2346	YES	NO
LL6SB-008-0001-SO	11/14/03	1-3 ft	Aluminum	16000		19500	7614	NO	YES
LL6SB-008-0001-SO	11/14/03	1-3 ft	Arsenic	11		19.8	0.39	NO	YES
LL6SB-008-0001-SO	11/14/03	1-3 ft	Iron	27000	H	35200	2346	NO	YES
LL6SB-008-0001-SO	11/14/03	1-3 ft	Manganese	230		3030	176	NO	YES
LL6SB-008-0001-SO	11/14/03	1-3 ft	Sodium	1600		145	--[n]	YES	NO
LL6SB-008-0001-SO	11/14/03	1-3 ft	Vanadium	24		37.6	7.8	NO	YES
LL6SB-009-0001-SO	11/20/03	1-3 ft	Aluminum	11000		19500	7614	NO	YES
LL6SB-009-0001-SO	11/20/03	1-3 ft	Arsenic	16		19.8	0.39	NO	YES
LL6SB-009-0001-SO	11/20/03	1-3 ft	Beryllium	1.1		0.88	15	YES	NO
LL6SB-009-0001-SO	11/20/03	1-3 ft	Iron	27000		35200	2346	NO	YES
LL6SB-009-0001-SO	11/20/03	1-3 ft	Manganese	810		3030	176	NO	YES
LL6SB-009-0001-SO	11/20/03	1-3 ft	Vanadium	19	H	37.6	7.8	NO	YES
LL6SB-010-0001-SO	12/02/03	1-3 ft	Aluminum	13000		19500	7614	NO	YES
LL6SB-010-0001-SO	12/02/03	1-3 ft	Arsenic	13		19.8	0.39	NO	YES
LL6SB-010-0001-SO	12/02/03	1-3 ft	Iron	26000		35200	2346	NO	YES
LL6SB-010-0001-SO	12/02/03	1-3 ft	Manganese	350		3030	176	NO	YES
LL6SB-010-0001-SO	12/02/03	1-3 ft	Vanadium	22		37.6	7.8	NO	YES
LL6SB-011-0001-SO	12/03/03	1-3 ft	Aluminum	13000		19500	7614	NO	YES
LL6SB-011-0001-SO	12/03/03	1-3 ft	Arsenic	9.9		19.8	0.39	NO	YES
LL6SB-011-0001-SO	12/03/03	1-3 ft	Iron	23000		35200	2346	NO	YES
LL6SB-011-0001-SO	12/03/03	1-3 ft	Manganese	360		3030	176	NO	YES
LL6SB-011-0001-SO	12/03/03	1-3 ft	Vanadium	22		37.6	7.8	NO	YES
LL6SB-012-0001-DUP	11/25/03	1-3 ft	Aluminum	21000		19500	7614	YES	YES
LL6SB-012-0001-DUP	11/25/03	1-3 ft	Arsenic	11		19.8	0.39	NO	YES
LL6SB-012-0001-DUP	11/25/03	1-3 ft	Iron	32000		35200	2346	NO	YES
LL6SB-012-0001-DUP	11/25/03	1-3 ft	Sodium	1500		145	--[n]	YES	NO
LL6SB-012-0001-DUP	11/25/03	1-3 ft	Vanadium	30		37.6	7.8	NO	YES
LL6SB-012-0001-SO	11/25/03	1-3 ft	Aluminum	19000		19500	7614	NO	YES
LL6SB-012-0001-SO	11/25/03	1-3 ft	Arsenic	12		19.8	0.39	NO	YES
LL6SB-012-0001-SO	11/25/03	1-3 ft	Iron	30000		35200	2346	NO	YES
LL6SB-012-0001-SO	11/25/03	1-3 ft	Manganese	340		3030	176	NO	YES
LL6SB-012-0001-SO	11/25/03	1-3 ft	Sodium	1600		145	--[n]	YES	NO
LL6SB-012-0001-SO	11/25/03	1-3 ft	Vanadium	29		37.6	7.8	NO	YES
LL6SB-013-0001-SO	11/21/03	1-3 ft	Aluminum	14000		19500	7614	NO	YES
LL6SB-013-0001-SO	11/21/03	1-3 ft	Arsenic	20		19.8	0.39	YES	YES
LL6SB-013-0001-SO	11/21/03	1-3 ft	Iron	28000		35200	2346	NO	YES
LL6SB-013-0001-SO	11/21/03	1-3 ft	Manganese	200		3030	176	NO	YES
LL6SB-013-0001-SO	11/21/03	1-3 ft	Vanadium	23		37.6	7.8	NO	YES
LL6SB-014-0001-SO	11/25/03	1-3 ft	Aluminum	9300		19500	7614	NO	YES
LL6SB-014-0001-SO	11/25/03	1-3 ft	Arsenic	12		19.8	0.39	NO	YES
LL6SB-014-0001-SO	11/25/03	1-3 ft	Iron	22000		35200	2346	NO	YES
LL6SB-014-0001-SO	11/25/03	1-3 ft	Manganese	390		3030	176	NO	YES
LL6SB-014-0001-SO	11/25/03	1-3 ft	Nitrocellulose	2.1	B	0.00	--	YES	NO
LL6SB-014-0001-SO	11/25/03	1-3 ft	Sodium	1200		145	--[n]	YES	NO

Table 4−5
Summary of Subsurface Soil Exceedances (>1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Subsurface Soil Background Criteria (mg/kg)	Subsurface Soil Region 9 PRGs (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SB-014-0001-SO	11/25/03	1-3 ft	Vanadium	15		37.6	7.8	NO	YES
LL6SB-014-0001-SO	11/25/03	1-3 ft	Zinc	97		93.3	2346	YES	NO
LL6SB-015-0001-DUP	11/25/03	1-3 ft	Aluminum	13000		19500	7614	NO	YES
LL6SB-015-0001-DUP	11/25/03	1-3 ft	Arsenic	18		19.8	0.39	NO	YES
LL6SB-015-0001-DUP	11/25/03	1-3 ft	Cadmium	0.12	B	0	3.7	YES	NO
LL6SB-015-0001-DUP	11/25/03	1-3 ft	Chromium	28		27.2	30	YES	NO
LL6SB-015-0001-DUP	11/25/03	1-3 ft	Copper	120		32.3	313	YES	NO
LL6SB-015-0001-DUP	11/25/03	1-3 ft	Iron	29000		35200	2346	NO	YES
LL6SB-015-0001-DUP	11/25/03	1-3 ft	Lead	250		19.1	400	YES	NO
LL6SB-015-0001-DUP	11/25/03	1-3 ft	Manganese	610		3030	176	NO	YES
LL6SB-015-0001-DUP	11/25/03	1-3 ft	Mercury	0.049		0.04	2.3	YES	NO
LL6SB-015-0001-DUP	11/25/03	1-3 ft	Sodium	1700		145	--[n]	YES	NO
LL6SB-015-0001-DUP	11/25/03	1-3 ft	Vanadium	20		37.6	7.8	NO	YES
LL6SB-015-0001-DUP	11/25/03	1-3 ft	Zinc	280		93.3	2346	YES	NO
LL6SB-015-0001-SO	11/25/03	1-3 ft	Aluminum	7800		19500	7614	NO	YES
LL6SB-015-0001-SO	11/25/03	1-3 ft	Arsenic	15		19.8	0.39	NO	YES
LL6SB-015-0001-SO	11/25/03	1-3 ft	Chromium	29		27.2	30	YES	NO
LL6SB-015-0001-SO	11/25/03	1-3 ft	Copper	110		32.3	313	YES	NO
LL6SB-015-0001-SO	11/25/03	1-3 ft	Iron	34000		35200	2346	NO	YES
LL6SB-015-0001-SO	11/25/03	1-3 ft	Lead	130		19.1	400	YES	NO
LL6SB-015-0001-SO	11/25/03	1-3 ft	Manganese	530		3030	176	NO	YES
LL6SB-015-0001-SO	11/25/03	1-3 ft	Sodium	970		145	--[n]	YES	NO
LL6SB-015-0001-SO	11/25/03	1-3 ft	Vanadium	14		37.6	7.8	NO	YES
LL6SB-015-0001-SO	11/25/03	1-3 ft	Zinc	160		93.3	2346	YES	NO
LL6SB-016-0001-SO	11/21/03	1-3 ft	Aluminum	14000		19500	7614	NO	YES
LL6SB-016-0001-SO	11/21/03	1-3 ft	Arsenic	13		19.8	0.39	NO	YES
LL6SB-016-0001-SO	11/21/03	1-3 ft	Cobalt	33		23.2	30	YES	YES
LL6SB-016-0001-SO	11/21/03	1-3 ft	Iron	28000		35200	2346	NO	YES
LL6SB-016-0001-SO	11/21/03	1-3 ft	Lead	20		19.1	400	YES	NO
LL6SB-016-0001-SO	11/21/03	1-3 ft	Manganese	570		3030	176	NO	YES
LL6SB-016-0001-SO	11/21/03	1-3 ft	Mercury	0.041		0.04	2.3	YES	NO
LL6SB-016-0001-SO	11/21/03	1-3 ft	Vanadium	20		37.6	7.8	NO	YES
LL6SB-017-0001-SO	11/19/03	1-3 ft	Aluminum	11000		19500	7614	NO	YES
LL6SB-017-0001-SO	11/19/03	1-3 ft	Arsenic	5		19.8	0.39	NO	YES
LL6SB-017-0001-SO	11/19/03	1-3 ft	Beryllium	0.9		0.88	15	YES	NO
LL6SB-017-0001-SO	11/19/03	1-3 ft	Cadmium	0.45		0	3.7	YES	NO
LL6SB-017-0001-SO	11/19/03	1-3 ft	Iron	17000		35200	2346	NO	YES
LL6SB-017-0001-SO	11/19/03	1-3 ft	Lead	47		19.1	400	YES	NO
LL6SB-017-0001-SO	11/19/03	1-3 ft	Manganese	820		3030	176	NO	YES
LL6SB-017-0001-SO	11/19/03	1-3 ft	Mercury	0.29		0.04	2.3	YES	NO
LL6SB-017-0001-SO	11/19/03	1-3 ft	Vanadium	20	H	37.6	7.8	NO	YES
LL6SB-018-0001-DUP	12/02/03	1-3 ft	Aluminum	12000		19500	7614	NO	YES
LL6SB-018-0001-DUP	12/02/03	1-3 ft	Arsenic	11		19.8	0.39	NO	YES
LL6SB-018-0001-DUP	12/02/03	1-3 ft	Cobalt	33		23.2	30	YES	YES
LL6SB-018-0001-DUP	12/02/03	1-3 ft	Iron	24000		35200	2346	NO	YES
LL6SB-018-0001-DUP	12/02/03	1-3 ft	Manganese	1600		3030	176	NO	YES
LL6SB-018-0001-DUP	12/02/03	1-3 ft	Vanadium	26		37.6	7.8	NO	YES

Table 4−5
Summary of Subsurface Soil Exceedances (>1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Subsurface Soil Background Criteria (mg/kg)	Subsurface Soil Region 9 PRGs (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SB-018-0001-SO	12/02/03	1-3 ft	Aluminum	13000		19500	7614	NO	YES
LL6SB-018-0001-SO	12/02/03	1-3 ft	Arsenic	13		19.8	0.39	NO	YES
LL6SB-018-0001-SO	12/02/03	1-3 ft	Iron	25000		35200	2346	NO	YES
LL6SB-018-0001-SO	12/02/03	1-3 ft	Manganese	260		3030	176	NO	YES
LL6SB-018-0001-SO	12/02/03	1-3 ft	Vanadium	32		37.6	7.8	NO	YES
LL6SB-019-0001-SO	11/19/03	1-3 ft	Aluminum	18000		19500	7614	NO	YES
LL6SB-019-0001-SO	11/19/03	1-3 ft	Arsenic	15		19.8	0.39	NO	YES
LL6SB-019-0001-SO	11/19/03	1-3 ft	Iron	30000		35200	2346	NO	YES
LL6SB-019-0001-SO	11/19/03	1-3 ft	Manganese	270		3030	176	NO	YES
LL6SB-019-0001-SO	11/19/03	1-3 ft	Vanadium	31	H	37.6	7.8	NO	YES
LL6SB-020-0001-SO	12/02/03	1-3 ft	Aluminum	13000		19500	7614	NO	YES
LL6SB-020-0001-SO	12/02/03	1-3 ft	Arsenic	19		19.8	0.39	NO	YES
LL6SB-020-0001-SO	12/02/03	1-3 ft	Beryllium	1		0.88	15	YES	NO
LL6SB-020-0001-SO	12/02/03	1-3 ft	Iron	27000		35200	2346	NO	YES
LL6SB-020-0001-SO	12/02/03	1-3 ft	Manganese	390		3030	176	NO	YES
LL6SB-020-0001-SO	12/02/03	1-3 ft	Vanadium	22		37.6	7.8	NO	YES
LL6SB-021-0001-SO	11/19/03	1-3 ft	Aluminum	11000		19500	7614	NO	YES
LL6SB-021-0001-SO	11/19/03	1-3 ft	Arsenic	2.6		19.8	0.39	NO	YES
LL6SB-021-0001-SO	11/19/03	1-3 ft	Iron	10000		35200	2346	NO	YES
LL6SB-021-0001-SO	11/19/03	1-3 ft	Vanadium	15	H	37.6	7.8	NO	YES
LL6SB-023-0001-SO	11/19/03	1-3 ft	Aluminum	16000		19500	7614	NO	YES
LL6SB-023-0001-SO	11/19/03	1-3 ft	Arsenic	9.7		19.8	0.39	NO	YES
LL6SB-023-0001-SO	11/19/03	1-3 ft	Iron	25000		35200	2346	NO	YES
LL6SB-023-0001-SO	11/19/03	1-3 ft	Manganese	320		3030	176	NO	YES
LL6SB-023-0001-SO	11/19/03	1-3 ft	Vanadium	26	H	37.6	7.8	NO	YES
LL6SB-024-0001-SO	11/25/03	1-3 ft	Aluminum	14000		19500	7614	NO	YES
LL6SB-024-0001-SO	11/25/03	1-3 ft	Arsenic	11		19.8	0.39	NO	YES
LL6SB-024-0001-SO	11/25/03	1-3 ft	Benzo(a)pyrene	0.2		--	0.062	NO	YES
LL6SB-024-0001-SO	11/25/03	1-3 ft	Iron	22000		35200	2346	NO	YES
LL6SB-024-0001-SO	11/25/03	1-3 ft	Lead	22		19.1	400	YES	NO
LL6SB-024-0001-SO	11/25/03	1-3 ft	Manganese	550		3030	176	NO	YES
LL6SB-024-0001-SO	11/25/03	1-3 ft	Nitrocellulose	1.1	B	0.00	--	YES	NO
LL6SB-024-0001-SO	11/25/03	1-3 ft	Sodium	1400		145	--[n]	YES	NO
LL6SB-024-0001-SO	11/25/03	1-3 ft	Vanadium	21		37.6	7.8	NO	YES
LL6SB-025-0001-SO	11/14/03	1-3 ft	Aluminum	14000		19500	7614	NO	YES
LL6SB-025-0001-SO	11/14/03	1-3 ft	Arsenic	6.8		19.8	0.39	NO	YES
LL6SB-025-0001-SO	11/14/03	1-3 ft	Iron	21000	H	35200	2346	NO	YES
LL6SB-025-0001-SO	11/14/03	1-3 ft	Sodium	1300		145	--[n]	YES	NO
LL6SB-025-0001-SO	11/14/03	1-3 ft	Vanadium	27		37.6	7.8	NO	YES
LL6SB-026-0001-SO	11/20/03	1-3 ft	Aluminum	19000		19500	7614	NO	YES
LL6SB-026-0001-SO	11/20/03	1-3 ft	Arsenic	16		19.8	0.39	NO	YES
LL6SB-026-0001-SO	11/20/03	1-3 ft	Iron	32000		35200	2346	NO	YES
LL6SB-026-0001-SO	11/20/03	1-3 ft	Vanadium	30	H	37.6	7.8	NO	YES
LL6SB-027-0001-SO	11/20/03	1-3 ft	Aluminum	15000		19500	7614	NO	YES
LL6SB-027-0001-SO	11/20/03	1-3 ft	Arsenic	10		19.8	0.39	NO	YES
LL6SB-027-0001-SO	11/20/03	1-3 ft	Iron	29000		35200	2346	NO	YES
LL6SB-027-0001-SO	11/20/03	1-3 ft	Manganese	460		3030	176	NO	YES

Table 4−5
Summary of Subsurface Soil Exceedances (>1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Subsurface Soil Background Criteria (mg/kg)	Subsurface Soil Region 9 PRGs (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SB-027-0001-SO	11/20/03	1-3 ft	Mercury	0.042		0.04	2.3	YES	NO
LL6SB-027-0001-SO	11/20/03	1-3 ft	Vanadium	31	H	37.6	7.8	NO	YES
LL6SB-028-0001-SO	11/18/03	1-3 ft	Aluminum	19000		19500	7614	NO	YES
LL6SB-028-0001-SO	11/18/03	1-3 ft	Arsenic	16		19.8	0.39	NO	YES
LL6SB-028-0001-SO	11/18/03	1-3 ft	Barium	160		124	538	YES	NO
LL6SB-028-0001-SO	11/18/03	1-3 ft	Beryllium	0.93		0.88	15	YES	NO
LL6SB-028-0001-SO	11/18/03	1-3 ft	Iron	28000	H	35200	2346	NO	YES
LL6SB-028-0001-SO	11/18/03	1-3 ft	Manganese	340		3030	176	NO	YES
LL6SB-028-0001-SO	11/18/03	1-3 ft	Vanadium	27		37.6	7.8	NO	YES
LL6SB-030-0001-SO	11/18/03	1-3 ft	Aluminum	19000		19500	7614	NO	YES
LL6SB-030-0001-SO	11/18/03	1-3 ft	Arsenic	11		19.8	0.39	NO	YES
LL6SB-030-0001-SO	11/18/03	1-3 ft	Iron	45000	H	35200	2346	YES	YES
LL6SB-030-0001-SO	11/18/03	1-3 ft	Manganese	440		3030	176	NO	YES
LL6SB-030-0001-SO	11/18/03	1-3 ft	Selenium	2.5		1.5	39	YES	NO
LL6SB-030-0001-SO	11/18/03	1-3 ft	Vanadium	31		37.6	7.8	NO	YES
LL6SB-031-0001-SO	11/18/03	6-8 ft	Aluminum	15000		19500	7614	NO	YES
LL6SB-031-0001-SO	11/18/03	6-8 ft	Arsenic	10		19.8	0.39	NO	YES
LL6SB-031-0001-SO	11/18/03	6-8 ft	Beryllium	0.9		0.88	15	YES	NO
LL6SB-031-0001-SO	11/18/03	6-8 ft	Calcium	39000		35500	--[n]	YES	NO
LL6SB-031-0001-SO	11/18/03	6-8 ft	Iron	27000	H	35200	2346	NO	YES
LL6SB-031-0001-SO	11/18/03	6-8 ft	Magnesium	9200		8790	--[n]	YES	NO
LL6SB-031-0001-SO	11/18/03	6-8 ft	Manganese	380		3030	176	NO	YES
LL6SB-031-0001-SO	11/18/03	6-8 ft	Vanadium	25		37.6	7.8	NO	YES
LL6SB-032-0001-SO	11/13/03	14-15 ft	Arsenic	20		19.8	0.39	YES	YES
LL6SB-032-0001-SO	11/13/03	14-15 ft	Iron	20000	H	35200	2346	NO	YES
LL6SB-032-0001-SO	11/13/03	14-15 ft	Manganese	400		3030	176	NO	YES
LL6SB-032-0001-SO	11/13/03	14-15 ft	Vanadium	11		37.6	7.8	NO	YES
LL6SB-033-0001-DUP	11/18/03	14-15 ft	Aluminum	9200		19500	7614	NO	YES
LL6SB-033-0001-DUP	11/18/03	14-15 ft	Arsenic	26		19.8	0.39	YES	YES
LL6SB-033-0001-DUP	11/18/03	14-15 ft	Iron	25000	H	35200	2346	NO	YES
LL6SB-033-0001-DUP	11/18/03	14-15 ft	Manganese	290		3030	176	NO	YES
LL6SB-033-0001-DUP	11/18/03	14-15 ft	Vanadium	15		37.6	7.8	NO	YES
LL6SB-033-0001-SO	11/18/03	6-8 ft	Aluminum	8400		19500	7614	NO	YES
LL6SB-033-0001-SO	11/18/03	6-8 ft	Arsenic	26		19.8	0.39	YES	YES
LL6SB-033-0001-SO	11/18/03	6-8 ft	Iron	24000	H	35200	2346	NO	YES
LL6SB-033-0001-SO	11/18/03	6-8 ft	Manganese	290		3030	176	NO	YES
LL6SB-033-0001-SO	11/18/03	6-8 ft	Vanadium	13		37.6	7.8	NO	YES
LL6SB-034-0001-SO	11/14/03	15-17 ft	Aluminum	8200		19500	7614	NO	YES
LL6SB-034-0001-SO	11/14/03	15-17 ft	Arsenic	16		19.8	0.39	NO	YES
LL6SB-034-0001-SO	11/14/03	15-17 ft	Iron	26000	H	35200	2346	NO	YES
LL6SB-034-0001-SO	11/14/03	15-17 ft	Manganese	330		3030	176	NO	YES
LL6SB-034-0001-SO	11/14/03	15-17 ft	Sodium	1200		145	--[n]	YES	NO
LL6SB-034-0001-SO	11/14/03	15-17 ft	Vanadium	14		37.6	7.8	NO	YES
LL6SB-035-0001-SO	11/14/03	11-13 ft	Aluminum	8300		19500	7614	NO	YES
LL6SB-035-0001-SO	11/14/03	11-13 ft	Arsenic	15		19.8	0.39	NO	YES
LL6SB-035-0001-SO	11/14/03	11-13 ft	Iron	22000	H	35200	2346	NO	YES
LL6SB-035-0001-SO	11/14/03	11-13 ft	Manganese	480		3030	176	NO	YES

Table 4−5
Summary of Subsurface Soil Exceedances (>1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Subsurface Soil Background Criteria (mg/kg)	Subsurface Soil Region 9 PRGs (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SB-035-0001-SO	11/14/03	11-13 ft	Sodium	1200		145	--[n]	YES	NO
LL6SB-035-0001-SO	11/14/03	11-13 ft	Vanadium	14		37.6	7.8	NO	YES
LL6SB-036-0001-SO	11/18/03	6-8 ft	Aluminum	9400		19500	7614	NO	YES
LL6SB-036-0001-SO	11/18/03	6-8 ft	Arsenic	15		19.8	0.39	NO	YES
LL6SB-036-0001-SO	11/18/03	6-8 ft	Iron	23000	H	35200	2346	NO	YES
LL6SB-036-0001-SO	11/18/03	6-8 ft	Manganese	220		3030	176	NO	YES
LL6SB-036-0001-SO	11/18/03	6-8 ft	Vanadium	15		37.6	7.8	NO	YES
LL6SB-037-0001-SO	11/14/03	12-14 ft	Arsenic	16		19.8	0.39	NO	YES
LL6SB-037-0001-SO	11/14/03	12-14 ft	Iron	20000	H	35200	2346	NO	YES
LL6SB-037-0001-SO	11/14/03	12-14 ft	Manganese	220		3030	176	NO	YES
LL6SB-037-0001-SO	11/14/03	12-14 ft	Sodium	1000		145	--[n]	YES	NO
LL6SB-037-0001-SO	11/14/03	12-14 ft	Vanadium	11		37.6	7.8	NO	YES
LL6SB-038-0001-SO	11/05/03	8-10 ft	Aluminum	15000		19500	7614	NO	YES
LL6SB-038-0001-SO	11/05/03	8-10 ft	Arsenic	13		19.8	0.39	NO	YES
LL6SB-038-0001-SO	11/05/03	8-10 ft	Iron	29000		35200	2346	NO	YES
LL6SB-038-0001-SO	11/05/03	8-10 ft	Manganese	280		3030	176	NO	YES
LL6SB-038-0001-SO	11/05/03	8-10 ft	Sodium	1500		145	--[n]	YES	NO
LL6SB-038-0001-SO	11/05/03	8-10 ft	Vanadium	24		37.6	7.8	NO	YES
LL6SB-039-0001-SO	11/05/03	8-10 ft	Aluminum	13000		19500	7614	NO	YES
LL6SB-039-0001-SO	11/05/03	8-10 ft	Arsenic	11		19.8	0.39	NO	YES
LL6SB-039-0001-SO	11/05/03	8-10 ft	Iron	25000		35200	2346	NO	YES
LL6SB-039-0001-SO	11/05/03	8-10 ft	Manganese	400		3030	176	NO	YES
LL6SB-039-0001-SO	11/05/03	8-10 ft	Sodium	1400		145	--[n]	YES	NO
LL6SB-039-0001-SO	11/05/03	8-10 ft	Vanadium	22		37.6	7.8	NO	YES
LL6SB-040-0001-SO	11/05/03	4-6 ft	Arsenic	13		19.8	0.39	NO	YES
LL6SB-040-0001-SO	11/05/03	4-6 ft	Iron	11000		35200	2346	NO	YES
LL6SB-040-0001-SO	11/05/03	4-6 ft	Sodium	740		145	--[n]	YES	NO
LL6SB-040-0001-SO	11/05/03	4-6 ft	Vanadium	11		37.6	7.8	NO	YES
LL6SB-041-0001-SO	10/27/03	5-7 ft	Aluminum	13000		19500	7614	NO	YES
LL6SB-041-0001-SO	10/27/03	5-7 ft	Arsenic	12		19.8	0.39	NO	YES
LL6SB-041-0001-SO	10/27/03	5-7 ft	Iron	29000	*H	35200	2346	NO	YES
LL6SB-041-0001-SO	10/27/03	5-7 ft	Manganese	540		3030	176	NO	YES
LL6SB-041-0001-SO	10/27/03	5-7 ft	Vanadium	21		37.6	7.8	NO	YES
LL6SB-042-0001-SO	12/03/03	1-3 ft	Aluminum	13000		19500	7614	NO	YES
LL6SB-042-0001-SO	12/03/03	1-3 ft	Arsenic	15		19.8	0.39	NO	YES
LL6SB-042-0001-SO	12/03/03	1-3 ft	Calcium	36000		35500	--[n]	YES	NO
LL6SB-042-0001-SO	12/03/03	1-3 ft	Iron	27000		35200	2346	NO	YES
LL6SB-042-0001-SO	12/03/03	1-3 ft	Manganese	370		3030	176	NO	YES
LL6SB-042-0001-SO	12/03/03	1-3 ft	Sodium	150		145	--[n]	YES	NO
LL6SB-042-0001-SO	12/03/03	1-3 ft	Vanadium	23		37.6	7.8	NO	YES
LL6SB-044-0001-DUP	12/02/03	1-3 ft	Aluminum	8500		19500	7614	NO	YES
LL6SB-044-0001-DUP	12/02/03	1-3 ft	Arsenic	5.2		19.8	0.39	NO	YES
LL6SB-044-0001-DUP	12/02/03	1-3 ft	Iron	15000		35200	2346	NO	YES
LL6SB-044-0001-DUP	12/02/03	1-3 ft	Manganese	210		3030	176	NO	YES
LL6SB-044-0001-DUP	12/02/03	1-3 ft	Nitrocellulose	2.8	J	0.00	--	YES	NO
LL6SB-044-0001-DUP	12/02/03	1-3 ft	Vanadium	17		37.6	7.8	NO	YES
LL6SB-044-0001-SO	12/02/03	1-3 ft	Aluminum	9100		19500	7614	NO	YES

Table 4−5
Summary of Subsurface Soil Exceedances (>1 ft)

Sample Number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Subsurface Soil Background Criteria (mg/kg)	Subsurface Soil Region 9 PRGs (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SB-044-0001-SO	12/02/03	1-3 ft	Arsenic	4.3		19.8	0.39	NO	YES
LL6SB-044-0001-SO	12/02/03	1-3 ft	Iron	16000		35200	2346	NO	YES
LL6SB-044-0001-SO	12/02/03	1-3 ft	Nitrocellulose	0.85	B J	0.00	--	YES	NO
LL6SB-044-0001-SO	12/02/03	1-3 ft	Vanadium	18		37.6	7.8	NO	YES
LL6SB-045-0001-SO	12/02/03	1-3 ft	Aluminum	16000		19500	7614	NO	YES
LL6SB-045-0001-SO	12/02/03	1-3 ft	Arsenic	15		19.8	0.39	NO	YES
LL6SB-045-0001-SO	12/02/03	1-3 ft	Beryllium	0.94		0.88	15	YES	NO
LL6SB-045-0001-SO	12/02/03	1-3 ft	Iron	29000		35200	2346	NO	YES
LL6SB-045-0001-SO	12/02/03	1-3 ft	Manganese	300		3030	176	NO	YES
LL6SB-045-0001-SO	12/02/03	1-3 ft	Vanadium	24		37.6	7.8	NO	YES
LL6SB-056-0001-SO	11/18/03	1-3 ft	Aluminum	16000		19500	7614	NO	YES
LL6SB-056-0001-SO	11/18/03	1-3 ft	Arsenic	13		19.8	0.39	NO	YES
LL6SB-056-0001-SO	11/18/03	1-3 ft	Iron	26000	H	35200	2346	NO	YES
LL6SB-056-0001-SO	11/18/03	1-3 ft	Vanadium	27		37.6	7.8	NO	YES

Notes:
-- - no background/PRG value is available for this analyte
blank cell indicates that the analyte was a non-detect (with a "U" qualifier) or analysis was not performed
PRG - preliminary remediation goals; the PRG for lead is the maximum contaminant level (MCL)
nc - non-cancer basis
ca - cancer basis
pbk - based on PBK modeling
mcl - based on CWA maximum contaminant level
max - ceiling limit
sat - soil saturation
[n] - nutrient
UC - unconsolidated
Inorganic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is less than the RL, but greater than or equal to the MDL
B - result is less than the CRDL/RL, but greater than or equal to the IDL/MDL
Inorganic Flags
^ - instrument related QC exceed the upper or lower control limits
* - batch QC exceeds the upper or lower control limit
H - batch QC is greater than RL
Organic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is an estimated value below the RL
Organic Flags
B - Method Blank: batch QC is greater than RL
* - batch QC exceeds the upper or lower control limit
^ - batch QC is greater than RL
H - alternate peak selection upon analytical review

Table 4–7
Summary of Groundwater Results

							LL6MW-001-0001-GW		LL6MW-002-0001-GW		LL6MW-003-0001-GW		LL6MW-004-0001-GW		LL6MW-005-0001-DUP		LL6MW-005-0001-GW		LL6MW-006-0001-GW		LL6MW-007-0001-GW	
						Sample Date	12/17/03		12/16/03		12/18/03		12/18/03		12/15/03		12/15/03		12/17/03		12/16/03	
						Screened Interval	7-17 ft.		12.5-22.5 ft.		12.5-22.5 ft.		12.5-22.5 ft.		9.5-19.5 ft.		9.5-19.5 ft.		7-17 ft.		9.5-19.5 ft	
Group	Method	Parameter	Region 9 (Tap Water) PRGs	UC-MW PRG Basis	RVAAP Unconsolidated Wells Background Criteria	Units																
Cyanide 9012A	9014/9010B	Cyanide, Total	730	nc	0.00	µg/L	4.4	U	4.4	U	4.4	U	4.4	U	4.4	U	4.4	U	4.4	U	4.4	U
Explosives 8330	8330	1,3,5-Trinitrobenzene	1095	nc	0.00	µg/L	0.11	U	0.11	U	0.08	U	0.084	U	0.084	U	0.08	U	0.08	U	0.11	U
		1,3-Dinitrobenzene	3.6	nc	0.00	µg/L	0.072	U	0.071	U	0.053	U	0.056	U	0.056	U	0.053	U	0.053	U	0.075	U
		2,4,6-TNT	2.2	ca	0.00	µg/L	0.092	U	0.091	U	0.068	U	0.071	U	0.071	U	0.068	U	0.068	U	0.096	U
		2,4-Dinitrotoluene	73	nc	0.00	µg/L	0.057	U	0.056	U	0.042	U	0.044	U	0.044	U	0.042	U	0.042	U	0.06	U
		2,6-Dinitrotoluene	36	nc	0.00	µg/L	0.28	U	0.28	U	0.21	U	0.22	U	0.22	U	0.21	U	0.21	U	0.29	U
		2-Nitrotoluene	0.049	ca	0.00	µg/L	0.22	U	0.22	U	0.16	U	0.17	U	0.17	U	0.16	U	0.16	U	0.23	U
		3-Nitrotoluene	122	nc	0.00	µg/L	0.14	U	0.14	U	0.1	U	0.11	U	0.11	U	0.1	U	0.1	U	0.14	U
		4-Nitrotoluene	0.66	ca	0.00	µg/L	0.45	U	0.45	U	0.34	U	0.35	U	0.35	U	0.34	U	0.34	U	0.48	U
		HMX	1825	nc	0.00	µg/L	0.3	U	0.3	U	0.22	U	0.24	U	0.24	U	0.22	U	0.22	U	0.32	U
		Nitrobenzene	3.4	nc	0.00	µg/L	0.12	U	0.12	U	0.092	U	0.097	U	0.097	U	0.092	U	0.092	U	0.13	U
		RDX	0.61	ca	0.00	µg/L	0.18	U	0.18	U	0.13	U	0.14	U	0.14	U	0.13	U	0.13	U	0.19	U
		Tetryl	365	nc	0.00	µg/L	0.29	U	0.29	U	0.22	U	0.23	U	0.23	U	0.22	U	0.22	U	0.31	U
Others	8081A	Toxaphene	0.061	ca	--	µg/L	0.13	U	0.13	U	0.14	U	0.14	U	0.14	U	0.13	U	0.14	U	0.14	U
	8270C	Phenanthrene	--	--	--	µg/L	0.13	U	0.13	U	0.14	U	0.14	U	0.14	U	0.13	U	0.14	U	0.14	U
PCB TCL 8082	8082	Aroclor 1016	0.96	ca	--	µg/L	0.16	U	0.16	U	0.17	U	0.17	U	0.17	U	0.16	U	0.17	U	0.17	U
		Aroclor 1221	0.034	ca	--	µg/L	0.44	U	0.44	U	0.45	U	0.45	U	0.45	U	0.43	U	0.45	U	0.45	U
		Aroclor 1232	0.034	ca	--	µg/L	0.21	U	0.21	U	0.22	U	0.22	U	0.22	U	0.21	U	0.22	U	0.21	U
		Aroclor 1242	0.034	ca	--	µg/L	0.18	U	0.18	U	0.19	U	0.19	U	0.19	U	0.18	U	0.19	U	0.18	U
		Aroclor 1248	0.034	ca	--	µg/L	0.2	U	0.2	U	0.21	U	0.21	U	0.21	U	0.2	U	0.21	U	0.2	U
		Aroclor 1254	0.034	ca	--	µg/L	0.12	U	0.12	U	0.13	U	0.13	U	0.13	U	0.12	U	0.13	U	0.13	U
		Aroclor 1260	0.034	ca	--	µg/L	0.14	U	0.14	U	0.15	U	0.15	U	0.15	U	0.14	U	0.15	U	0.15	U
Pesticides 8081A	8081A	4,4'-DDD	0.28	ca	--	µg/L	0.035	U	0.035	U	0.035	U	0.035	U	0.035	U	0.034	U	0.035	U	0.035	U
		4,4'-DDE	0.20	ca	--	µg/L	0.022	U	0.022	U	0.023	U	0.023	U	0.023	U	0.021	U	0.023	U	0.022	U
		4,4'-DDT	0.20	ca	--	µg/L	0.047	U	0.047	U	0.048	U	0.048	U	0.048	U	0.046	U	0.048	U	0.048	U
		Aldrin	0.0040	ca	--	µg/L	0.027	U	0.027	U	0.027	U	0.027	U	0.027	U	0.026	U	0.027	U	0.027	U
		alpha-BHC	0.011	nc	--	µg/L	0.045	U	0.045	U	0.046	U	0.046	U	0.046	U	0.044	U	0.046	U	0.046	U
		alpha-Chlordane	0.19	ca	--	µg/L	0.015	U	0.015	U	0.016	U	0.016	U	0.016	U	0.015	U	0.016	U	0.016	U

Table 4–7
Summary of Groundwater Results

Group	Method	Parameter	Region 9 (Tap Water) PRGs	UC-MW PRG Basis	RVAAP Unconsolidated Wells Background Criteria	Units	LL6MW-001-0001-GW	LL6MW-002-0001-GW	LL6MW-003-0001-GW	LL6MW-004-0001-GW	LL6MW-005-0001-DUP	LL6MW-005-0001-GW	LL6MW-006-0001-GW	LL6MW-007-0001-GW
		Sample Date					12/17/03	12/16/03	12/18/03	12/18/03	12/15/03	12/15/03	12/17/03	12/16/03
		Screened Interval					7-17 ft.	12.5-22.5 ft.	12.5-22.5 ft.	12.5-22.5 ft.	9.5-19.5 ft.	9.5-19.5 ft.	7-17 ft.	9.5-19.5 ft
		beta-BHC	0.037	ca	--	µg/L	0.027 U	0.027 U	0.027 U	0.027 U	0.027 U	0.026 U	0.027 U	0.027 U
		delta-BHC	--	--	--	µg/L	0.024 U	0.024 U	0.025 U	0.025 U	0.025 U	0.023 U	0.025 U	0.024 U
		Dieldrin	0.0042	ca	--	µg/L	0.017 U	0.017 U	0.018 U	0.018 U	0.018 U	0.017 U	0.018 U	0.017 U
		Endosulfan I	220	nc	--	µg/L	0.02 U	0.02 U	0.021 U	0.021 U	0.021 U	0.02 U	0.021 U	0.02 U
		Endosulfan II	220	nc	--	µg/L	0.04 U	0.04 U	0.041 U	0.041 U	0.041 U	0.039 U	0.041 U	0.041 U
		Endosulfan sulfate	220	nc	--	µg/L	0.042 U	0.042 U	0.043 U	0.043 U	0.043 U	0.041 U	0.043 U	0.043 U
		Endrin	11	nc	--	µg/L	0.016 U	0.016 U	0.017 U	0.017 U	0.017 U	0.016 U	0.017 U	0.017 U
		Endrin aldehyde	--	--	--	µg/L	0.034 U	0.034 U*	0.034 U	0.034 U	0.034 U*	0.033 U*	0.034 U	0.034 U*
		Endrin ketone	--	--	--	µg/L	0.028 U	0.028 U*	0.028 U	0.028 U	0.028 U*	0.027 U*	0.028 U	0.028 U*
		gamma-BHC (Lindane)	0.052	ca	--	µg/L	0.04 U	0.04 U	0.041 U	0.041 U	0.041 U	0.039 U	0.041 U	0.041 U
		gamma-Chlordane	0.19	ca	--	µg/L	0.016 U	0.016 U	0.017 U	0.017 U	0.017 U	0.016 U	0.017 U	0.017 U
		Heptachlor	0.015	ca	--	µg/L	0.039 U	0.039 U	0.04 U	0.04 U	0.04 U	0.038 U	0.04 U	0.04 U
		Heptachlor epoxide	0.0074	ca	--	µg/L	0.035 U	0.035 U	0.035 U	0.035 U	0.035 U	0.034 U	0.035 U	0.035 U
		Methoxychlor	182	nc	--	µg/L	0.16 U	0.16 U	0.17 U	0.17 U	0.17 U	0.16 U	0.17 U	0.17 U
Propellants 8330	353.2	Nitrocellulose	--	--	0.00	µg/L	110 B J	85 B J	500 U	100 B J	85 B J	500 U	500 U	110 B J
	8330	Nitroglycerin	4.8	ca	0.00	µg/L	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U
	UV/HPLC per SOP	Nitroguanidine	3650	nc	0.00	µg/L	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
SVOCs TCL 8270 C	8270C	1,2,4-Trichlorobenzene	7.2	nc	--	µg/L	0.33 U	0.32 U	0.33 U	0.33 U	0.33 U	0.33 U	0.34 U	0.34 U
		1,2-Dichlorobenzene	370	nc	--	µg/L	0.34 U	0.33 U	0.34 U	0.34 U	0.34 U	0.34 U	0.35 U	0.35 U
		1,3-Dichlorobenzene	182	nc	--	µg/L	0.41 U	0.4 U	0.42 U	0.42 U	0.42 U	0.41 U	0.43 U	0.43 U
		1,4-Dichlorobenzene	0.50	ca	--	µg/L	0.32 U	0.31 U	0.32 U	0.32 U	0.32 U	0.32 U	0.33 U	0.33 U
		2,2-oxybis (1-chloropropane)	0.27	ca	--	µg/L	0.27 U	0.26 U	0.27 U	0.27 U	0.27 U	0.27 U	0.28 U	0.28 U
		2,4,5-Trichlorophenol	3650	nc	--	µg/L	1.3 U	1.3 U	1.4 U	1.4 U	1.4 U	1.3 U	1.4 U	1.4 U
		2,4,6-Trichlorophenol	3.6	nc	--	µg/L	0.2 U	0.2 U	0.21 U	0.21 U	0.2 U	0.2 U	0.21 U	0.21 U
		2,4-Dichlorophenol	109	nc	--	µg/L	0.87 U	0.85 U	0.89 U	0.89 U	0.88 U	0.87 U	0.9 U	0.9 U
		2,4-Dimethylphenol	730	nc	--	µg/L	1.2 U	1.2 U	1.3 U	1.3 U	1.3 U	1.2 U	1.3 U	1.3 U
		2,4-Dinitrophenol	73	nc	--	µg/L	3.2 U	3.1 U	3.2 U	3.2 U	3.2 U	3.2 U	3.3 U	3.3 U
		2-Chloronaphthalene	487	nc	--	µg/L	0.25 U	0.24 U	0.25 U	0.25 U	0.25 U	0.25 U	0.26 U	0.26 U
		2-Chlorophenol	30	nc	--	µg/L	0.12 U	0.11 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U
		2-Methylnaphthalene	--	--	--	µg/L	0.12 U	0.12 U	0.13 U	0.13 U	0.13 U	0.12 U	0.13 U	0.13 U
		2-Methylphenol (o-cresol)	1825	nc	--	µg/L	0.25 U	0.24 U	0.25 U	0.25 U	0.25 U	0.25 U	0.26 U	0.26 U
		2-Nitroaniline	109	nc	--	µg/L	0.21 U	0.21 U	0.22 U	0.22 U	0.21 U	0.21 U	0.22 U	0.22 U

Table 4–7
Summary of Groundwater Results

							LL6MW-001-0001-GW		LL6MW-002-0001-GW		LL6MW-003-0001-GW		LL6MW-004-0001-GW		LL6MW-005-0001-DUP		LL6MW-005-0001-GW		LL6MW-006-0001-GW		LL6MW-007-0001-GW	
						Sample Date	12/17/03		12/16/03		12/18/03		12/18/03		12/15/03		12/15/03		12/17/03		12/16/03	
						Screened Interval	7-17 ft.		12.5-22.5 ft.		12.5-22.5 ft.		12.5-22.5 ft.		9.5-19.5 ft.		9.5-19.5 ft.		7-17 ft.		9.5-19.5 ft	
Group	Method	Parameter	Region 9 (Tap Water) PRGs	UC-MW PRG Basis	RVAAP Unconsolidated Wells Background Criteria	Units																
		2-Nitrophenol	--	--	--	µg/L	0.79	U	0.77	U	0.8	U	0.8	U	0.8	U	0.79	U	0.81	U	0.81	U
		3,3-Dichlorobenzidine	0.15	ca	--	µg/L	0.69	U	0.67	U	0.71	U	0.71	U	0.7	U	0.69	U	0.71	U	0.71	U
		3-Nitroaniline	3.2	ca	--	µg/L	2	U	2	U	2.1	U*	2.1	U*	2	U	2	U	2.1	U	2.1	U
		4,6-Dinitro-2-methylphenol	3.6	nc	--	µg/L	2.3	U	2.2	U	2.4	U	2.4	U	2.3	U	2.3	U	2.4	U	2.4	U
		4-Bromophenyl phenyl ether	--	--	--	µg/L	0.18	U	0.18	U	0.19	U	0.19	U	0.18	U	0.18	U	0.19	U	0.19	U
		4-Chloro-3-methylphenol	--	--	--	µg/L	2.3	U	2.2	U	2.4	U	2.4	U	2.3	U	2.3	U	2.4	U	2.4	U
		4-Chloroaniline	146	nc	--	µg/L	2.7	U	2.6	U	2.7	U	2.7	U	2.7	U	2.7	U	2.8	U	2.8	U
		4-Chlorophenyl phenyl ether	--	--	--	µg/L	0.72	U	0.7	U	0.74	U	0.74	U	0.73	U	0.72	U	0.74	U	0.74	U
		4-Methylphenol (m/p-cresol)	182	nc	--	µg/L	0.096	U	0.093	U	0.098	U	0.098	U	0.097	U	0.096	U	0.099	U	0.099	U
		4-Nitroaniline	3.2	ca	--	µg/L	2.2	U	2.1	U	2.3	U	2.3	U	2.2	U	**4.1**	J	2.3	U	2.3	U
		4-Nitrophenol	--	--	--	µg/L	3.6	U	3.5	U	3.6	U	3.6	U	3.6	U	3.6	U	3.7	U	3.7	U
		Acenaphthene	365	nc	--	µg/L	0.12	U	0.11	U	0.12	U	0.12	U	0.12	U	0.12	U	0.12	U	0.12	U
		Acenaphthylene	--	--	--	µg/L	0.12	U	0.11	U	0.12	U	0.12	U	0.12	U	0.12	U	0.12	U	0.12	U
		Anthracene	1825	nc	--	µg/L	0.14	U	0.14	U	0.15	U	0.15	U	0.15	U	0.14	U	0.15	U	0.15	U
		Benzo(a)anthracene	0.092	ca	--	µg/L	0.047	U	0.046	U	0.048	U	0.048	U	0.048	U	0.047	U	0.049	U	0.049	U
		Benzo(a)pyrene	0.0092	ca	--	µg/L	0.081	U	0.079	U	0.082	U	0.082	U	0.082	U	0.081	U	0.083	U	0.083	U
		Benzo(b)fluoranthene	0.092	ca	--	µg/L	0.064	U	0.063	U	0.066	U	0.066	U	0.065	U	0.064	U	0.066	U	0.066	U
		Benzo(ghi)perylene	--	--	--	µg/L	0.18	U	0.18	U	0.19	U	0.19	U	0.18	U	0.18	U	0.19	U	0.19	U
		Benzo(k)fluoranthene	0.92	ca	--	µg/L	0.069	U	0.067	U	0.071	U	0.071	U	0.07	U	0.069	U	0.071	U	0.071	U
		Bis(2-chloroethoxy)methane	--	--	--	µg/L	0.3	U	0.29	U	0.3	U	0.3	U	0.3	U	0.3	U	0.31	U	0.31	U
		Bis(2-chloroethyl)ether	0.010	ca	--	µg/L	0.29	U	0.28	U	0.29	U	0.29	U	0.29	U	0.29	U	0.3	U	0.3	U
		Bis(2-ethylhexyl)phthalate	4.8	ca	--	µg/L	**14**		3.6	U	3.8	U	3.8	U	**9.1**		3.7	U	**14**		3.9	U
		Butyl benzyl phthalate	7300	nc	--	µg/L	0.37	U	0.36	U	0.38	U	0.38	U	0.38	U	0.37	U	0.39	U	0.39	U
		Carbazole	3.4	ca	--	µg/L	0.28	U	0.27	U	0.28	U	0.28	U	0.28	U	0.28	U	0.29	U	0.29	U
		Chrysene	9.2	ca	--	µg/L	0.043	U	0.042	U	0.044	U	0.044	U	0.044	U	0.043	U	0.045	U	0.045	U
		Dibenzo(a,h)anthracene	0.0092	ca	--	µg/L	0.12	U	0.12	U	0.13	U	0.13	U	0.13	U	0.12	U	0.13	U	0.13	U
		Dibenzofuran	12	nc	--	µg/L	0.12	U	0.12	U	0.13	U	0.13	U	0.13	U	0.12	U	0.13	U	0.13	U
		Diethyl phthalate	29199	nc	--	µg/L	0.14	U	0.14	U	0.15	U	0.15	U	0.15	U	0.14	U	0.15	U	0.15	U
		Dimethyl phthalate	364867	nc	--	µg/L	0.2	U	0.2	U	0.21	U	0.21	U	0.2	U	0.2	U	0.21	U	0.21	U
		Di-n-butyl phthalate	3650	nc	--	µg/L	0.35	U	0.34	U	0.35	U	0.35	U	0.35	U	0.35	U	0.36	U	0.36	U
		Di-n-octyl phthalate	1460	nc	--	µg/L	2.4	U	2.3	U	2.5	U	2.5	U	2.4	U	2.4	U	2.5	U	2.5	U
		Fluoranthene	1460	nc	--	µg/L	0.13	U	0.13	U	0.14	U	0.14	U	0.14	U	0.13	U	0.14	U	0.14	U
		Fluorene	243	nc	--	µg/L	0.12	U	0.12	U	0.13	U	0.13	U	0.13	U	0.12	U	0.13	U	0.13	U

Table 4–7
Summary of Groundwater Results

Group	Method	Parameter	Region 9 (Tap Water) PRGs	UC-MW PRG Basis	RVAAP Unconsolidated Wells Background Criteria	Units	LL6MW-001-0001-GW	LL6MW-002-0001-GW	LL6MW-003-0001-GW	LL6MW-004-0001-GW	LL6MW-005-0001-DUP	LL6MW-005-0001-GW	LL6MW-006-0001-GW	LL6MW-007-0001-GW
		Sample Date					12/17/03	12/16/03	12/18/03	12/18/03	12/15/03	12/15/03	12/17/03	12/16/03
		Screened Interval					7-17 ft.	12.5-22.5 ft.	12.5-22.5 ft.	12.5-22.5 ft.	9.5-19.5 ft.	9.5-19.5 ft.	7-17 ft.	9.5-19.5 ft
		Hexachlorobenzene	0.042	ca	--	µg/L	0.093 U	0.091 U	0.095 U	0.095 U	0.094 U	0.093 U	0.096 U	0.096 U
		Hexachlorobutadiene	0.86	ca	--	µg/L	0.62 U	0.6 U	0.63 U	0.63 U	0.62 U	0.62 U	0.63 U	0.63 U
		Hexachlorocyclopentadiene	219	nc	--	µg/L	0.62 U	0.61 U	0.64 U*	0.64 U*	0.63 U	0.62 U	0.64 U	0.64 U
		Hexachloroethane	4.8	ca	--	µg/L	0.59 U	0.57 U	0.6 U	0.6 U	0.59 U	0.59 U	0.6 U	0.6 U
		Indeno(1,2,3-cd)pyrene	0.092	ca	--	µg/L	0.083 U	0.08 U	0.084 U	0.084 U	0.083 U	0.083 U	0.085 U	0.085 U
		Isophorone	71	ca	--	µg/L	0.25 U	0.24 U	0.25 U	0.25 U	0.25 U	0.25 U	0.26 U	0.26 U
		Naphthalene	6.2	nc	--	µg/L	0.15 U	0.15 U	0.16 U	0.16 U	0.16 U	0.15 U	0.16 U	0.16 U
		n-Nitroso-di-n-propylamine	0.0096	ca	--	µg/L	0.078 U	0.076 U	0.079 U	0.079 U	0.079 U	0.078 U	0.08 U	0.08 U
		n-Nitrosodiphenylamine	14	ca	--	µg/L	0.12 U	0.12 U	0.13 U	0.13 U	0.13 U	0.12 U	0.13 U	0.13 U
		Pentachlorophenol	0.56	ca	--	µg/L	1.6 U	1.6 U	1.7 U	1.7 U	1.7 U	1.6 U	1.7 U	1.7 U
		Phenol	10950	nc	--	µg/L	0.34 U	0.33 U	0.34 U	0.34 U	0.34 U	0.34 U	0.35 U	0.35 U
		Pyrene	182	nc	--	µg/L	0.12 U	0.11 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U
TAL Metals 6010B	6010B	Aluminum	36499	nc	0.00	µg/L	24 U	24 U	24 U	24 U	24 U	24 U	24 U	24 U
		Barium	2555	nc	82.1	µg/L	19	23	14	40	41	40	25	24
		Beryllium	73	nc	0.00	µg/L	0.17 U	0.17 U	0.17 U	0.17 U	0.17 U	0.17 U	0.17 U	0.17 U
		Cadmium	18	nc	0.00	µg/L	0.44 U	0.44 U	0.44 U	0.44 U	0.44 U	0.44 U	0.44 U	0.44 U
		Calcium	--	[n]	115000	µg/L	75000 H	130000 H	75000 H	73000 H	83000 H	81000 H	75000 H	61000 H
		Chromium	109	nc	7.3	µg/L	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U
		Cobalt	730	nc	0.00	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
		Copper	1460	nc	0.00	µg/L	6.2 B	3.2 B	2.1 B	1.9 B	1.8 B	2.3 B	2 B	3.4 B
		Iron	10950	nc	279	µg/L	40 U	40 U	40 U	1000	1400	1600	40 U	42 B
		Magnesium	--	[n]	43300	µg/L	37000	29000	36000	29000	26000	26000	28000	26000
		Manganese	876	nc	1020	µg/L	12	280	170	190	280	270	**910**	420
		Nickel	730	nc	0.00	µg/L	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
		Potassium	--	[n]	2890	µg/L	3800	1700	2800	1700	1500	1500	3900	1400
		Selenium	182	nc	0.00	µg/L	5.7	5 U	5 U	5 U	5 U	5 U	5 U	5 U
		Silver	182	nc	0.00	µg/L	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U
		Sodium	--	[n]	45700	µg/L	9800	1900	13000	11000	9100	9100	8000	9300
		Vanadium	36	nc	0.00	µg/L	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U
		Zinc	10950	nc	60.9	µg/L	11	23	10 U	10 U	10 U	10 U	10 U	10 U
	7041	Antimony	15	nc	0.00	µg/L	2.2 U	2.2 U	4.2 B	2.7 B	2.2 U	2.2 U	2.2 U	3.9 B
	7060A	Arsenic	0.045	ca	11.7	µg/L	0.73 U	0.73 U	0.73 U	0.73 U	**12**	**13**	0.73 U	**0.76** B
	7421	Lead	15	mcl	0.00	µg/L	0.78 U	0.78 U	0.78 U	0.78 U	0.78 U	0.78 U	0.78 U	0.78 U

Table 4–7
Summary of Groundwater Results

Group	Method	Parameter	Region 9 (Tap Water) PRGs	UC-MW PRG Basis	RVAAP Unconsolidated Wells Background Criteria	Units	LL6MW-001-0001-GW	LL6MW-002-0001-GW	LL6MW-003-0001-GW	LL6MW-004-0001-GW	LL6MW-005-0001-DUP	LL6MW-005-0001-GW	LL6MW-006-0001-GW	LL6MW-007-0001-GW
		Sample Date					12/17/03	12/16/03	12/18/03	12/18/03	12/15/03	12/15/03	12/17/03	12/16/03
		Screened Interval					7-17 ft.	12.5-22.5 ft.	12.5-22.5 ft.	12.5-22.5 ft.	9.5-19.5 ft.	9.5-19.5 ft.	7-17 ft.	9.5-19.5 ft
	7470A	Mercury	11	nc	0.00	µg/L	0.049 U	0.049 U	0.049 U	0.049 U	0.049 U	0.049 U	0.049 U	0.049 U
	7841	Thallium	2.4	nc	0.00	µg/L	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U
VOCs TCL 8260B	8260B	1,1,1-Trichloroethane	3172	nc	--	µg/L	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U
		1,1,2,2-Tetrachloroethane	0.055	ca	--	µg/L	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U
		1,1,2-Trichloroethane	0.20	ca	--	µg/L	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U
		1,1-Dichloroethane	811	nc	--	µg/L	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
		1,1-Dichloroethene	339	nc	--	µg/L	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U
		1,2-Dichloroethane	0.12	ca	--	µg/L	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U
		1,2-Dichloroethene (total)	120	nc	--	µg/L	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U
		1,2-Dichloropropane	0.16	ca	--	µg/L	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U
		2-Butanone (MEK)	6968	nc	--	µg/L	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U
		2-Hexanone	2000	nc	--	µg/L	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U
		4-Methyl-2-pentanone (MIBK)	1993	nc	--	µg/L	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U
		Acetone	5475	nc	--	µg/L	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U
		Benzene	0.35	ca	--	µg/L	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U
		Bromodichloromethane	0.18	ca	--	µg/L	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
		Bromoform	8.5	ca	--	µg/L	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
		Bromomethane	8.7	nc	--	µg/L	0.1 U	0.1 U*	0.1 U	0.1 U	0.1 U*	0.1 U*	0.1 U	0.1 U*
		Carbon disulfide	1043	nc	--	µg/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
		Carbon tetrachloride	0.17	ca	--	µg/L	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
		Chlorobenzene	106	nc	--	µg/L	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U
		Chloroethane	4.6	ca	--	µg/L	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U
		Chloroform	0.17	ca	--	µg/L	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
		Chloromethane	158	nc	--	µg/L	0.08 U	0.08 U*	0.08 U	0.08 U	0.08 U*	0.08 U*	0.08 U	0.08 U*
		cis-1,3-Dichloropropene	0.40	ca	--	µg/L	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U
		Dibromochloromethane	0.13	ca	--	µg/L	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U
		Ethylbenzene	1340	nc	--	µg/L	0.07 U	0.07 U	0.07 U	0.07 U	0.07 U	0.07 U	0.07 U	0.07 U
		Methylene chloride	4.3	ca	--	µg/L	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U
		Styrene	1641	nc	--	µg/L	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
		Tetrachloroethene	0.10	ca	--	µg/L	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U
		Toluene	723	nc	--	µg/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
		trans-1,3-Dichloropropene	0.40	ca	--	µg/L	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U
		Trichloroethene	0.028	ca	--	µg/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U

Table 4–7
Summary of Groundwater Results

							LL6MW-001-0001-GW	LL6MW-002-0001-GW	LL6MW-003-0001-GW	LL6MW-004-0001-GW	LL6MW-005-0001-DUP	LL6MW-005-0001-GW	LL6MW-006-0001-GW	LL6MW-007-0001-GW
						Sample Date	12/17/03	12/16/03	12/18/03	12/18/03	12/15/03	12/15/03	12/17/03	12/16/03
						Screened Interval	7-17 ft.	12.5-22.5 ft.	12.5-22.5 ft.	12.5-22.5 ft.	9.5-19.5 ft.	9.5-19.5 ft.	7-17 ft.	9.5-19.5 ft
Group	Method	Parameter	Region 9 (Tap Water) PRGs	UC-MW PRG Basis	RVAAP Unconsolidated Wells Background Criteria	Units								
		Vinyl chloride	0.020	ca	--	µg/L	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U
		Xylenes (total)	206	nc	--	µg/L	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U

Notes:
blank cells indicates that analysis was not performed
-- - no background/PRG value is available for this analyte
PRG - preliminary remediation goals; the screening value for lead is the maximum contaminant level (MCL) from the Safe Drinking Water Act.
nc - non-cancer basis
ca - cancer basis
pbk - based on PBK modeling
mcl - based on CWA maximum contaminant level
max - ceiling limit
sat - soil saturation
[n] - nutrient
UC - unconsolidated
All groundwater samples filtered for metals in the field
If Result = or > Background, then the value is presented in a shaded cell.
If Result = or > Background and PRG, then the value is presented in shaded cell in boldface.
If Result = or > PRG, then the value is presented in boldface.
If Result < PRG and Background, then the value is presented without shading or boldface
Inorganic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is less than the RL, but greater than or equal to the MDL
B - result is less than the CRDL/RL, but greater than or equal to the IDL/MDL
Inorganic Flags
^ - instrument related QC exceed the upper or lower control limits
* - batch QC exceeds the upper or lower control limit
H - batch QC is greater than RL
Organic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is an estimated value below the RL
Organic Flags
B - Method Blank: batch QC is greater than RL
* - batch QC exceeds the upper or lower control limit
^ - batch QC is greater than RL
H - alternate peak selection upon analytical review

Table 4–8
Summary of Groundwater Exceedances

Sample Number	Sample Date	Sample Depth	Analyte	Result (µg/l)	Qualifier	Unconsolidated Wells Background Criteria (µg/l)	Unconsolidated Wells Region 9 PRGs (µg/l)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6MW-001-0001-GW	12/17/03	15 ft	Bis(2-ethylhexyl)phthalate	14		--	4.8	NO	YES
LL6MW-001-0001-GW	12/17/03	15 ft	Copper	6.2	B	0	1460	YES	NO
LL6MW-001-0001-GW	12/17/03	15 ft	Nitrocellulose	110	B J	0.00	--	YES	NO
LL6MW-001-0001-GW	12/17/03	15 ft	Potassium	3800		2890	--[n]	YES	NO
LL6MW-001-0001-GW	12/17/03	15 ft	Selenium	5.7		0	182	YES	NO
LL6MW-002-0001-GW	12/16/03	21 ft	Calcium	130000	H	115000	--[n]	YES	NO
LL6MW-002-0001-GW	12/16/03	21 ft	Copper	3.2	B	0	1460	YES	NO
LL6MW-002-0001-GW	12/16/03	21 ft	Nitrocellulose	85	B J	0.00	--	YES	NO
LL6MW-003-0001-GW	12/18/03	18 ft	Antimony	4.2	B	0	15	YES	NO
LL6MW-003-0001-GW	12/18/03	18 ft	Copper	2.1	B	0	1460	YES	NO
LL6MW-004-0001-GW	12/18/03	17 ft	Antimony	2.7	B	0	15	YES	NO
LL6MW-004-0001-GW	12/18/03	17 ft	Copper	1.9	B	0	1460	YES	NO
LL6MW-004-0001-GW	12/18/03	17 ft	Iron	1000		279	10950	YES	NO
LL6MW-004-0001-GW	12/18/03	17 ft	Nitrocellulose	100	B J	0.00	--	YES	NO
LL6MW-004-0001-GW	12/18/03	17 ft	Nitrocellulose	100	B J	0.00	--	YES	NO
LL6MW-005-0001-DUP	12/15/03	17 ft	Arsenic	12		11.7	0.045	YES	YES
LL6MW-005-0001-DUP	12/15/03	17 ft	Bis(2-ethylhexyl)phthalate	9.1		--	4.8	NO	YES
LL6MW-005-0001-DUP	12/15/03	17 ft	Copper	1.8	B	0	1460	YES	NO
LL6MW-005-0001-DUP	12/15/03	17 ft	Iron	1400		279	10950	YES	NO
LL6MW-005-0001-DUP	12/15/03	17 ft	Nitrocellulose	85	B J	0.00	--	YES	NO
LL6MW-005-0001-GW	12/15/03	15 ft	4-Nitroaniline	4.1	J	--	3.2	NO	YES
LL6MW-005-0001-GW	12/15/03	15 ft	Arsenic	13		11.7	0.045	YES	YES
LL6MW-005-0001-GW	12/15/03	15 ft	Copper	2.3	B	0	1460	YES	NO
LL6MW-005-0001-GW	12/15/03	15 ft	Iron	1600		279	10950	YES	NO
LL6MW-006-0001-GW	12/17/03	15 ft	Bis(2-ethylhexyl)phthalate	14		--	4.8	NO	YES
LL6MW-006-0001-GW	12/17/03	15 ft	Copper	2	B	0	1460	YES	NO
LL6MW-006-0001-GW	12/17/03	15 ft	Manganese	910		1020	876	NO	YES
LL6MW-006-0001-GW	12/17/03	15 ft	Potassium	3900		2890	--[n]	YES	NO
LL6MW-007-0001-GW	12/16/03	10 ft	Antimony	3.9	B	0	15	YES	NO
LL6MW-007-0001-GW	12/16/03	10 ft	Arsenic	0.76	B	11.7	0.045	NO	YES
LL6MW-007-0001-GW	12/16/03	10 ft	Copper	3.4	B	0	1460	YES	NO
LL6MW-007-0001-GW	12/16/03	10 ft	Nitrocellulose	110	B J	0.00	--	YES	NO

Table 4–9
Summary of Surface Water Results

							LL6SW-002-0001-DUP		LL6SW-002-0001-SW		LL6SW-003-0001-SW		LL6SW-004-0001-SW		LL6SW-005-0001-SW		LL6SW-006-0001-SW		LL6SW-008-0001-SW	
						Sample Date	12/01/03		12/01/03		12/01/03		12/01/03		12/01/03		12/01/03		12/01/03	
						Sample Depth	Surface		Surface		Surface		Surface		Surface		20 ft.		15 ft.	
Group	Method	Parameter	Region 9 (Tap Water) PRGs	SW PRG Basis	RVAAP Surface Water Background Criteria	Units														
Cyanide 9012A	9014/9010B	Cyanide, Total	730	nc	0.00	µg/L	4.4	U	4.4	U	4.4	U	4.4	U	4.4	U	4.4	U	4.4	U
Explosives 8330	8330	1,3,5-Trinitrobenzene	1095	nc	0.00	µg/L	0.08	U	0.087	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U
		1,3-Dinitrobenzene	3.6	nc	0.00	µg/L	0.053	U	0.057	U	0.053	U	0.053	U	0.053	U	0.053	U	0.053	U
		2,4,6-TNT	2.2	ca	0.00	µg/L	0.068	U	0.074	U	0.068	U	0.068	U	0.068	U	0.068	U	0.068	U
		2,4-Dinitrotoluene	73	nc	0.00	µg/L	0.042	U	0.046	U	0.042	U	0.042	U	0.042	U	0.042	U	0.042	U
		2,6-Dinitrotoluene	36	nc	0.00	µg/L	0.21	U	0.22	U	0.21	U	0.21	U	0.21	U	0.21	U	0.21	U
		2-Nitrotoluene	0.049	ca	0.00	µg/L	0.16	U	0.18	U	0.16	U	0.16	U	0.16	U	0.16	U	0.16	U
		3-Nitrotoluene	122	nc	0.00	µg/L	0.1	U	0.11	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
		4-Nitrotoluene	0.66	ca	0.00	µg/L	0.34	U	0.37	U	0.34	U	0.34	U	0.34	U	0.34	U	0.34	U
		HMX	1825	nc	0.00	µg/L	0.22	U	0.24	U	0.22	U	0.22	U	0.22	U	5.4		5.2	
		Nitrobenzene	3.4	nc	0.00	µg/L	0.092	U	0.1	U	0.092	U	0.092	U	0.092	U	0.092	U	0.092	U
		RDX	0.61	ca	0.00	µg/L	0.13	U	0.14	U	0.13	U	0.13	U	0.13	U	**15**		**14**	
		Tetryl	365	nc	0.00	µg/L	0.22	U	0.24	U	0.22	U	0.22	U	0.22	U	0.22	U	0.22	U
PCB TCL 8082	8082	Aroclor 1016	0.96	ca	--	µg/L	0.17	U	0.17	U										
		Aroclor 1221	0.034	ca	--	µg/L	0.47	U	0.46	U										
		Aroclor 1232	0.034	ca	--	µg/L	0.22	U	0.22	U										
		Aroclor 1242	0.034	ca	--	µg/L	0.19	U	0.19	U										
		Aroclor 1248	0.034	ca	--	µg/L	0.21	U	0.21	U										
		Aroclor 1254	0.034	ca	--	µg/L	0.13	U	0.13	U										
		Aroclor 1260	0.034	ca	--	µg/L	0.15	U	0.15	U										
Pesticides 8081A	8081A	4,4'-DDD	0.28	ca	--	µg/L	0.037	U	0.036	U										
		4,4'-DDE	0.20	ca	--	µg/L	0.023	U	0.023	U										
		4,4'-DDT	0.20	ca	--	µg/L	0.05	U	0.049	U										
		Aldrin	0.0040	ca	--	µg/L	0.029	U	0.028	U										
		alpha-BHC	0.011	nc	--	µg/L	0.048	U	0.047	U										
		alpha-Chlordane	0.19	ca	--	µg/L	0.016	U	0.016	U										
		beta-BHC	0.037	ca	--	µg/L	0.029	U	0.028	U										
		delta-BHC	--		--	µg/L	0.026	U	0.025	U										
		Dieldrin	0.0042	ca	--	µg/L	0.018	U	0.018	U										
		Endosulfan I	220	nc	--	µg/L	0.021	U	0.021	U										
		Endosulfan II	220	nc	--	µg/L	0.043	U	0.042	U										
		Endosulfan sulfate	220	nc	--	µg/L	0.045	U	0.044	U										
		Endrin	11	nc	--	µg/L	0.017	U	0.017	U										
		Endrin aldehyde	--	--	--	µg/L	0.036	U	0.035	U										
		Endrin ketone	--	--	--	µg/L	0.03	U	0.029	U										
		gamma-BHC (Lindane)	0.052	ca	--	µg/L	0.043	U	0.042	U										
		gamma-Chlordane	0.19	ca	--	µg/L	0.017	U	0.017	U										

Table 4–9
Summary of Surface Water Results

							LL6SW-002-0001-DUP		LL6SW-002-0001-SW		LL6SW-003-0001-SW	LL6SW-004-0001-SW	LL6SW-005-0001-SW	LL6SW-006-0001-SW	LL6SW-008-0001-SW
						Sample Date	12/01/03		12/01/03		12/01/03	12/01/03	12/01/03	12/01/03	12/01/03
						Sample Depth	Surface		Surface		Surface	Surface	Surface	20 ft.	15 ft.
Group	Method	Parameter	Region 9 (Tap Water) PRGs	SW PRG Basis	RVAAP Surface Water Background Criteria	Units									
		Heptachlor	0.015	ca	--	µg/L	0.042	U	0.041	U					
		Heptachlor epoxide	0.0074	ca	--	µg/L	0.037	U	0.036	U					
		Methoxychlor	182	nc	--	µg/L	0.17	U	0.17	U					
		Toxaphene	--	--	--	µg/L	0.14	U	0.14	U					
Propellants 8330	353.2	Nitrocellulose	--	--	0.00	µg/L	100	B J	500	U					
	8330	Nitroglycerin	4.8	ca	0.00	µg/L	0.65	U	0.65	U					
	UV/HPLC per SOP	Nitroguanidine	3650	nc	0.00	µg/L	20	U	20	U					
SVOCs TCL 8270 C	8270C	1,2,4-Trichlorobenzene	7.2	nc	--	µg/L	0.38	U	0.34	U					
		1,2-Dichlorobenzene	370	nc	--	µg/L	0.39	U	0.35	U					
		1,3-Dichlorobenzene	182	nc	--	µg/L	0.48	U	0.43	U					
		1,4-Dichlorobenzene	0.50	ca	--	µg/L	0.37	U	0.33	U					
		2,2-oxybis (1-chloropropane)	0.27	ca	--	µg/L	0.31	U	0.28	U					
		2,4,5-Trichlorophenol	3650	nc	--	µg/L	1.6	U	1.4	U					
		2,4,6-Trichlorophenol	3.6	nc	--	µg/L	0.23	U	0.21	U					
		2,4-Dichlorophenol	109	nc	--	µg/L	1	U	0.92	U					
		2,4-Dimethylphenol	730	nc	--	µg/L	1.4	U	1.3	U					
		2,4-Dinitrophenol	73	nc	--	µg/L	3.7	U	3.3	U					
		2-Chloronaphthalene	487	nc	--	µg/L	0.29	U	0.26	U					
		2-Chlorophenol	30	nc	--	µg/L	0.13	U	0.12	U					
		2-Methylnaphthalene	--	--	--	µg/L	0.14	U	0.13	U					
		2-Methylphenol (o-cresol)	1825	nc	--	µg/L	0.29	U	0.26	U					
		2-Nitroaniline	109	nc	--	µg/L	0.24	U	0.22	U					
		2-Nitrophenol	--	--	--	µg/L	0.91	U	0.83	U					
		3,3-Dichlorobenzidine	0.15	ca	--	µg/L	0.8	U	0.73	U					
		3-Nitroaniline	3.2	ca	--	µg/L	2.3	U	2.1	U					
		4,6-Dinitro-2-methylphenol	3.6	nc	--	µg/L	2.7	U	2.4	U					
		4-Bromophenyl phenyl ether	--	--	--	µg/L	0.21	U	0.19	U					
		4-Chloro-3-methylphenol	--	--	--	µg/L	2.7	U	2.4	U					
		4-Chloroaniline	146	nc	--	µg/L	3.1	U	2.8	U					
		4-Chlorophenyl phenyl ether	--	--	--	µg/L	0.83	U	0.76	U					
		4-Methylphenol (m/p-cresol)	182	nc	--	µg/L	0.36	Ja	0.26	Ja					
		4-Nitroaniline	3.2	ca	--	µg/L	2.6	U	2.3	U					
		4-Nitrophenol	--	--	--	µg/L	4.1	U	3.7	U					
		Acenaphthene	365	nc	--	µg/L	0.13	U	0.12	U					
		Acenaphthylene	--	--	--	µg/L	0.13	U	0.12	U					
		Anthracene	1825	nc	--	µg/L	0.17	U	0.15	U					
		Benzo(a)anthracene	0.092	ca	--	µg/L	0.054	U	0.049	U					
		Benzo(a)pyrene	0.0092	ca	--	µg/L	0.093	U	0.085	U					
		Benzo(b)fluoranthene	0.092	ca	--	µg/L	0.074	U	0.068	U					

Table 4–9
Summary of Surface Water Results

							LL6SW-002-0001-DUP		LL6SW-002-0001-SW		LL6SW-003-0001-SW		LL6SW-004-0001-SW		LL6SW-005-0001-SW		LL6SW-006-0001-SW		LL6SW-008-0001-SW	
						Sample Date	12/01/03		12/01/03		12/01/03		12/01/03		12/01/03		12/01/03		12/01/03	
						Sample Depth	Surface		Surface		Surface		Surface		Surface		20 ft.		15 ft.	
Group	Method	Parameter	Region 9 (Tap Water) PRGs	SW PRG Basis	RVAAP Surface Water Background Criteria	Units														
		Benzo(ghi)perylene	--	--	--	µg/L	0.21	U	0.19	U										
		Benzo(k)fluoranthene	0.92	ca	--	µg/L	0.08	U	0.073	U										
		Bis(2-chloroethoxy)methane	--	--	--	µg/L	0.34	U	0.31	U										
		Bis(2-chloroethyl)ether	0.010	ca	--	µg/L	0.33	U	0.3	U										
		Bis(2-ethylhexyl)phthalate	4.8	ca	--	µg/L	4.3	U	3.9	U										
		Butyl benzyl phthalate	7300	nc	--	µg/L	0.43	U	0.39	U										
		Carbazole	3.4	ca	--	µg/L	0.32	U	0.29	U										
		Chrysene	9.2	ca	--	µg/L	0.05	U	0.045	U										
		Dibenzo(a,h)anthracene	0.0092	ca	--	µg/L	0.14	U	0.13	U										
		Dibenzofuran	12	nc	--	µg/L	0.14	U	0.13	U										
		Diethyl phthalate	29199	nc	--	µg/L	0.17	U	0.15	U										
		Dimethyl phthalate	364867	nc	--	µg/L	0.23	U	0.21	U										
		Di-n-butyl phthalate	3650	nc	--	µg/L	0.4	U	0.36	U										
		Di-n-octyl phthalate	1460	nc	--	µg/L	2.8	U	2.5	U										
		Fluoranthene	1460	nc	--	µg/L	0.16	U	0.14	U										
		Fluorene	243	nc	--	µg/L	0.14	U	0.13	U										
		Hexachlorobenzene	0.042	ca	--	µg/L	0.11	U	0.098	U										
		Hexachlorobutadiene	0.86	ca	--	µg/L	0.71	U	0.65	U										
		Hexachlorocyclopentadiene	219	nc	--	µg/L	0.72	U	0.66	U										
		Hexachloroethane	4.8	ca	--	µg/L	0.68	U	0.62	U										
		Indeno(1,2,3-cd)pyrene	0.092	ca	--	µg/L	0.096	U	0.087	U										
		Isophorone	71	ca	--	µg/L	0.29	U	0.26	U										
		Naphthalene	6.2	nc	--	µg/L	0.18	U	0.16	U										
		n-Nitroso-di-n-propylamine	0.0096	ca	--	µg/L	0.09	U	0.082	U										
		n-Nitrosodiphenylamine	14	ca	--	µg/L	0.14	U	0.13	U										
		Pentachlorophenol	0.56	ca	--	µg/L	1.9	U	1.7	U										
		Phenanthrene	--	--	--	µg/L	0.16	U	0.14	U										
		Phenol	10950	nc	--	µg/L	0.39	U	0.35	U										
		Pyrene	182	nc	--	µg/L	0.13	U	0.12	U										
TAL Metals 6010B	6010B	Aluminum	36499	nc	3370	µg/L	240		710		580		16000		8300		82	B	110	B
		Barium	2555	nc	47.5	µg/L	47		49		19		230		79		24		25	
		Beryllium	73	nc	0.00	µg/L	0.17	U	0.17	U	0.17	U	0.8	B	0.31	B	0.17	U	0.17	U
		Cadmium	18	nc	0.00	µg/L	0.44	U	0.44	U	0.44	U	1.1	B	0.44	U	0.44	U	0.44	U
		Calcium	--	[n]	41400	µg/L	67000		72000		11000		55000		47000		50000		52000	
		Chromium	109	nc	0.00	µg/L	1.6	B	2.3	B	1.5	U	23		9.8	B	1.5	U	1.5	U
		Cobalt	730	nc	0.00	µg/L	1.1	B	1.1	B	1	U	22		3.6	B	1	U	1	U
		Copper	1460	nc	7.9	µg/L	3.6	B	4.2	B	4.3	B	31		15		2.6	B	3	B
		Iron	10950	nc	2560	µg/L	1200		1600		1000		**38000**		**12000**		85		140	
		Magnesium	--	[n]	10800	µg/L	7700		8100		2100		8800		6900		15000		15000	

Table 4–9
Summary of Surface Water Results

							LL6SW-002-0001-DUP		LL6SW-002-0001-SW		LL6SW-003-0001-SW		LL6SW-004-0001-SW		LL6SW-005-0001-SW		LL6SW-006-0001-SW		LL6SW-008-0001-SW	
						Sample Date	12/01/03		12/01/03		12/01/03		12/01/03		12/01/03		12/01/03		12/01/03	
						Sample Depth	Surface		Surface		Surface		Surface		Surface		20 ft.		15 ft.	
Group	Method	Parameter	Region 9 (Tap Water) PRGs	SW PRG Basis	RVAAP Surface Water Background Criteria	Units														
		Manganese	876	nc	391	µg/L	**2500**		**2200**		62		**11000**		230		20		39	
		Nickel	730	nc	0.00	µg/L	1.9	U	1.9	U	1.9	U	25		12		1.9	U	1.9	U
		Potassium	--	[n]	3170	µg/L	2800		2800		2100		4600		5500		1400		2000	
		Selenium	182	nc	0.00	µg/L	5	U	5	U	5	U	7.2		5	U	5	U	5	U
		Silver	182	nc	0.00	µg/L	3.1	U	3.1	U	3.1	U	3.1	U	3.1	U	3.1	U	3.1	U
		Sodium	--	[n]	21300	µg/L	660	B	530	B	650	B	3200		2900		5700		6400	
		Vanadium	36	nc	0.00	µg/L	2.1	U	2.1	U	2.1	U	28		14		2.1	U	2.1	U
		Zinc	10950	nc	42	µg/L	13		15		21		430		59		10	U	10	U
	7041	Antimony	15	nc	0.00	µg/L	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U
	7060A	Arsenic	0.045	ca	3.2	µg/L	**1.6**	B	**1.6**	B	0.73	U	**26**		**8.2**		0.73	U	0.73	U
	7421	Lead	15	mcl	0.00	µg/L	0.78	U	8.3		0.96	B	**83**		**26**		0.78	U	0.78	U
	7470A	Mercury	11	nc	0.00	µg/L	0.049	U	0.049	U	0.049	U	0.12	B	0.072	B	0.049	U	0.049	U
	7841	Thallium	2.4	nc	0.00	µg/L	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U
VOCs TCL 8260B	8260B	1,1,1-Trichloroethane	3172	nc	--	µg/L	0.08	U	0.08	U										
		1,1,2,2-Tetrachloroethane	0.055	ca	--	µg/L	0.09	U	0.09	U										
		1,1,2-Trichloroethane	0.20	ca	--	µg/L	0.15	U	0.15	U										
		1,1-Dichloroethane	811	nc	--	µg/L	0.11	U	0.11	U										
		1,1-Dichloroethene	339	nc	--	µg/L	0.12	U	0.12	U										
		1,2-Dichloroethane	0.12	ca	--	µg/L	0.09	U	0.09	U										
		1,2-Dichloroethene (total)	120	nc	--	µg/L	0.23	U	0.23	U										
		1,2-Dichloropropane	0.16	ca	--	µg/L	0.12	U	0.12	U										
		2-Butanone (MEK)	6968	nc	--	µg/L	1.2	U	1.2	U										
		2-Hexanone	2000	nc	--	µg/L	0.53	U	0.53	U										
		4-Methyl-2-pentanone (MIBK)	1993	nc	--	µg/L	0.65	U	0.65	U										
		Acetone	5475	nc	--	µg/L	8.2		2.2											
		Benzene	0.35	ca	--	µg/L	0.09	U	0.09	U										
		Bromodichloromethane	0.18	ca	--	µg/L	0.11	U	0.11	U										
		Bromoform	8.5	ca	--	µg/L	0.11	U	0.11	U										
		Bromomethane	8.7	nc	--	µg/L	0.1	U	0.1	U										
		Carbon disulfide	1043	nc	--	µg/L	0.2	U	0.2	U										
		Carbon tetrachloride	0.17	ca	--	µg/L	0.13	U	0.13	U										
		Chlorobenzene	106	nc	--	µg/L	0.08	U	0.08	U										
		Chloroethane	4.6	ca	--	µg/L	0.08	U	0.08	U										
		Chloroform	0.17	ca	--	µg/L	0.11	U	0.11	U										
		Chloromethane	158	nc	--	µg/L	0.08	U	0.08	U										
		cis-1,3-Dichloropropene	0.40	ca	--	µg/L	0.12	U	0.12	U										
		Dibromochloromethane	0.13	ca	--	µg/L	0.06	U	0.06	U										
		Ethylbenzene	1340	nc	--	µg/L	0.07	U	0.07	U										
		Methylene chloride	4.3	ca	--	µg/L	0.35	U	0.35	U										

Table 4–9
Summary of Surface Water Results

							LL6SW-002-0001-DUP		LL6SW-002-0001-SW		LL6SW-003-0001-SW	LL6SW-004-0001-SW	LL6SW-005-0001-SW	LL6SW-006-0001-SW	LL6SW-008-0001-SW
						Sample Date	12/01/03		12/01/03		12/01/03	12/01/03	12/01/03	12/01/03	12/01/03
						Sample Depth	Surface		Surface		Surface	Surface	Surface	20 ft.	15 ft.
Group	Method	Parameter	Region 9 (Tap Water) PRGs	SW PRG Basis	RVAAP Surface Water Background Criteria	Units									
		Styrene	1641	nc	--	µg/L	0.13	U	0.13	U					
		Tetrachloroethene	0.10	ca	--	µg/L	0.09	U	0.09	U					
		Toluene	723	nc	--	µg/L	0.1	U	0.1	U					
		trans-1,3-Dichloropropene	0.40	ca	--	µg/L	0.15	U	0.15	U					
		Trichloroethene	0.028	ca	--	µg/L	0.1	U	0.1	U					
		Vinyl chloride	0.020	ca	--	µg/L	0.08	U	0.08	U					
		Xylenes (total)	206	nc	--	µg/L	0.28	U	0.28	U					

Notes:
blank cells indicates that analysis was not performed
-- - no background/PRG value is available for this analyte
PRG - preliminary remediation goals; the screening value for lead is the maximum contaminant level (MCL) from the Safe Drinking Water Act.
nc - non-cancer basis
ca - cancer basis
pbk - based on PBK modeling
mcl - based on CWA maximum contaminant level
max - ceiling limit
sat - soil saturation
[n] - nutrient
If Result = or > Background, then the value is presented in a shaded cell.
If Result = or > Background and PRG, then the value is presented in a shaded cell and in boldface.
If Result = or > PRG, then the value is presented in boldface.
If Result < PRG and Background, then the value is presented without shading or boldface.
Inorganic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is less than the RL, but greater than or equal to the MDL
B - result is less than the CRDL/RL, but greater than or equal to the IDL/MDL

Inorganic Flags
^ - instrument related QC exceed the upper or lower control limits
* - batch QC exceeds the upper or lower control limit
H - batch QC is greater than RL
Organic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is an estimated value below the RL
Organic Flags
B - Method Blank: batch QC is greater than RL
* - batch QC exceeds the upper or lower control limit
^ - batch QC is greater than RL
a - concentration is below the method Reporting Limit (RL)
H - alternate peak selection upon analytical review

Table 4–10
Summary of Surface Water Sample Results
Collected During Azide Screening

ANALYTE**, UNITS, METHOD NO.	RVAAP Surface Water Background Criteria µg/L	Region 9 PRG Data (Tap Water) µg/L	LL6SW-001-0001-SW	LL6SW-001-0001-FD
Sample Date			3/14/2002	3/14/2002
Explosives 8330 µg/L				
HMX	0.0	1825 nc	0.46 U	0.74 U
RDX	0.0	0.61 ca	0.19 U	0.3 U
1,3,5-Trinitrobenzene	0.0	1095 nc	0.19 U	0.3 U
1,3-Dinitrobenzene	0.0	3.6 nc	0.19 U	0.3 U
Nitrobenzene	0.0	3.4 nc	0.19 U	0.3 U
2,4,6-Trinitrtoluene	0.0	2.2 ca	0.19 U	0.3 U
Tetryl	0.0	365 nc	0.37 U	0.59 U
2,4-Dinitrotoluene	0.0	73 nc	0.19 U	0.3 U
2,6-Dinitrotoluene	0.0	36 nc	0.37 U	0.59 U
2-Nitrotoluene	0.0	0.049 ca	0.37 U	0.59 U
4-Nitrtoluene	0.0	0.66 ca	0.92 U	1.5 U
3-Nitrotoluene	0.0	122 nc	0.37 U	0.59 U
TAL Metals 6010B µg/L				
Antimony	0.0	15 nc	3 U	3 U
Arsenic	3.2	0.045 ca	6 U	6 U
Lead	0.0	15 mcl	2 U	2 U
Thallium	0.0	2.4 nc	2 U	2 U
Mercury	0.0	11 nc	0.2 U	0.2 U
Aluminum	3370	36499 nc	107 B	97.2 B
Barium	47.5	2555 nc	15.2	15.4
Beryllium	0.0	73 nc	4 U	4 U
Cadmium	0.0	18 nc	2 U	2 U

Table 4–10
Summary of Surface Water Sample Results
Collected During Azide Screening

ANALYTE**, UNITS, METHOD NO.	RVAAP Surface Water Background Criteria µg/L	Region 9 PRG Data (Tap Water) µg/L	LL6SW-001-0001-SW	LL6SW-001-0001-FD
Sample Date			3/14/2002	3/14/2002
Calcium	41400	-- [n]	29400 H	29500 H
Chromium	0.0	109 nc	10 U	10 U
Cobalt	0.0	730 nc	5 U	5 U
Copper	7.9	1460 nc	10 U	10 U
Iron	2560.0	10950 nc	1240	1210
Magnesium	10800.0	-- [n]	5400	5440
Manganese	391	876 nc	88.4	86.6
Nickel	0.0	730 nc	10 U	10 U
Potassium	3170	-- [n]	2530	2520
Selenium	0	182 nc	10 U	10 U
Silver	0	182 nc	5 U	5 U
Sodium	21300	-- [n]	795 B	780 B
Vanadium	0.0	36 nc	5 U	5 U
Zinc	42	10950 nc	4.7 B	10 B

Notes:
PRG - preliminary remediation goals
nc - non-cancer basis
ca - cancer basis
mcl - based on CWA maximum contaminant level
[n] - nutrient
-- - no background/PRG value available for this analyte
If Result = or > Background, then the value is presented in a shaded cell
If Result = or > Background and PRG, then the value is presented in a shadedcell and in boldface
If Result = or > PRG, then the value is presented with a bold style
If Result < PRG and Background, then the value is presented without shading or boldface.

Inorganic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is less than the RL, but greater than or equal to the MDL
B - result is less than the CRDL/RL, but greater than or equal to the IDL/MDL
Inorganic Flags
H - batch QC is greater than RL
Organic Qualifiers
U - analyte was not detected at or above the stated limit

Table 4–11
Summary of Surface Water Exceedances

Sample Number	Sample Date	Sample Depth	Analyte	Result (µg/l)	Qualifier	Surface Water Background Criteria (µg/L)	Surface Water Region 9 PRGs (µg/l)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SW-002-0001-DUP	12/01/03	0-1 ft	Arsenic	1.6	B	3.2	0.045	NO	YES
LL6SW-002-0001-DUP	12/01/03	0-1 ft	Calcium	67,000		41,400	--[n]	YES	NO
LL6SW-002-0001-DUP	12/01/03	0-1 ft	Chromium	1.6	B	0	109	YES	NO
LL6SW-002-0001-DUP	12/01/03	0-1 ft	Cobalt	1.1	B	0	730	YES	NO
LL6SW-002-0001-DUP	12/01/03	0-1 ft	Manganese	2,500		391	876	YES	YES
LL6SW-002-0001-DUP	12/01/03	0-1 ft	Nitrocellulose	100	B J	0.00	--	YES	NO
LL6SW-002-0001-SW	12/01/03	Surface	Arsenic	1.6	B	3.2	0.045	NO	YES
LL6SW-002-0001-SW	12/01/03	Surface	Barium	49		47.5	2555	YES	NO
LL6SW-002-0001-SW	12/01/03	Surface	Calcium	72,000		41,400	--[n]	YES	NO
LL6SW-002-0001-SW	12/01/03	Surface	Chromium	2.3	B	0	109	YES	NO
LL6SW-002-0001-SW	12/01/03	Surface	Cobalt	1.1	B	0	730	YES	NO
LL6SW-002-0001-SW	12/01/03	Surface	Lead	8.3		0	15	YES	NO
LL6SW-002-0001-SW	12/01/03	Surface	Manganese	2200		391	876	YES	YES
LL6SW-003-0001-SW	12/01/03	Surface	Lead	0.96	B	0	15	YES	NO
LL6SW-004-0001-SW	12/01/03	Surface	Aluminum	16,000		3,370	36,499	YES	NO
LL6SW-004-0001-SW	12/01/03	Surface	Arsenic	26		3.2	0.045	YES	YES
LL6SW-004-0001-SW	12/01/03	Surface	Barium	230		47.5	2,555	YES	NO
LL6SW-004-0001-SW	12/01/03	Surface	Beryllium	0.8	B	0	73	YES	NO
LL6SW-004-0001-SW	12/01/03	Surface	Cadmium	1.1	B	0	18	YES	NO
LL6SW-004-0001-SW	12/01/03	Surface	Calcium	55,000		41,400	--[n]	YES	NO
LL6SW-004-0001-SW	12/01/03	Surface	Chromium	23		0	109	YES	NO
LL6SW-004-0001-SW	12/01/03	Surface	Cobalt	22		0	730	YES	NO
LL6SW-004-0001-SW	12/01/03	Surface	Copper	31		7.9	1,460	YES	NO
LL6SW-004-0001-SW	12/01/03	Surface	Iron	38,000		2,560	10,950	YES	YES
LL6SW-004-0001-SW	12/01/03	Surface	Lead	83		0	15	YES	YES
LL6SW-004-0001-SW	12/01/03	Surface	Manganese	11,000		391	876	YES	YES
LL6SW-004-0001-SW	12/01/03	Surface	Mercury	0.12	B	0	11	YES	NO
LL6SW-004-0001-SW	12/01/03	Surface	Nickel	25		0	730	YES	NO
LL6SW-004-0001-SW	12/01/03	Surface	Potassium	4,600		3,170	--[n]	YES	NO
LL6SW-004-0001-SW	12/01/03	Surface	Selenium	7.2		0	182	YES	NO
LL6SW-004-0001-SW	12/01/03	Surface	Vanadium	28		0	36	YES	NO
LL6SW-004-0001-SW	12/01/03	Surface	Zinc	430		42	10,950	YES	NO
LL6SW-005-0001-SW	12/01/03	Surface	Aluminum	8,300		3370	36,499	YES	NO
LL6SW-005-0001-SW	12/01/03	Surface	Arsenic	8.2		3.2	0.045	YES	YES
LL6SW-005-0001-SW	12/01/03	Surface	Barium	79		47.5	2,555	YES	NO
LL6SW-005-0001-SW	12/01/03	Surface	Beryllium	0.31	B	0	73	YES	NO
LL6SW-005-0001-SW	12/01/03	Surface	Calcium	47,000		41,400	--[n]	YES	NO
LL6SW-005-0001-SW	12/01/03	Surface	Chromium	9.8	B	0	109	YES	NO
LL6SW-005-0001-SW	12/01/03	Surface	Cobalt	3.6	B	0	730	YES	NO
LL6SW-005-0001-SW	12/01/03	Surface	Copper	15		7.9	1,460	YES	NO
LL6SW-005-0001-SW	12/01/03	Surface	Iron	12,000		2,560	10,950	YES	YES
LL6SW-005-0001-SW	12/01/03	Surface	Lead	26		0	15	YES	YES

Table 4–11
Summary of Surface Water Exceedances

Sample Number	Sample Date	Sample Depth	Analyte	Result (µg/l)	Qualifier	Surface Water Background Criteria (µg/L)	Surface Water Region 9 PRGs (µg/l)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SW-005-0001-SW	12/01/03	Surface	Mercury	0.072	B	0	11	YES	NO
LL6SW-005-0001-SW	12/01/03	Surface	Nickel	12		0	730	YES	NO
LL6SW-005-0001-SW	12/01/03	Surface	Potassium	5,500		3,170	--[n]	YES	NO
LL6SW-005-0001-SW	12/01/03	Surface	Vanadium	14		0	36	YES	NO
LL6SW-005-0001-SW	12/01/03	Surface	Zinc	59		42	10,950	YES	NO
LL6SW-006-0001-SW	12/01/03	20 ft	Calcium	50,000		41,400	--[n]	YES	NO
LL6SW-006-0001-SW	12/01/03	20 ft	Magnesium	15,000		10,800	--[n]	YES	NO
LL6SW-006-0001-SW	12/01/03	20 ft	RDX	15		--	0.61	NO	YES
LL6SW-008-0001-SW	12/01/03	15 ft	Calcium	52,000		41,400	--[n]	YES	NO
LL6SW-008-0001-SW	12/01/03	15 ft	Magnesium	15,000		10,800	--[n]	YES	NO
LL6SW-008-0001-SW	12/01/03	15 ft	RDX	14		--	0.61	NO	YES

Notes:
-- - no background/PRG value is available for this analyte
blank cell indicates that the analyte was a non-detect (with a "U" qualifier) or analysis was not performed
PRG - preliminary remediation goals; the PRG for lead is the maximum contaminant level (MCL)
nc - non-cancer basis
ca - cancer basis
pbk - based on PBK modeling
mcl - based on CWA maximum contaminant level
max - ceiling limit
sat - soil saturation
[n] - nutrient
UC - unconsolidated
Inorganic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is less than the RL, but greater than or equal to the MDL
B - result is less than the CRDL/RL, but greater than or equal to the IDL/MDL
Inorganic Flags
^ - instrument related QC exceed the upper or lower control limits
* - batch QC exceeds the upper or lower control limit
H - batch QC is greater than RL
Organic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is an estimated value below the RL
Organic Flags
B - Method Blank: batch QC is greater than RL
* - batch QC exceeds the upper or lower control limit
^ - batch QC is greater than RL
H - alternate peak selection upon analytical review

Table 4–12
Summary of Sediment Results

							LL6SD-002-0001-SD	LL6SD-003-0001-SD	LL6SD-004-0001-SD	LL6SD-005-0001-DUP	LL6SD-005-0001-SD	LL6SD-010-0001-DUP	LL6SD-010-0001-SD	LL6SD-011-0001-SD*	LL6SD-012-0001-SD*	LL6SD-013-0001-SD	LL6SD-014-0001-SD	LL6SD-015-0001-SD
						Sample Date	12/01/03	12/01/03	12/01/03	12/01/03	12/01/03	12/01/03	12/01/03	12/02/03	12/02/03	12/02/03	12/02/03	12/02/03
						Sample Depth	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-1 ft.	0-1 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SD PRG Basis	RVAAP Sediment Background Criteria	Units												
Cyanide 9012A	9014/9010B	Cyanide, Total	122	nc	0.00	mg/kg		0.15 U				0.3 U	0.15 U					
Explosives 8330	8330	1,3,5-Trinitrobenzene	183	nc	0.00	mg/kg		0.017 U				0.017 U	0.017 U					
		1,3-Dinitrobenzene	0.61	nc	0.00	mg/kg		0.018 U				0.018 U	0.017 U					
		2,4,6-TNT	16	ca	0.00	mg/kg		0.034 U				0.034 U	0.033 U					
		2,4-Dinitrotoluene	12	nc	0.00	mg/kg		0.035 U				0.035 U	0.035 U					
		2,6-Dinitrotoluene	6.1	nc	0.00	mg/kg		0.047 U*				0.047 U*	0.047 U*					
		2-Nitrotoluene	0.88	ca	0.00	mg/kg		0.033 U				0.033 U	0.033 U					
		3-Nitrotoluene	73	nc	0.00	mg/kg		0.05 U				0.05 U	0.049 U					
		4-Nitrotoluene	12	ca	0.00	mg/kg		0.046 U				0.046 U	0.046 U					
		HMX	306	nc	0.00	mg/kg		0.11 U				0.11 U	0.11 U					
		Nitrobenzene	2	nc	0.00	mg/kg		0.022 U				0.022 U	0.022 U					
		RDX	4.4	ca	0.00	mg/kg		0.058 U				0.058 U	0.057 U					
		Tetryl	61	nc	0.00	mg/kg		0.043 U				0.043 U	0.043 U					
PCB TCL 8082	8082	Aroclor 1016	0.39	nc	--	mg/kg		0.0023 U				0.0026 U	0.0026 U					
		Aroclor 1221	0.22	ca	--	mg/kg		0.0025 U				0.0028 U	0.0028 U					
		Aroclor 1232	0.22	ca	--	mg/kg		0.0025 U				0.0028 U	0.0028 U					
		Aroclor 1242	0.22	ca	--	mg/kg		0.0025 U				0.0028 U	0.0028 U					
		Aroclor 1248	0.22	ca	--	mg/kg		0.0025 U				0.0028 U	0.0028 U					
		Aroclor 1254	0.22	ca	--	mg/kg		0.0025 U				0.0028 U	0.0028 U					
		Aroclor 1260	0.22	ca	--	mg/kg		0.0017 U				0.0065 J	0.0096 J					
Pesticides 8081A	8081A	4,4'-DDD	2.4	ca	--	mg/kg		0.00044 U				0.0005 U	0.0005 U					
		4,4'-DDE	1.7	ca	--	mg/kg		0.0008 U				0.0015 J	0.0024					
		4,4'-DDT	1.7	ca	--	mg/kg		0.00046 U				0.00051 U	0.00052 U					
		Aldrin	0.029	ca	--	mg/kg		0.00016 U				0.00018 U	0.00018 U					
		alpha-BHC	0.09	sat	--	mg/kg		0.0002 U				0.00022 U	0.00022 U					
		alpha-Chlordane	1.6	ca	--	mg/kg		0.00015 U				0.00017 U	0.00017 U					
		beta-BHC	0.32	ca	--	mg/kg		0.00018 U				0.00021 U	0.00021 U					
		delta-BHC	--	--	--	mg/kg		0.00014 U				0.00015 U	0.00015 U					
		Dieldrin	0.030	ca	--	mg/kg		0.00042 U				0.00047 U	0.00047 U					
		Endosulfan I	37	nc	--	mg/kg		0.00033 U				0.00037 U	0.00038 U					
		Endosulfan II	37	nc	--	mg/kg		0.00034 U				0.00039 U	0.00039 U					
		Endosulfan sulfate	37	nc	--	mg/kg		0.00036 U				0.0004 U	0.0004 U					
		Endrin	1.8	nc	--	mg/kg		0.00053 U				0.00059 U	0.0006 U					
		Endrin aldehyde	--	--	--	mg/kg		0.00041 U				0.00046 U	0.00046 U					
		Endrin ketone	--	--	--	mg/kg		0.00036 U				0.0004 U	0.0004 U					
		gamma-BHC (Lindane)	0.44	ca	--	mg/kg		0.00028 U				0.00032 U	0.00032 U					
		gamma-Chlordane	1.6	ca	--	mg/kg		0.00018 U				0.00021 U	0.00021 U					
		Heptachlor	0.11	ca	--	mg/kg		0.00022 U				0.00025 U	0.00025 U					
		Heptachlor epoxide	0.053	ca	--	mg/kg		0.00017 U				0.00019 U	0.0002 U					
		Methoxychlor	31	nc	--	mg/kg		0.0028 U				0.0032 U	0.0032 U					
		Toxaphene	--	--	--	mg/kg		0.0057 U				0.0063 U	0.0064 U					

Table 4–12
Summary of Sediment Results

							LL6SD-002-0001-SD	LL6SD-003-0001-SD	LL6SD-004-0001-SD	LL6SD-005-0001-DUP	LL6SD-005-0001-SD	LL6SD-010-0001-DUP	LL6SD-010-0001-SD	LL6SD-011-0001-SD*	LL6SD-012-0001-SD*	LL6SD-013-0001-SD	LL6SD-014-0001-SD	LL6SD-015-0001-SD
					Sample Date		12/01/03	12/01/03	12/01/03	12/01/03	12/01/03	12/01/03	12/01/03	12/02/03	12/02/03	12/02/03	12/02/03	12/02/03
					Sample Depth		0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-1 ft.	0-1 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SD PRG Basis	RVAAP Sediment Background Criteria	Units												
Propellants 8330	353.2	Nitrocellulose	--	--	0.00	mg/kg		2.2 B J				1.7 B J	1.5 B J					
	8330	Nitroglycerin	35	ca	0.00	mg/kg		0.5 U				0.5 U	0.5 U					
	UV/HPLC per SOP	Nitroguanidine	611	nc	0.00	mg/kg		0.25 U				0.25 U	0.25 U					
SVOCs TCL 8270 C	8270C	1,2,4-Trichlorobenzene	6.2	nc	--	mg/kg		0.073 U				0.082 U	0.081 U					
		1,2-Dichlorobenzene	600	sat	--	mg/kg		0.097 U				0.11 U	0.11 U					
		1,3-Dichlorobenzene	53	nc	--	mg/kg		0.097 U				0.11 U	0.11 U					
		1,4-Dichlorobenzene	3.4	ca	--	mg/kg		0.088 U				0.099 U	0.097 U					
		2,2-oxybis (1-chloropropane)	2.9	ca	--	mg/kg		0.093 U				0.1 U	0.1 U					
		2,4,5-Trichlorophenol	611	nc	--	mg/kg		0.047 U				0.053 U	0.052 U					
		2,4,6-Trichlorophenol	0.61	nc	--	mg/kg		0.058 U				0.066 U	0.064 U					
		2,4-Dichlorophenol	18	nc	--	mg/kg		0.059 U				0.067 U	0.066 U					
		2,4-Dimethylphenol	122	nc	--	mg/kg		0.074 U				0.084 U	0.082 U					
		2,4-Dinitrophenol	12	nc	--	mg/kg		0.14 U				0.16 U	0.16 U					
		2-Chloronaphthalene	494	nc	--	mg/kg		0.059 U				0.067 U	0.066 U					
		2-Chlorophenol	6.3	nc	--	mg/kg		0.073 U				0.082 U	0.081 U					
		2-Methylnaphthalene	--	--	--	mg/kg		0.0019 U				0.015 J	0.0099 J					
		2-Methylphenol (o-cresol)	306	nc	--	mg/kg		0.01 U				0.012 U	0.011 U					
		2-Nitroaniline	18.3	nc	--	mg/kg		0.042 U				0.048 U	0.046 U					
		2-Nitrophenol	--	--	--	mg/kg		0.078 U				0.088 U	0.086 U					
		3,3-Dichlorobenzidine	1.1	ca	--	mg/kg		0.022 U				0.025 U	0.025 U					
		3-Nitroaniline	1.8	nc	--	mg/kg		0.14 U*				0.16 U*	0.15 U*					
		4,6-Dinitro-2-methylphenol	0.61	nc	--	mg/kg		0.12 U				0.13 U	0.13 U					
		4-Bromophenyl phenyl ether	--	--	--	mg/kg		0.0038 U				0.0043 U	0.0042 U					
		4-Chloro-3-methylphenol	--	--	--	mg/kg		0.047 U				0.053 U	0.052 U					
		4-Chloroaniline	24	nc	--	mg/kg		0.12 U				0.14 U	0.14 U					
		4-Chlorophenyl phenyl ether	--	--	--	mg/kg		0.0044 U				0.005 U	0.0049 U					
		4-Methylphenol (m/p-cresol)	31	nc	--	mg/kg		0.0072 U				0.0081 U	0.0079 U					
		4-Nitroaniline	23	ca	--	mg/kg		0.048 U				0.055 U	0.053 U					
		4-Nitrophenol	--	--	--	mg/kg		0.1 U				0.11 U	0.11 U					
		Acenaphthene	368	nc	--	mg/kg		0.0017 U				0.002 U	0.0019 U					
		Acenaphthylene	--	--	--	mg/kg		0.0011 U				0.0013 U	0.0012 U					
		Anthracene	2189	nc	--	mg/kg		0.0011 U				0.0012 U	0.0012 U					
		Benzo(a)anthracene	0.62	ca	--	mg/kg		0.0052 J				0.03 J	0.028 J					
		Benzo(a)pyrene	0.062	ca	--	mg/kg		0.0062 J				0.038 J	0.03 J					
		Benzo(b)fluoranthene	0.62	ca	--	mg/kg		0.0058 J				0.044 J	0.034 J					
		Benzo(ghi)perylene	--	--	--	mg/kg		0.0023 U				0.03 J	0.026 J					
		Benzo(k)fluoranthene	6.2	ca	--	mg/kg		0.0035 U				0.045 J	0.033 J					
		Bis(2-chloroethoxy)methane	--	--	--	mg/kg		0.0036 U				0.0041 U	0.004 U					
		Bis(2-chloroethyl)ether	0.22	ca	--	mg/kg		0.0025 U				0.0028 U	0.0027 U					
		Bis(2-ethylhexyl)phthalate	35	ca	--	mg/kg		0.012 U				0.036 J	0.013 U					
		Butyl benzyl phthalate	1222	nc	--	mg/kg		0.0051 U				0.0057 U	0.0056 U					
		Carbazole	24	ca	--	mg/kg		0.043 U				0.049 U	0.048 U					

Table 4–12
Summary of Sediment Results

Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SD PRG Basis	RVAAP Sediment Background Criteria	Units	LL6SD-002-0001-SD	LL6SD-003-0001-SD	LL6SD-004-0001-SD	LL6SD-005-0001-DUP	LL6SD-005-0001-SD	LL6SD-010-0001-DUP	LL6SD-010-0001-SD	LL6SD-011-0001-SD*	LL6SD-012-0001-SD*	LL6SD-013-0001-SD	LL6SD-014-0001-SD	LL6SD-015-0001-SD
		Sample Date					12/01/03	12/01/03	12/01/03	12/01/03	12/01/03	12/01/03	12/01/03	12/02/03	12/02/03	12/02/03	12/02/03	12/02/03
		Sample Depth					0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-1 ft.	0-1 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.
		Chrysene	62	ca	--	mg/kg		0.0081 J				0.048	0.035 J					
		Dibenzo(a,h)anthracene	0.062	ca	--	mg/kg		0.0027 U				0.0094 J	0.003 U					
		Dibenzofuran	15	nc	--	mg/kg		0.0033 U				0.0038 U	0.0037 U					
		Diethyl phthalate	4888	nc	--	mg/kg		0.0046 U				0.0052 U	0.0051 U					
		Dimethyl phthalate	100000	max	--	mg/kg		0.0044 U				0.005 U	0.0049 U					
		Di-n-butyl phthalate	611	nc	--	mg/kg		0.025 U				0.028 U	0.027 U					
		Di-n-octyl phthalate	244	nc	--	mg/kg		0.011 U				0.012 U	0.012 U					
		Fluoranthene	229	nc	--	mg/kg		0.014 J				0.074	0.053					
		Fluorene	275	nc	--	mg/kg		0.002 U				0.0022 U	0.0022 U					
		Hexachlorobenzene	0.30	ca	--	mg/kg		0.0022 U				0.0025 U	0.0025 U					
		Hexachlorobutadiene	6.2	ca	--	mg/kg		0.0041 U				0.0046 U	0.0045 U					
		Hexachlorocyclopentadiene	37	nc	--	mg/kg		0.067 U				0.075 U	0.074 U					
		Hexachloroethane	35	ca	--	mg/kg		0.0041 U				0.0046 U	0.0045 U					
		Indeno(1,2,3-cd)pyrene	0.62	ca	--	mg/kg		0.0043 J				0.028 J	0.022 J					
		Isophorone	512	ca	--	mg/kg		0.003 U				0.0034 U	0.0033 U					
		Naphthalene	5.6	nc	--	mg/kg		0.0021 U				0.013 J	0.0023 U					
		n-Nitroso-di-n-propylamine	0.069	ca	--	mg/kg		0.0038 U				0.0032 U	0.0031 U					
		n-Nitrosodiphenylamine	99	ca	--	mg/kg		0.0036 U				0.0041 U	0.004 U					
		Pentachlorophenol	3.0	ca	--	mg/kg		0.12 U				0.14 U	0.14 U					
		Phenanthrene	--	--	--	mg/kg		0.0012 U				0.033 J	0.025 J					
		Phenol	1833	nc	--	mg/kg		0.002 U				0.0022 U	0.0022 U					
		Pyrene	232	nc	--	mg/kg		0.011 J				0.058	0.039 J					
TAL Metals 6010B	6010B	Aluminum	7614	nc	13900	mg/kg	**9600**	4500	**13000**	**11000**	**11000**	**8600**	**8900**	**12000**	6700	7500	**13000**	**12000**
		Barium	538	nc	123	mg/kg	73	57	95	66	67	70	81	76	40	30	83	80
		Beryllium	15	nc	0.38	mg/kg	0.41 B	0.62	0.69	0.43 B	0.45 B	0.46 B	0.43 B	0.74	0.47	0.49	0.82	0.73
		Cadmium	3.7	nc	0.00	mg/kg	0.14 U	0.1 B	1.1	0.39	0.51	0.88	0.97	0.094 U	0.09 U	0.088 U	0.22 B	0.13 U
		Calcium	--	[n]	5510	mg/kg	4700	620	3800	3300	4000	22000	14000	10000	1600	1200	3300	2900
		Chromium	30	ca	18.1	mg/kg	14	9.1	21	16	16	17	16	18	10	9.8	18	16
		Cobalt	902	ca	9.1	mg/kg	6.3	15	9.7	9.4	8.7	9.7	11	10	7.7	6.9	9.9	7.2
		Copper	313	nc	27.6	mg/kg	21	13	57	24	24	29	25	21	16	16	97	21
		Iron	2346	nc	28200	mg/kg	**20000**	**21000**	**23000**	**23000**	**22000**	**22000**	**24000**	**26000**	**19000**	**16000**	**25000**	**21000**
		Magnesium	--	[n]	2760	mg/kg	2000	670	2500	2900	2900	3700	3600	4300	2000	1800	3500	2600
		Manganese	176	nc	1950	mg/kg	**380**	**770**	**450**	**350**	**400**	**450**	**670**	**410**	**370**	**250**	**340**	**240**
		Nickel	156	nc	17.7	mg/kg	14	12	20	19	18	31	31	23	17	12	25	17
		Potassium	--	[n]	1950	mg/kg	1000	400	1200	1100	1200	1300	1200	1500	780	620	1400	1200
		Selenium	39	nc	1.7	mg/kg	0.68 U	0.72 B	1.3 B	0.69 B	0.67 B	0.52 U	0.66 B	0.47 U	0.45 U	0.44 U	0.63 U	0.66 U
		Silver	39	nc	0.00	mg/kg	0.53 U	0.31 U	0.52 U	0.42 U	0.43 U	0.4 U	0.43 U	0.36 U	0.35 U	0.34 U	0.49 U	0.52 U
		Sodium	--	[n]	112	mg/kg	150 U	88 U	150 U	120 U	120 U	110 U	120 U	100 U	97 U	95 U	140 U	140 U
		Vanadium	7.8	nc	26.1	mg/kg	**17**	**13**	**23**	**21**	**21**	**15**	**16**	**22**	**13**	**13**	**22**	**22**
		Zinc	2346	nc	532	mg/kg	68	130	450	98	97	200	200	72	56	49	100	110

Table 4–12
Summary of Sediment Results

Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SD PRG Basis	RVAAP Sediment Background Criteria	Units	LL6SD-002-0001-SD	LL6SD-003-0001-SD	LL6SD-004-0001-SD	LL6SD-005-0001-DUP	LL6SD-005-0001-SD	LL6SD-010-0001-DUP	LL6SD-010-0001-SD	LL6SD-011-0001-SD*	LL6SD-012-0001-SD*	LL6SD-013-0001-SD	LL6SD-014-0001-SD	LL6SD-015-0001-SD
		Sample Date					12/01/03	12/01/03	12/01/03	12/01/03	12/01/03	12/01/03	12/01/03	12/02/03	12/02/03	12/02/03	12/02/03	12/02/03
		Sample Depth					0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-1 ft.	0-1 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.
	7041	Antimony	3.1	nc	0.00	mg/kg	0.63 U	0.45 U	0.73 U	0.57 U	0.52 U	0.54 U	0.6 U	0.51 U	0.52 U	0.56 U	0.77 U	0.79 U
	7060A	Arsenic	0.39	ca	19.5	mg/kg	**8.7**	**9**	**37**	**11**	**11**	**18**	**15**	**11**	**18**	**12**	**14**	**6.8**
	7421	Lead	400	pbk	27.4	mg/kg	36	16	85	43	44	46	51	65	19	11	27	39
	7471A	Mercury	2.3	nc	0.06	mg/kg	0.052	0.02 B	0.094	0.18	0.13	0.031	0.026	0.026	0.018 B	0.014 B	0.048	0.25
	7841	Thallium	0.52	nc	0.89	mg/kg	0.27 U	0.2 U	0.31 U	0.25 U	0.22 U	0.23 U	0.26 U	0.33	0.23 U	0.24 U	0.33 U	0.34 U
	Lloyd Kahn	TOC Average Duplicates	--	--	--	mg/kg	14000	6900	27000	8600	8800	4600	9400			3900	9900	13000
VOCs TCL 8260B	8260B	1,1,1-Trichloroethane	1200	sat	--	mg/kg		0.0014 U				0.0016 U	0.0015 U					
		1,1,2,2-Tetrachloroethane	0.41	ca	--	mg/kg		0.0012 U				0.0014 U	0.0014 U					
		1,1,2-Trichloroethane	0.73	ca	--	mg/kg		0.0014 U				0.0016 U	0.0015 U					
		1,1-Dichloroethane	51	nc	--	mg/kg		0.0012 U				0.0014 U	0.0014 U					
		1,1-Dichloroethene	12	nc	--	mg/kg		0.0016 U				0.0018 U	0.0018 U					
		1,2-Dichloroethane	0.28	ca	--	mg/kg		0.0012 U				0.0013 U	0.0013 U					
		1,2-Dichloroethene (total)	6.9	nc	--	mg/kg		0.0026 U				0.003 U	0.003 U					
		1,2-Dichloropropane	0.34	ca	--	mg/kg		0.0012 U				0.0014 U	0.0014 U					
		2-Butanone (MEK)	2231	nc	--	mg/kg		0.0048 U				0.0055 U	0.0055 U					
		2-Hexanone	530	nc	--	mg/kg		0.0014 U				0.0016 U	0.0015 U					
		4-Methyl-2-pentanone (MIBK)	528	nc	--	mg/kg		0.0012 U				0.0014 U	0.0014 U					
		Acetone	1412	nc	--	mg/kg		0.0057 U				0.0065 U	0.0065 U					
		Benzene	0.64	ca	--	mg/kg		0.0014 U				0.0016 U	0.0015 U					
		Bromodichloromethane	0.82	ca	--	mg/kg		0.0012 U				0.0014 U	0.0014 U					
		Bromoform	62	ca	--	mg/kg		0.00093 U				0.0011 U	0.0011 U					
		Bromomethane	0.39	nc	--	mg/kg		0.0016 U				0.0018 U	0.0018 U					
		Carbon disulfide	36	nc	--	mg/kg		0.0015 U				0.0017 U	0.0017 U					
		Carbon tetrachloride	0.25	ca	--	mg/kg		0.0014 U				0.0016 U	0.0015 U					
		Chlorobenzene	15	nc	--	mg/kg		0.0014 U				0.0016 U	0.0015 U					
		Chloroethane	3.0	ca	--	mg/kg		0.0012 U				0.0014 U	0.0014 U					
		Chloroform	0.22	ca	--	mg/kg		0.0014 U				0.0016 U	0.0015 U					
		Chloromethane	4.7	nc	--	mg/kg		0.0014 U				0.0016 U	0.0015 U					
		cis-1,3-Dichloropropene	0.78	ca	--	mg/kg		0.0011 U				0.0013 U	0.0013 U					
		Dibromochloromethane	1.1	ca	--	mg/kg		0.00098 U				0.0011 U	0.0011 U					
		Ethylbenzene	395	sat	--	mg/kg		0.0014 U				0.0016 U	0.0015 U					
		Methylene chloride	9.1	ca	--	mg/kg		0.0036 U				0.0041 U	0.0041 U					
		Styrene	1700	sat	--	mg/kg		0.0014 U				0.0016 U	0.0015 U					
		Tetrachloroethene	0.48	ca	--	mg/kg		0.0015 U				0.0017 U	0.0017 U					
		Toluene	520	sat	--	mg/kg		0.0014 U				0.0016 U	0.0015 U					
		trans-1,3-Dichloropropene	0.78	ca	--	mg/kg		0.00098 U				0.0011 U	0.0011 U					
		Trichloroethene	0.053	ca	--	mg/kg		0.0014 U				0.0016 U	0.0015 U					

Table 4–12
Summary of Sediment Results

							LL6SD-002-0001-SD	LL6SD-003-0001-SD	LL6SD-004-0001-SD	LL6SD-005-0001-DUP	LL6SD-005-0001-SD	LL6SD-010-0001-DUP	LL6SD-010-0001-SD	LL6SD-011-0001-SD*	LL6SD-012-0001-SD*	LL6SD-013-0001-SD	LL6SD-014-0001-SD	LL6SD-015-0001-SD
						Sample Date	12/01/03	12/01/03	12/01/03	12/01/03	12/01/03	12/01/03	12/01/03	12/02/03	12/02/03	12/02/03	12/02/03	12/02/03
						Sample Depth	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.	0-1 ft.	0-1 ft.	0-0.5 ft.	0-0.5 ft.	0-0.5 ft.
Group	Method	Parameter	Region 9 (Residential Soil) PRGs	SD PRG Basis	RVAAP Sediment Background Criteria	Units												
		Vinyl chloride	0.079	ca	--	mg/kg		0.0014 U				0.0016 U	0.0015 U					
		Xylenes (total)	27	nc	--	mg/kg		0.0042 U				0.0048 U	0.0048 U					

Notes:
blank cells indicates that analysis was not performed
-- - no background/PRG value is available for this analyte
PRG - preliminary remediation goals
nc - non-cancer basis, value is 1/10th the published PRG
ca - cancer basis
pbk - based on PBK modeling
mcl - based on CWA maximum contaminant level
max - ceiling limit
sat - soil saturation
* sediment sample not available at the site. A surface soil sample (0.0-1 ft) was collected in place of the sediment sample.
[n] - nutrient
If Result = or > Background, then the value is presented with a shaded/highlighted style
If Result = or > Background and PRG, then the value is presented with a bold + shaded/highlighted style
If Result = or > PRG, then the value is presented with a bold style
If Result < PRG and Background, then the value is presented with a normal style
Inorganic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is less than the RL, but greater than or equal to the MDL
B - result is less than the CRDL/RL, but greater than or equal to the IDL/MDL
Inorganic Flags
^ - instrument related QC exceed the upper or lower control limits
* - batch QC exceeds the upper or lower control limit
H - batch QC is greater than RL
Organic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is an estimated value below the RL
Organic Flags
B - Method Blank: batch QC is greater than RL
* - batch QC exceeds the upper or lower control limit
^ - batch QC is greater than RL
H - alternate peak selection upon analytical review

Table 4–13
Summary of Sediment Sample Results
Collected During Azide Screening

ANALYTE**, UNITS, METHOD NO.	RVAAP Sediment (Background Criteria) (mg/kg)	Region 9 PRG Data (Residential Soil) (mg/kg)		LL6SD-001-0001-SD
Sample Date				3/14/2002
Explosives 8330 mg/kg				
HMX	0.0	306	nc	0.25 U
RDX	0.0	4.4	ca	0.1 U
1,3,5-Trinitrobenzene	0.0	183	nc	0.1 U
1,3-Dinitrobenzene	0.0	0.61	nc	0.1 U
Nitrobenzene	0.0	2	nc	0.1 U
2,4,6-Trinitrtoluene	0.0	16	ca	0.1 U
Tetryl	0.0	61	nc	0.2 U
2,4-Dinitrotoluene	0.0	12	nc	0.1 U
2,6-Dinitrotoluene	0.0	6.1	nc	0.2 U
2-Nitrotoluene	0.0	0.88	ca	0.2 U
4-Nitrtoluene	0.0	12	ca	0.5 U
3-Nitrotoluene	0.0	73	nc	0.2 U
TAL Metals 6010B mg/kg				
Antimony	0.0	3.1	nc	0.6
Arsenic	19.5	0.39	ca	**11.6**
Lead	27.4	400	pbk	156
Thallium	0.9	0.52	nc	0.31 U
Mercury	0.06	2.3	nc	0.020 B
Aluminum	13900	7,614	nc	**16,200**
Barium	123	538	nc	91.3
Beryllium	0.38	15	nc	0.71
Cadmium	0.0	3.7	nc	0.34 U
Calcium	5510	--	[n]	4110
Chromium	18.1	30	ca	23.2
Cobalt	9.1	902	ca	10.2
Copper	27.6	313	nc	68.4

Table 4–13
Summary of Sediment Sample Results
Collected During Azide Screening

ANALYTE**, UNITS, METHOD NO.	RVAAP Sediment (Background Criteria) (mg/kg)	Region 9 PRG Data (Residential Soil) (mg/kg)	LL6SD-001-0001-SD
Sample Date			3/14/2002
Iron	28200	2,346 nc	**27,500 H**
Magnesium	2760	-- [n]	3,880
Manganese	1950	176 nc	**315**
Nickel	17.7	156 nc	28.4
Potassium	1950	-- [n]	1820
Selenium	1.7	39 nc	1.7 U
Silver	0.0	39 nc	0.85 U
Sodium	112	-- [n]	243
Vanadium	26.1	7.8 nc	**27.2**
Zinc	532	2,346 nc	72.1

Notes:
PRG - preliminary remediation goals
nc - non-cancer basis, value is 1/10th the published PRG
ca - cancer basis
pbk - based on PBK modeling
[n] - nutrient
-- - no background/PRG value available for this analyte
If Result = or > Background, then the value is presented in a shaded cell.
If Result = or > Background and PRG, then the value is presented in a shaded cell in boldface
If Result = or > PRG, then the value is presented in boldface.
If Result < PRG and Background, then the value is presented without shading or boldface.
Inorganic Qualifiers
U - analyte was not detected at or above the stated limit
J - result is less than the RL, but greater than or equal to the MDL
B - result is less than the CRDL/RL, but greater than or equal to the IDL/MDL
Inorganic Flags
H - batch QC is greater than RL
Organic Qualifiers
U - analyte was not detected at or above the stated limit

Table 4–14
Summary of Sediment Exceedances

Sample number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Sediment Background Criteria (mg/kg)	Sediment Region 9 PRGs (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SD-001-0001-SD	3/14/2002		Aluminum	16200.00		13900	7614.00	YES	YES
LL6SD-001-0001-SD	3/14/2002		Antimony	0.60		0.0	3.10	YES	NO
LL6SD-001-0001-SD	3/14/2002		Arsenic	11.60		19.5	0.39	NO	YES
LL6SD-001-0001-SD	3/14/2002		Beryllium	0.71		0.38	15.00	YES	NO
LL6SD-001-0001-SD	3/14/2002		Chromium	23.20		18.1	30.00	YES	NO
LL6SD-001-0001-SD	3/14/2002		Cobalt	10.20		9.1	902.00	YES	NO
LL6SD-001-0001-SD	3/14/2002		Copper	68.40		27.6	313.00	YES	NO
LL6SD-001-0001-SD	3/14/2002		Iron	27500.00	H	28200	2346.00	NO	YES
LL6SD-001-0001-SD	3/14/2002		Lead	156.00		27.4	400.00	YES	NO
LL6SD-001-0001-SD	3/14/2002		Magnesium	3880.00		2760	-- [n]	YES	NO
LL6SD-001-0001-SD	3/14/2002		Manganese	315.00		1950	176.00	NO	YES
LL6SD-001-0001-SD	3/14/2002		Nickel	28.40		17.7	156.00	YES	NO
LL6SD-001-0001-SD	3/14/2002		Sodium	243.00		112	-- [n]	YES	NO
LL6SD-001-0001-SD	3/14/2002		Vanadium	27.20		26.1	7.80	YES	YES
LL6SD-002-0001-SD	12/01/03	0-0.5 ft	Aluminum	9600		13900	7614	NO	YES
LL6SD-002-0001-SD	12/01/03	0-0.5 ft	Arsenic	8.7		19.5	0.39	NO	YES
LL6SD-002-0001-SD	12/01/03	0-0.5 ft	Beryllium	0.41	B	0.38	15	YES	NO
LL6SD-002-0001-SD	12/01/03	0-0.5 ft	Iron	20000		28200	2346	NO	YES
LL6SD-002-0001-SD	12/01/03	0-0.5 ft	Lead	36		27.4	400	YES	NO
LL6SD-002-0001-SD	12/01/03	0-0.5 ft	Manganese	380		1950	176	NO	YES
LL6SD-002-0001-SD	12/01/03	0-0.5 ft	TOC Average Duplicates	14000		0.89	0.52	YES	YES
LL6SD-002-0001-SD	12/01/03	0-0.5 ft	Vanadium	17		26.1	7.8	NO	YES
LL6SD-003-0001-SD	12/01/03	0-0.5 ft	Arsenic	9		19.5	0.39	NO	YES
LL6SD-003-0001-SD	12/01/03	0-0.5 ft	Beryllium	0.62		0.38	15	YES	NO
LL6SD-003-0001-SD	12/01/03	0-0.5 ft	Cadmium	0.1	B	0	3.7	YES	NO
LL6SD-003-0001-SD	12/01/03	0-0.5 ft	Cobalt	15		9.1	30	YES	NO
LL6SD-003-0001-SD	12/01/03	0-0.5 ft	Iron	21000		28200	2346	NO	YES
LL6SD-003-0001-SD	12/01/03	0-0.5 ft	Manganese	770		1950	176	NO	YES
LL6SD-003-0001-SD	12/01/03	0-0.5 ft	Nitrocellulose	2.2	B J	0.00	--	YES	NO
LL6SD-003-0001-SD	12/01/03	0-0.5 ft	TOC Average Duplicates	6900		0.89	0.52	YES	YES
LL6SD-003-0001-SD	12/01/03	0-0.5 ft	Vanadium	13		26.1	7.8	NO	YES
LL6SD-004-0001-SD	12/01/03	0-0.5 ft	Aluminum	13000		13900	7614	NO	YES
LL6SD-004-0001-SD	12/01/03	0-0.5 ft	Arsenic	37		19.5	0.39	YES	YES
LL6SD-004-0001-SD	12/01/03	0-0.5 ft	Beryllium	0.69		0.38	15	YES	NO
LL6SD-004-0001-SD	12/01/03	0-0.5 ft	Cadmium	1.1		0	3.7	YES	NO
LL6SD-004-0001-SD	12/01/03	0-0.5 ft	Chromium	21		18.1	30	YES	NO

Table 4–14
Summary of Sediment Exceedances

Sample number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Sediment Background Criteria (mg/kg)	Sediment Region 9 PRGs (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SD-004-0001-SD	12/01/03	0-0.5 ft	Cobalt	9.7		9.1	30	YES	NO
LL6SD-004-0001-SD	12/01/03	0-0.5 ft	Copper	57		27.6	313	YES	NO
LL6SD-004-0001-SD	12/01/03	0-0.5 ft	Iron	23000		28200	2346	NO	YES
LL6SD-004-0001-SD	12/01/03	0-0.5 ft	Lead	85		27.4	400	YES	NO
LL6SD-004-0001-SD	12/01/03	0-0.5 ft	Manganese	450		1950	176	NO	YES
LL6SD-004-0001-SD	12/01/03	0-0.5 ft	Mercury	0.094		0.06	2.3	YES	NO
LL6SD-004-0001-SD	12/01/03	0-0.5 ft	Nickel	20		17.7	156	YES	NO
LL6SD-004-0001-SD	12/01/03	0-0.5 ft	TOC Average Duplicates	27000		0.89	0.52	YES	YES
LL6SD-004-0001-SD	12/01/03	0-0.5 ft	Vanadium	23		26.1	7.8	NO	YES
LL6SD-005-0001-DUP	12/01/03	0-0.5 ft	Aluminum	11000		13900	7614	NO	YES
LL6SD-005-0001-DUP	12/01/03	0-0.5 ft	Arsenic	11		19.5	0.39	NO	YES
LL6SD-005-0001-DUP	12/01/03	0-0.5 ft	Beryllium	0.43	B	0.38	15	YES	NO
LL6SD-005-0001-DUP	12/01/03	0-0.5 ft	Cadmium	0.39		0	3.7	YES	NO
LL6SD-005-0001-DUP	12/01/03	0-0.5 ft	Cobalt	9.4		9.1	30	YES	NO
LL6SD-005-0001-DUP	12/01/03	0-0.5 ft	Iron	23000		28200	2346	NO	YES
LL6SD-005-0001-DUP	12/01/03	0-0.5 ft	Lead	43		27.4	400	YES	NO
LL6SD-005-0001-DUP	12/01/03	0-0.5 ft	Magnesium	2900		2760	--[n]	YES	NO
LL6SD-005-0001-DUP	12/01/03	0-0.5 ft	Manganese	350		1950	176	NO	YES
LL6SD-005-0001-DUP	12/01/03	0-0.5 ft	Mercury	0.18		0.06	2.3	YES	NO
LL6SD-005-0001-DUP	12/01/03	0-0.5 ft	Nickel	19		17.7	156	YES	NO
LL6SD-005-0001-DUP	12/01/03	0-0.5 ft	TOC Average Duplicates	8600		0.89	0.52	YES	YES
LL6SD-005-0001-DUP	12/01/03	0-0.5 ft	Vanadium	21		26.1	7.8	NO	YES
LL6SD-005-0001-SD	12/01/03	0-0.5 ft	Aluminum	11000		13900	7614	NO	YES
LL6SD-005-0001-SD	12/01/03	0-0.5 ft	Arsenic	11		19.5	0.39	NO	YES
LL6SD-005-0001-SD	12/01/03	0-0.5 ft	Beryllium	0.45	B	0.38	15	YES	NO
LL6SD-005-0001-SD	12/01/03	0-0.5 ft	Cadmium	0.51		0	3.7	YES	NO
LL6SD-005-0001-SD	12/01/03	0-0.5 ft	Iron	22000		28200	2346	NO	YES
LL6SD-005-0001-SD	12/01/03	0-0.5 ft	Lead	44		27.4	400	YES	NO
LL6SD-005-0001-SD	12/01/03	0-0.5 ft	Magnesium	2900		2760	--[n]	YES	NO
LL6SD-005-0001-SD	12/01/03	0-0.5 ft	Manganese	400		1950	176	NO	YES
LL6SD-005-0001-SD	12/01/03	0-0.5 ft	Mercury	0.13		0.06	2.3	YES	NO
LL6SD-005-0001-SD	12/01/03	0-0.5 ft	Nickel	18		17.7	156	YES	NO
LL6SD-005-0001-SD	12/01/03	0-0.5 ft	TOC Average Duplicates	8800		0.89	0.52	YES	YES
LL6SD-005-0001-SD	12/01/03	0-0.5 ft	Vanadium	21		26.1	7.8	NO	YES

Table 4–14
Summary of Sediment Exceedances

Sample number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Sediment Background Criteria (mg/kg)	Sediment Region 9 PRGs (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SD-010-0001-DUP	12/01/03	0-0.5 ft	Aluminum	8600		13900	7614	NO	YES
LL6SD-010-0001-DUP	12/01/03	0-0.5 ft	Arsenic	18		19.5	0.39	NO	YES
LL6SD-010-0001-DUP	12/01/03	0-0.5 ft	Beryllium	0.46	B	0.38	15	YES	NO
LL6SD-010-0001-DUP	12/01/03	0-0.5 ft	Cadmium	0.88		0	3.7	YES	NO
LL6SD-010-0001-DUP	12/01/03	0-0.5 ft	Calcium	22000		5510	--[n]	YES	NO
LL6SD-010-0001-DUP	12/01/03	0-0.5 ft	Cobalt	9.7		9.1	30	YES	NO
LL6SD-010-0001-DUP	12/01/03	0-0.5 ft	Copper	29		27.6	313	YES	NO
LL6SD-010-0001-DUP	12/01/03	0-0.5 ft	Iron	22000		28200	2346	NO	YES
LL6SD-010-0001-DUP	12/01/03	0-0.5 ft	Lead	46		27.4	400	YES	NO
LL6SD-010-0001-DUP	12/01/03	0-0.5 ft	Magnesium	3700		2760	--[n]	YES	NO
LL6SD-010-0001-DUP	12/01/03	0-0.5 ft	Manganese	450		1950	176	NO	YES
LL6SD-010-0001-DUP	12/01/03	0-0.5 ft	Nickel	31		17.7	156	YES	NO
LL6SD-010-0001-DUP	12/01/03	0-0.5 ft	Nitrocellulose	1.7	B J	0.00	--	YES	NO
LL6SD-010-0001-DUP	12/01/03	0-0.5 ft	TOC Average Duplicates	4600		0.89	0.52	YES	YES
LL6SD-010-0001-DUP	12/01/03	0-0.5 ft	Vanadium	15		26.1	7.8	NO	YES
LL6SD-010-0001-SD	12/01/03	0-0.5 ft	Aluminum	8900		13900	7614	NO	YES
LL6SD-010-0001-SD	12/01/03	0-0.5 ft	Arsenic	15		19.5	0.39	NO	YES
LL6SD-010-0001-SD	12/01/03	0-0.5 ft	Beryllium	0.43	B	0.38	15	YES	NO
LL6SD-010-0001-SD	12/01/03	0-0.5 ft	Cadmium	0.97		0	3.7	YES	NO
LL6SD-010-0001-SD	12/01/03	0-0.5 ft	Calcium	14000		5510	--[n]	YES	NO
LL6SD-010-0001-SD	12/01/03	0-0.5 ft	Cobalt	11		9.1	30	YES	NO
LL6SD-010-0001-SD	12/01/03	0-0.5 ft	Iron	24000		28200	2346	NO	YES
LL6SD-010-0001-SD	12/01/03	0-0.5 ft	Lead	51		27.4	400	YES	NO
LL6SD-010-0001-SD	12/01/03	0-0.5 ft	Magnesium	3600		2760	--[n]	YES	NO
LL6SD-010-0001-SD	12/01/03	0-0.5 ft	Manganese	670		1950	176	NO	YES
LL6SD-010-0001-SD	12/01/03	0-0.5 ft	Nickel	31		17.7	156	YES	NO
LL6SD-010-0001-SD	12/01/03	0-0.5 ft	Nitrocellulose	1.5	B J	0.00	--	YES	NO
LL6SD-010-0001-SD	12/01/03	0-0.5 ft	TOC Average Duplicates	9400		0.89	0.52	YES	YES
LL6SD-010-0001-SD	12/01/03	0-0.5 ft	Vanadium	16		26.1	7.8	NO	YES
LL6SD-011-0001-SD	12/02/03	0-1 ft	Aluminum	12000		13900	7614	NO	YES
LL6SD-011-0001-SD	12/02/03	0-1 ft	Arsenic	11		19.5	0.39	NO	YES
LL6SD-011-0001-SD	12/02/03	0-1 ft	Beryllium	0.74		0.38	15	YES	NO

Table 4–14
Summary of Sediment Exceedances

Sample number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Sediment Background Criteria (mg/kg)	Sediment Region 9 PRGs (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SD-011-0001-SD	12/02/03	0-1 ft	Calcium	10000		5510	--[n]	YES	NO
LL6SD-011-0001-SD	12/02/03	0-1 ft	Cobalt	10		9.1	30	YES	NO
LL6SD-011-0001-SD	12/02/03	0-1 ft	Iron	26000		28200	2346	NO	YES
LL6SD-011-0001-SD	12/02/03	0-1 ft	Lead	65		27.4	400	YES	NO
LL6SD-011-0001-SD	12/02/03	0-1 ft	Magnesium	4300		2760	--[n]	YES	NO
LL6SD-011-0001-SD	12/02/03	0-1 ft	Manganese	410		1950	176	NO	YES
LL6SD-011-0001-SD	12/02/03	0-1 ft	Nickel	23		17.7	156	YES	NO
LL6SD-011-0001-SD	12/02/03	0-1 ft	Vanadium	22		26.1	7.8	NO	YES
LL6SD-012-0001-SD	12/02/03	0-1 ft	Arsenic	18		19.5	0.39	NO	YES
LL6SD-012-0001-SD	12/02/03	0-1 ft	Beryllium	0.47		0.38	15	YES	NO
LL6SD-012-0001-SD	12/02/03	0-1 ft	Iron	19000		28200	2346	NO	YES
LL6SD-012-0001-SD	12/02/03	0-1 ft	Manganese	370		1950	176	NO	YES
LL6SD-012-0001-SD	12/02/03	0-1 ft	Vanadium	13		26.1	7.8	NO	YES
LL6SD-013-0001-SD	12/02/03	0-0.5 ft	Arsenic	12		19.5	0.39	NO	YES
LL6SD-013-0001-SD	12/02/03	0-0.5 ft	Beryllium	0.49		0.38	15	YES	NO
LL6SD-013-0001-SD	12/02/03	0-0.5 ft	Iron	16000		28200	2346	NO	YES
LL6SD-013-0001-SD	12/02/03	0-0.5 ft	Manganese	250		1950	176	NO	YES
LL6SD-013-0001-SD	12/02/03	0-0.5 ft	TOC Average Duplicates	3900		0.89	0.52	YES	YES
LL6SD-013-0001-SD	12/02/03	0-0.5 ft	Vanadium	13		26.1	7.8	NO	YES
LL6SD-014-0001-SD	12/02/03	0-0.5 ft	Aluminum	13000		13900	7614	NO	YES
LL6SD-014-0001-SD	12/02/03	0-0.5 ft	Arsenic	14		19.5	0.39	NO	YES
LL6SD-014-0001-SD	12/02/03	0-0.5 ft	Beryllium	0.82		0.38	15	YES	NO
LL6SD-014-0001-SD	12/02/03	0-0.5 ft	Cadmium	0.22	B	0	3.7	YES	NO
LL6SD-014-0001-SD	12/02/03	0-0.5 ft	Cobalt	9.9		9.1	30	YES	NO
LL6SD-014-0001-SD	12/02/03	0-0.5 ft	Copper	97		27.6	313	YES	NO
LL6SD-014-0001-SD	12/02/03	0-0.5 ft	Iron	25000		28200	2346	NO	YES
LL6SD-014-0001-SD	12/02/03	0-0.5 ft	Magnesium	3500		2760	--[n]	YES	NO
LL6SD-014-0001-SD	12/02/03	0-0.5 ft	Manganese	340		1950	176	NO	YES
LL6SD-014-0001-SD	12/02/03	0-0.5 ft	Nickel	25		17.7	156	YES	NO
LL6SD-014-0001-SD	12/02/03	0-0.5 ft	TOC Average Duplicates	9900		0.89	0.52	YES	YES
LL6SD-014-0001-SD	12/02/03	0-0.5 ft	Vanadium	22		26.1	7.8	NO	YES

Table 4–14
Summary of Sediment Exceedances

Sample number	Sample Date	Sample Depth	Analyte	Result (mg/kg)	Qualifier	Sediment Background Criteria (mg/kg)	Sediment Region 9 PRGs (mg/kg)	Exceed Installation Background?	Exceed Region 9 Criteria?
LL6SD-015-0001-SD	12/02/03	0-0.5 ft	Aluminum	12000		13900	7614	NO	YES
LL6SD-015-0001-SD	12/02/03	0-0.5 ft	Arsenic	6.8		19.5	0.39	NO	YES
LL6SD-015-0001-SD	12/02/03	0-0.5 ft	Beryllium	0.73		0.38	15	YES	NO
LL6SD-015-0001-SD	12/02/03	0-0.5 ft	Iron	21000		28200	2346	NO	YES
LL6SD-015-0001-SD	12/02/03	0-0.5 ft	Lead	39		27.4	400	YES	NO
LL6SD-015-0001-SD	12/02/03	0-0.5 ft	Manganese	240		1950	176	NO	YES
LL6SD-015-0001-SD	12/02/03	0-0.5 ft	Mercury	0.25		0.06	2.3	YES	NO
LL6SD-015-0001-SD	12/02/03	0-0.5 ft	TOC Average Duplicates	13000		0.89	0.52	YES	YES
LL6SD-015-0001-SD	12/02/03	0-0.5 ft	Vanadium	22		26.1	7.8	NO	YES

Notes:

-- - no background/PRG value is available for this analyte

blank cell indicates that the analyte was a non-detect (with a "U" qualifier) or analysis was not performed

PRG - preliminary remediation goals; the PRG for lead is the maximum contaminant level (MCL)

nc - non-cancer basis

ca - cancer basis

pbk - based on PBK modeling

mcl - based on CWA maximum contaminant level

max - ceiling limit

sat - soil saturation

[n] - nutrient

UC - unconsolidated

Inorganic Qualifiers

U - analyte was not detected at or above the stated limit

J - result is less than the RL, but greater than or equal to the MDL

B - result is less than the CRDL/RL, but greater than or equal to the IDL/MDL

Inorganic Flags

^ - instrument related QC exceed the upper or lower control limits

* - batch QC exceeds the upper or lower control limit

H - batch QC is greater than RL

Organic Qualifiers

U - analyte was not detected at or above the stated limit

J - result is an estimated value below the RL

Organic Flags

B - Method Blank: batch QC is greater than RL

* - batch QC exceeds the upper or lower control limit

^ - batch QC is greater than RL

H - alternate peak selection upon analytical review

5.0 CONTAMINANT FATE AND TRANSPORT

Knowledge about a contaminant's potential to migrate and persist in an environmental medium is important when evaluating the potential for a chemical to elicit an adverse human health or ecological effect. This section contains information on chemical properties and degradation potential of the chemicals detected at concentrations in excess of RVAAP installation background criteria levels, with an emphasis on chemicals selected as COPCs. The environmental conditions of the site and hydrological considerations that are likely to affect contaminant fate and transport near LL–6 and the surrounding area are also discussed. It is expected that the fate and transport of minor site contaminants would be similar to the major contaminants (i.e., COPCs) that have similar physical and chemical properties.

Section 5.1 discusses the various chemical and physical properties of these chemicals. Section 5.2 reviews the potential for chemical compounds to biodegrade or undergo other transformations. Section 5.3 describes transport pathways where migration and attenuation might be occurring and explains how spatial and temporal variations in hydrologic conditions might affect transport. Section 5.4 summarizes contaminant migration in and around LL–6.

5.1 Chemical and Physical Properties Affecting Chemical Mobility

Table 5–1 presents physical and chemical properties of representative organic chemicals detected at LL–6. Because organic chemicals are considered not to be present in background, this table includes properties for all organic chemicals detected at LL–6 with the exception of minor contaminants. COPCs are included in Table 5–1. Table 5–2 is a simple representation of the gross mobility of metal ions that is expected under various combinations of oxidation-reduction (redox) potential and pH. These properties can be used to estimate qualitatively the environmental mobility and fate of site contaminants. The following properties are discussed:

- Specific gravity,
- Vapor pressure,
- Water solubility−Henry's Law constant,
- Octanol/water partition coefficient (K_{ow}),
- Organic carbon partition coefficient (K_{oc}),
- Soil-water distribution coefficient (Kd),
- Bioconcentration factor (BCF), and
- Mobility index (MI).

Table 5–1
Environmental Fate and Transport
Properties of Organic Chemicals

Chemical	Specific Gravity (1)	Vapor Pressure (1)	Solubility (1)	Octanol/Water Partition Coefficient(1)	Organic Carbon Partition Coefficient(2)	Henry's Law Constant (1)	Bioconcentration Factor (2)	Mobility Index log((solubility*VP)/K_{oc})
ENERGETICS								
HMX								
Nirocellulose	1.67 (3)	NA (4)	NA (4)	NA (4)	NA (4)	NA (4)	NA (4)	NA (4)
KETONES								
Acetone	0.7899	2.66E+2 (25°C)	Miscible	5.75E-01	7.08E+03 (5)	4.276E-5 (25°C)	3.81E-1(6)	NA (4)
HALOGENATED ALIPHATICS								
Methylene chloride	1.3266	4.29E+2 (25°C)	1.67E+4 (25°C)	1.78E+01	1.17E+01 (5)	3.19E-3 (25°C)	6.00E+00	5.79E+00
MONOCYCLIC AROMATICS								
4-Methylphenol	1.0178	1.1E-1 (25°C)	2.4E+4 (25°C)	8.32E+01	9.0E-1(7)	3.92E-07	1.7E+1(6)	3.47E+00
PHTHALATE ESTERS								
Bis(2-ethylhexyl)phthalate	0.99 (20/20°C)	1.2E+0 (200°C)	4E-1 (25°C)	2.00E+05	1.51E+07 (5)	3.00E-07	2.30E+08	-7.50E+00
Di-n-octylphthalate	0.978	2.50E-06	2.00E-02	1.15E+08	8.32E+07	6.68E-05	2.6E+03 - 9.3E+03	-1.52E+01
PESTICIDES								
4,4'-DDE	NA	6.50E-06	4.00E-02	4.90E+05	4.47E+06 (5)	2.34E-05	8.90E+05	-1.32E+01
4,4'-DDT	1.5 (15/4°C)	1.50E-07	3.1E-3 (25°C)	1.55E+06	2.63E+06 (5)	3.89E-5 (25°C)	8.00E+06	-1.58E+01
PCBs								
Aroclor-1254	1.50 (25°C)(2)	7.71E-5(2)	3.1E-2(2)	1.1E+6(2)	5.30E+05	2.6E-3(2)	1.30E+05	-1.13E+01
Aroclor-1260	1.58 (25°C)(2)	4.05E-5(2)	2.7E-3(2)	1.4E+7(2)	6.70E+06	7.4E-1(2)	1.30E+06	-1.38E+01
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)								
2-Methylnaphthalene	1.0058	1E+1 (105°C)	2.6E+1 (25°C)	7.24E+03	7.27E+2 (8)	4.99E-4 (25°C)	5.1E+2 (6)	-4.47E-01
Acenaphthene	1.07	5.00E-03	4.24E+02	8.32E+03	7.08E+03	1.55E-04	1.10E+03	-3.52E+00
Acenaphthylene	1.02	2.30E-02	1.61E+01	1.17E+04	2.00E+03	1.14E-04	3.80E+02	-3.73E+00
Anthracene	1.283 (25/4°C)	1.95E-4 (25°C)	1.29E+0 (25°C)	2.82E+04	2.95E+04 (5)	8.6E-5 (25°C)	4.70E+03	-8.07E+00
Benzo(a)anthracene	1.274	5.00E-09	1E-2 (24°C)	4.07E+05	3.98E+05 (5)	6.60E-07	5.30E+04	-1.59E+01
Benzo(a)pyrene	1.351	5.00E-09	3.8E-3 (25°C)	9.55E+05	1.02E+06 (5)	4.9E-7 (25°C)	1.40E+05	-1.67E+01
Benzo(b)fluoranthene	NA	5.00E-07	1.2E-3 (25°C)	3.72E+06	1.23E+06 (5)	1.20E-05	1.40E+05	-1.53E+01
Benzo(g,h,i)perylene	1.35	1.00E-10	2.6E-4 (25°C)	1.70E+07	1.60E+06	1.4E-7 (25°C)	3.50E+05	-1.98E+01
Benzo(k)fluoranthene	NA	9.59E-11	5.5E-4 (25°C)	6.92E+06	1.23E+06 (5)	1.04E-03	1.40E+05	-1.94E+01
Carbazole	1.1	1.37E-06	7.48E+00	3.89E+03	3.39E+03	1.53E-08	5.01E+02	-8.52E+00
Chrysene	1.274 (20°C)	6.3E-9 (25°C)	6E-3 (25°C)	4.07E+05	3.98E+05 (5)	1.05E-6 (25°C)	5.30E+04	-1.60E+01
Dibenzo(a,h)anthracene	1.282	1.00E-10	5E-4 (25°C)	9.33E+05	3.80E+06 (5)	7.3E-8 (25°C)	6.90E+05	-1.99E+01
Dibenzofuran	1.0886	4.40E-02	4.22E+00	1.32E+04	8.13E+03	NA	8.00E+02	-4.64E+00
Fluoranthene	1.252	5.0E-6 (25°C)	2.65E-1 (25°C)	2.14E+05	1.07E+05 (5)	6.5E-6 (25°C)	1.20E+04	-1.09E+01
Fluorene	1.202	1.00E+01	1.98E+00	1.62E+04	1.38E+04	6.36E-05	3.80E+03	-2.84E+00
Indeno(1,2,3-cd)pyrene	NA	1E-10 (25°C)	6.20E-02	4.57E+07	3.47E+06 (5)	6.95E-8 (25°C)	3.50E+05	-1.77E+01
Naphthalene	1.162	8.2E-2 (25°C)	3E+1 (25°C)	2.34E+03	2.00E+03 (5)	4.83E-4 (25°C)	4.20E+02	-2.91E+00
Phenanthrene	0.980 (4°C)	1E+0 (118.2°C)	8.16E-1 (21°C)	2.88E+04	1.40E+04	3.93E-5 (25°C)	4.70E+03	-4.23E+00
Pyrene	1.271 (23/4°C)	2.5E+0 (200°C)	1.6E-1 (26°C)	1.51E+05	1.05E+05 (5)	5.1E-6 (25°C)	1.20E+04	-5.42E+00

Footnotes:
1 EPA, September 1992, *Handbook of RCRA Groundwater Monitoring Constituents: Chemical and Physical Properties.*
2 USEPA, December 1982, *Aquatic Fate Process Data for Organic Priority Pollutants* .
3 Meyer et al., 2002 - See text for full reference.
4 NA - Not Available
5 EPA, July 1996, Soil Screening Guidance.
6 Lyman et al., 1990, Eq. 5-2
7 Howard, 1989, *Handbook of Environmental Fate and Exposure Data for Organic Chemicals* , Volume 1.
8 Lyman et al., 1990; Equation 4-5

Table 5–2

Relative Mobilities of Select Metals Under Various Environmental Conditions of Eh and pH

Relative Mobility	Environmental Conditions			
	Oxidizing	Acidic	Neutral/Alkaline	Reducing
Very High			Se	
High	Se, Zn	Se, Zn, Cu, Ni, Hg,Ag		
Medium	Cu, Ni, Hg, Ag, As, Cd	As, Cd	As, Cd	
Low	Pb, Ba, Se	Pb, Ba, Be	Pb, Ba, Be	
Very Low	Fe, Cr	Cr	Cr, Zn, Cu, Ni, Hg, Ag	Cr, Se, Zn, Cu, Ni, Hg, Pb, Ba, Be, Ag

Notes:

Ag = silver
As = arsenic
Ba = barium
Be = beryllium
Cd = cadmium
Cr = chromium
Cu = copper
Eh = standard redox potential
Fe = iron
Hg = mercury
Ni = nickel
Pb = lead
Se = selenium
Zn = zinc

Source: Swartzbaugh et al., *Remediating Sites Contaminated with Heavy Metals.* Hazardous Materials Control, November/December 1992.

Literature values of the water solubility, K_{ow}, K_{oc}, vapor pressure, Henry's Law constant, BCF, MI, and specific gravity are presented for each organic chemical, when available, in Table 5–1. Calculated values, which were obtained using approximation methods, are presented when literature values are not available and the values could be computed. The environmental significance of each of these parameters is discussed in the following subsections.

5.1.1 Specific Gravity

Specific gravity is the ratio of the density of a given volume of pure chemical at a specified temperature (usually 20° Celsius[C]) to the density of the same volume of water at a given temperature (usually 4°C). Its primary use is to determine whether a liquid chemical will have a tendency to float or sink in water if it is present as a pure chemical, i.e., at very high concentrations. Non-aqueous phase liquids (NAPLs) with a specific gravity greater than 1, including halogenated aliphatic compounds, polyaromatic hydrocarbons (PAHs), and pesticides,

will tend to sink if present as a pure liquid or mixture of pure liquids. This is true whether the NAPL is present in a water body or in a matrix such as soil. Chemicals with a specific gravity less than 1 (i.e., light hydrocarbons) will tend to float. This physical characteristic becomes important only when the chemicals present are at very high concentrations and are liquid when they are in pure phase. For LL–6, no NAPLs were detected. Therefore, the characteristic of specific gravity is not expected to be important for LL–6.

5.1.2 Vapor Pressure

Vapor pressure indicates the tendency for chemical volatilization from both solid and aqueous matrices. It is of primary importance at environmental interfaces such as surface soil/air and surface water/air. In unsaturated soils, volatility also governs whether interstitial air pockets can become saturated with chemical vapor. Volatilization from stream sediments could also be significant under low-flow conditions (i.e., during summer months and drought conditions) when the sediments are exposed to the atmosphere in a dry creek bed. Volatilization is not as important when evaluating contaminated groundwater and subsurface soils that are not exposed to the atmosphere. Vapor pressures for ketones and halogenated aliphatics are generally many times greater than vapor pressures for PAHs, pesticides, energetic compounds, and phthalate esters. Generally, the more volatile chemicals are liquid at normal temperatures and pressures whereas the less volatile chemicals are solids under the same conditions. Chemicals with greater vapor pressures are expected to enter the atmosphere much more readily than chemicals with lower vapor pressures. Volatilization from surface water, surface soil, and sediment is a significant loss process for VOCs. Volatilization is not significant for most metals unless the inorganic materials have been converted to organometallic compounds through biochemical action.

5.1.3 Water Solubility

Solubilities are easily determined under laboratory conditions. Many chemicals of environmental interest are often considered to be insoluble in reference books (i.e., the "Handbook of Chemistry and Physics") because they are insoluble for most practical situations. However, most chemicals are soluble to some extent in water; and even those that are classified as insoluble may be soluble in the parts-per-billion (µg/L) or parts-per-million (mg/L) concentration ranges. These ranges may yield toxic effects, depending on the chemical, and are routinely measured during environmental work.

The tendency for a chemical to be leached from soil by infiltrating precipitation is governed by its water solubility. More soluble chemicals are more readily leached than less soluble chemicals. The water solubilities presented in Table 5–1 indicate that ketones and halogenated aliphatics are usually several orders of magnitude more water soluble than pesticides, PCBs, and some of the PAHs. PCBs, in particular, are not frequently detected as dissolved compounds in aqueous samples because of their low solubility.

5.1.4 Henry's Law Constant

Both vapor pressure and water solubility are useful for determining volatilization rates from surface water bodies and groundwater. The measured ratio of these two parameters (the Henry's Law constant) under equilibrium conditions is used to calculate the equilibrium chemical concentrations in the vapor (air) phase versus the liquid (water) phase for the dilute solutions commonly encountered in environmental settings. In general, chemicals having a Henry's Law constant less than 1E-05 (atm–m^3/mole), such as pesticides, PCBs, and PAHs, are expected to volatilize very little and to be present only in minute amounts in the atmosphere or soil vapor. For chemicals with Henry's Law constants greater than 5E-03 atm–m^3/mole, such as many of the halogenated aliphatics, volatilization and diffusion in soil vapor could be significant.

5.1.5 Octanol/Water Partition Coefficient (K_{ow})

K_{ow} is a measure of the equilibrium partitioning of chemicals between octanol and water as determined under laboratory conditions. A linear relationship between the K_{ow} and the uptake of chemicals by fatty tissues of animal and human receptors, or the bioconcentration factor (BCF), has been established (Lyman et al., 1990). The K_{OW} is also useful in characterizing the sorption of compounds by organic soils where experimental values for soil are not available. Pesticides and aromatic compounds, lacking functional groups that enhance water solubility, are several orders of magnitude more likely to partition into fatty tissues than the more water-soluble VOCs. K_{ow} values are also used to estimate BCFs in aquatic organisms.

5.1.6 Organic Carbon-Water Partition Coefficient (K_{oc})

K_{oc} indicates the tendency of a chemical to adhere to organic matter contained in soils under laboratory conditions. Many VOCs, for example, have relatively low K_{OC} values, and they tend to be fairly mobile in the environment as a result of groundwater or surface water movement. Chemicals with high K_{oc} values generally have low water solubility and vice versa. This parameter may be used to infer the relative rates at which the more mobile chemicals (i.e., ketones and halogenated aliphatics) are transported in groundwater. Chemicals such as most pesticides, PCBs, and PAHs are relatively immobile in the soil and are preferentially bound to the soil. These compounds are not subject to groundwater transport to the same extent as compounds with higher water solubilities. However, these immobile chemicals can be transported by erosional processes when they occur in surface soils.

Several factors affect the measured value of K_{oc}. Values of K_{oc} usually decrease with increasing temperature. The fine silt and clay fraction of soil and sediments may have a greater tendency to absorb chemicals because they often have a higher concentration of organic matter and more adsorption sites per unit volume.

5.1.7 Soil-Water Distribution Coefficient (Kd)

Kd is a measure of the equilibrium distribution of a chemical in soil/water systems. The Kd of organic chemicals is a function of both K_{oc} and the fraction of organic carbon in the soil (f_{oc}):

$$Kd = K_{oc} * f_{oc}$$

The degree to which organic chemicals sorb to soils is very important when assessing migration potential. If a chemical tends to sorb strongly to soil, there is much less probability that the chemical will reach groundwater and affect the groundwater quality. In sediments, a high degree of sorption similarly indicates that the chemical is more likely to be transported in entrained sediments than as a dissolved species in surface water.

Chemicals, such as PAHs, that migrate slowly through soil and the upper unsaturated rock units are subjected to biodegradation processes for a relatively long time before they reach the first water-bearing rock unit. As a consequence of low migration potential, there is a very low probability that chemicals with very high Kd values (i.e., PAHs) will reach surface water bodies via groundwater flow. However, if PAHs or pesticides are present at the ground surface, eroded, and transported in surface runoff with soil particles (as a sorbed phase), then there is potential for these compounds to reach adjacent stream channels.

For metals, the sorption coefficients, in large part, represent the ion exchange tendencies of the metals with the soil. Table 5–3 presents sorption coefficients for select metals, several of which were detected at LL–6. Other factors aside, the more positively charged an ion, the more tightly it is bound to soils. Ions that bind tightly tend to displace ions that are less tightly bound because the ions compete for the same ion exchange sites. In addition, soils with high organic material content tend to bind metals in large chemical complexes. This process is described in Section 5.1.8.

Table 5–3

Soil-Water Partition Coefficients for Metals

Inorganic Element	Kd at pH = 5.5[(1)] (L/kg)	Kd at pH = 6.2[(2)] (L/kg)	Kd[(3)] (L/kg)
aluminum	NA	NA	1,500
antimony	NA	NA	45
arsenic	26	28	200
barium	21	33	41
beryllium			790
cadmium	27	42	75
chromium (as Cr^{+3})	2,100	420,000	1,800,000
chromium (as Cr^{+6})	NA	NA	850

Table 5–3 (Continued)

Soil-Water Partition Coefficients for Metals

Inorganic Element	Kd at pH = 5.5[1] (L/kg)	Kd at pH = 6.2[2] (L/kg)	Kd[3] (L/kg)
cobalt			45
copper	NA	NA	428
cyanide (CN^-)			10
iron	NA	NA	25
lead			900
magnesium			5
manganese	NA	NA	65
mercury			52
nickel	28	42	65
selenium	12	75	5
silver			8
strontium	NA	NA	35
thallium			71
vanadium	NA	NA	1,000
zinc	26	42	62

(1) Values from Illinois EPA Tiered Approach to Corrective Action Objectives (TACO) Program; Kd values presented assume an average pH of 5.5.

(2) Values from Illinois EPA TACO Program; Kd values presented assume an average pH of 6.2.

(3) Values from the U.S EPA-sponsored Risk Assessment Information System (RAIS) Internet site: "http://risk.lsd.ornl.gov/rap_hp.html"

NA = Not applicable.

Kd = Soil-water distribution coefficient.

5.1.8 Chemical Complex Formation

Metals may form chemical complexes or combinations that alter their mobility. This may also occur for non-metals. Some of the most important environmental chemicals that form metal complexes are humic substances. These complex mixtures of organic acids and other organic matter are formed naturally in shallow surface soils, pond and, lake bottoms, through the decay of vegetable matter. These substances, after binding with a metal, can increase its mobility by dissolving into an aqueous phase. If the humic substances are adsorbed to a solid substrate, such as soil, sediment, or vegetation, they will tend to remove metal ions from solution by binding to the metals and fixing them to the solid substrate. The binding equilibria are affected by pH. At low pH, the bound metals are released; and at high pH, the metals are preferentially bound. Iron is an exception to this rule (Dragun, 1988). Fulvic acid is a component of humic substances. The pH at which fulvic acid complexes begin to release relatively large proportions

of bound metals has been shown to be less than 5 (Dragun, 1988). Thus, most metals are expected to be preferentially bound to the humic substances at pH values greater than 5.

5.1.9 Bioconcentration Factor

BCF represents the ratio of aquatic animal tissue concentration to water concentration. The ratio is both contaminant- and species-specific. When site-specific values are not measured, literature values are used or the BCF is derived from the K_{ow}. Many of the pesticides and PAHs will bioconcentrate at levels three to five orders of magnitude greater than those concentrations found in the water, but VOCs and energetic compounds are not as readily bioconcentrated. Any bioconcentration that occurs generally requires that the chemical of interest be in the dissolved state; otherwise, the chemical is inaccessible to the organism. For plants, this means that the chemical must be dissolved in the surrounding soil. For other organisms that can inhale, aspirate, or ingest solid particles, the chemical may be bound to the particles and released after ingestion.

5.1.10 Mobility Index

The MI is a quantitative assessment of mobility that uses water solubility (S), vapor pressure (VP), and the K_{oc} (Laskowski, 1983). It is defined as:

$$MI = \log ((S*VP)/K_{oc})$$

A scale to evaluate MI, as presented by Ford and Gurba (1984), is:

Relative MI	Mobility Description
> 5	extremely mobile
0 to 5	very mobile
-5 to 0	slightly mobile
-10 to -5	immobile
< -10	very immobile

Of the organic chemicals detected at LL–6, chlorinated solvents and ketones generally have MIs greater than 5 and are considered extremely mobile. Lighter molecular weight PAHs, such as naphthalene, have MIs ranging from -5 to 0 and are considered slightly mobile. Heavier molecular weight PAHs [i.e., benzo(a)pyrene] are classified as very immobile, having MIs less than -10.

5.1.11 Miscellaneous Characteristics

The solubility and mobility of an inorganic chemical is strongly influenced by its valence state(s) and mineral forms present in soils (i.e., silicates, hydroxides, oxides, and carbonates). The solubility of a metal also depends largely on the pH and oxidation-reduction potential (Eh) of its

environment, the ambient temperature, and other ionic species in solution (the Debye-Huckel theory). Most metals have increased solubility and mobility at lower water pH values (i.e., < 5.0). Some metals such as aluminum, however, have increased solubilities at both low and high pH values (greater than 8). Iron and manganese are metals that have more than one common valence state and are more soluble in the reduced valence states. For example, iron (+3) and manganese (+4) are generally less soluble than iron (+2) and manganese (+2) in the environment. As a result, these metals are more mobile under reducing conditions. Chromium (+6), however, is more mobile than chromium (+3) under typical environmental conditions. The mobility is highly dependent on the anions that are associated with the metal. For example, silver nitrate is very soluble in water, but most other silver compounds are highly insoluble. The solubility product constants reported in the literature vary with the type of chemical complex formed. Metals can be rapidly transformed from one oxidation state to another as they encounter different local environments. For example, manganese that may have been dissolved from local geologic materials at one location may precipitate out of solution as the groundwater containing the dissolved manganese migrates to another area. The wide array of potential metal-anion combinations and environmental conditions leads to a wide array of potential metal mobilities that must be evaluated on a case-by-case basis for potential environmental impact.

5.2 Chemical Persistence and Degradation Processes

Degradation and other transformation processes that affect site contaminants are discussed in this section. Degradation leads to the following possibilities, depending on the contaminant of interest and the contaminant's environment:

- Transfer of the chemically unaltered contaminant from one environmental medium to another (physical changes may occur, i.e., transfer of dissolved contaminant to vapor);
- Transformation of the original contaminant into a less toxic chemical;
- Transformation of the original contaminant into a more toxic or otherwise problematic chemical; and
- Transfer of a chemically or biochemically transformed contaminant from one environmental medium to another.

All of these transformations may occur individually or together, and more than one of these processes may occur for any single chemical. Consequently, the number and complexity of possibilities is partly a function of the number of contaminants and partly a function of which contaminants are present.

For organic chemicals, degradation typically involves a gradual reduction in the molecular weight of the chemical as molecular bonds are cleaved. Cleavage may occur in sequential steps with the most susceptible bonds being cleaved first. For this reason, larger, more

complex molecules that have more chemical bonds commonly have more molecular degradation pathways than smaller molecules. With the changes in molecular structure come changes in chemical and physical properties. For example, daughter compounds are commonly more volatile than their parent compounds. They may also be more or less toxic than the parent compound. For inorganic chemicals, degradation may be a purely inorganic chemical reaction that results in a change of valence state. Depending on the chemical, it may also involve biochemical reactions that transform the inorganic chemical into an organometallic compound or another inorganic species.

Hydrolysis, biodegradation, photolysis, and chemical oxidation/reduction reactions are four processes that are important for many environmental investigations because the potential for their occurrence is high, depending on the contaminants that are present and where those contaminants are located. These four processes are discussed in more detail below.

Hydrolysis is a reaction between the chemical of interest and water that produces a cleavage of the water molecules. Many of these reactions can be catalyzed by the presence of acids or bases. Biodegradation is a generic term that includes oxidation or reduction transformations resulting from enzymatic or other biochemical processes that occur in or near living organisms. Many of these reactions take place in naturally occurring microorganisms such as bacteria that are present in the Earth's crust, especially at the Earth's surface. A chemical or family of chemicals (i.e., chlorinated solvents or ketones) may be highly susceptible to transformation by one type of microorganism but much less so by other organisms. Consequently, the rates of biodegradation can vary widely from no degradation to very rapid degradation, depending on the presence of organisms that can degrade the chemicals. The presence of other chemicals and the ambient conditions can also greatly influence the potential for, and the rate of, degradation. Rates are difficult to predict, however, because they are sensitive to ambient conditions, including the presence or absence of microorganisms that are capable of degrading particular chemicals biochemically. Some of these difficulties are described further below.

Photolysis is the cleavage of chemical bonds induced by light, especially ultraviolet wavelengths. Hence, environmental photolysis characteristically occurs at the Earth's surface in surface water, shallow surface soils, shallow sediments exposed to air, and in the atmosphere, where exposure of the chemicals to sunlight can occur routinely.

Degradation of chemical compounds can frequently be modeled as a first-order decrease or decay of the concentrations over time. If the concentration of the chemical is plotted over time, the concentration decrease is rapid early in the degradation process, but slows as time goes on because the rate of degradation at any point in time is directly proportional to the remaining concentration of the chemical. Such models are useful for predicting the concentration of a chemical at any future time. The true degradation, however, may not follow a first-order decay process even though a first-order decay is used to model the degradation. Furthermore, because many different decay processes can occur in concert, which may have different mechanisms, the first-order decay model will effectively be a composite of the pertinent

processes. This often leads to significant uncertainties in estimating degradation rates. Any uncertainties associated with estimating the degradation rates translate into uncertainties in estimates of future concentrations.

A characteristic of first-order decays is a relationship between half-life and degradation rate. A half-life is the time required to reduce a concentration to one-half of its value. Chemicals with long half-lives have a long persistence in the environment whereas chemicals with short half-lives degrade or disperse quickly. For first-order decays, the half-life, $t_{1/2}$, is equal to the natural logarithm (Ln) of 2 divided by the degradation rate constant, k, [i.e., $t_{1/2}$ = Ln(2)/k]. In the discussions below, mathematical models are not used to estimate degradation rates or to predict future concentrations. The concept of half-life is, however, occasionally referenced to offer perspective on relative degradation rates of various chemicals. Table 5–4 presents half–lives of select chemicals detected at LL–6. The half-lives presented in Table 5–4 and discussed below are taken from literature studies and may not accurately represent degradation rates at LL–6, but they provide indications of relative degradation rates to be expected for these compounds.

Table 5–4

Ranges and Biodegradation Rates for Organic Chemicals

Chemical	SOIL		GROUND WATER	
	Short Half-Life (days)	Long Half-Life (days)	Short Half-Life (days)	Long Half-Life (days)
Energetics				
HMX	NA	NA	NA	NA
nitrocellulose	NA (1)	NA (1)	NA (1)	NA (1)
Volatile Organic Chemicals				
acetone	1	7	2	14
methylene chloride	7	28	14	56
Pesticides				
4,4'–DDE	730	5700	16	11000
Polychlorinated Biphenyls				
aroclor 1254	> 3700 (2)	> 3700 (2)	> 3700 (2)	> 3700 (2)

Table 5–4 (Continued)

Ranges and Biodegradation Rates for Organic Chemicals

Chemical	SOIL		GROUND WATER	
	Short Half-Life (days)	Long Half-Life (days)	Short Half-Life (days)	Long Half-Life (days)
Polycyclic Aromatic Hydrocarbons				
acenaphthene	12.3	102	24.6	204
benzo(a)anthracene	102	680	204	1360
benzo(a)pyrene	57	530	114	1060
benzo(b)fluoranthene	360	610	720	1220
benzo(k)fluoranthene	5	23	10	389
chrysene				
fluoranthene	140	440	280	880
indeno(1,2,3–cd)pyrene	560	730	1200	1460
phenanthrene	16	200	32	400
pyrene	210	1900	420	3800
Semivolatile Organic Compounds				
bis(2–ethylhexyl)phthalate	5	23	10	389

1 Assume to be greater than 365 days, based on properties of cellulose.

2 Rough estimate based on: Erickson: 2001– See text references for full citation. Actual half-lives vary widely.

NA = Not available.

The fate and transport of each contaminant detected at LL–6 are described below. The chemicals are discussed in groups that are indicated by their analytical fractions (i.e., VOCs, or metals) because these fractions generally represent chemicals with similar properties. Only those processes that are most applicable to the indicated fractions are described. No attempt was made to model the fate and transport of the chemicals mathematically, in part because simple rules of thumb concerning contaminant half-lives are sufficient to gain an understanding of contaminant fate. In addition, the levels of contaminants are generally low and migration will tend to reduce the concentrations further through dispersion, dilution, and other transport mechanisms. The contaminants that were identified are generally considered to be immobile or slow-moving contaminants so the migration rates will be slow, except when migrating in sediments and surface water as adsorbed or dissolved species.

5.2.1 Volatile Organic Chemicals

Two chemicals − acetone and methylene chloride − in this category were detected at LL–6. Acetone, an aliphatic ketone, is not halogenated. It is completely miscible with water and is therefore mobile in aqueous media. Hydrolysis is generally not a significant fate process for these chemicals. Acetone has a high vapor pressure and, once released to the atmosphere, photolysis and reaction with hydroxyl radicals result in an average half-life of 22 days (Howard, 1990). Biodegradation mechanisms can be important for this compound. Acetone has a relatively low toxicity and is not problematic at the detected concentrations from a risk perspective. Because of the infrequent acetone detection and relatively low toxicity, this chemical is not discussed further.

The other detected VOC, methylene chloride, is a chlorinated aliphatic compound. Hydrolysis is generally not a significant fate process for this chemical. Biodegradation mechanism, however, can be important for this compound. Photolysis and oxidation reactions are not considered to be significant degradation mechanisms for chlorinated aliphatic compounds (Mabey et al., 1982), including methylene chloride.

The total mass of each of these contaminants at LL–6 is evidently low, based on the observed concentrations levels. Acetone was selected as an ecological COPC for surface water only because surface water toxicity data are not available for this compound. For these reasons indicating that these chemicals are not significant site-related contaminants, neither acetone nor methylene chloride is discussed further. The USEPA considers acetone, 2–butanone (methyl–ethyl ketone), methylene chloride, and the phthalate esters to be common laboratory contaminants (USEPA, 1989a). It is possible that detections of these chemicals do not represent site conditions but are simply a reflection of lab contamination.

5.2.2 Semi-volatile Organic Chemicals

Benzo(a)pyrene, a polycyclic aromatic hydrocarbon (PAH), bis(2–ethylhexyl)phthalate, and 4–nitroaniline were the only chemicals in the SVOC category to be selected as human health COPCs for LL–6. Several other SVOCs, most of which are PAHs, were also detected at LL–6 and selected as ecological risk COPCs. Appendix V, Tables 2.1 through 2.6, indicate which SVOCs were detected at LL–6 and, of those, which were selected as COPCs in various media. Benzo(a)pyrene was selected as a human health COPC in soil only, bis(2–ethylehexyl)phthalate and 4–nitroaniline were selected as a human health COPC in groundwater only. Several PAHs were selected as ecological COPCs in surface soils (see Tables 7–1 and 7–2).

PAHs, as a group, are much more likely to bind to soil and be transported via erosion and surface water runoff than to be solubilized. PAHs are subject to slow degradation via aerobic bacterial metabolism, but may be relatively persistent in the absence of microbial populations or macronutrients such as phosphorus and nitrogen.

Landspreading applications have indicated that PAHs are highly amenable to microbial degradation in soil. This would presumably apply to sewer sediments as well. The rates of degradation in these media are influenced by temperature, pH, oxygen concentrations, initial chemical concentrations, and moisture. Photolysis, hydrolysis, and oxidation are not important fate processes for the degradation of PAHs in soil (Agency for Toxic Substances and Disease Registry [ATSDR], 1997).

The most important fates of PAHs in water are photo-oxidation, chemical oxidation, and biodegradation. Metabolism in higher animals is another degradation pathway and becomes important when the PAHs are metabolized to carcinogenic species (UN, 1998). PAHs do not contain functional groups that are susceptible to hydrolytic action, and hydrolysis is considered to be an insignificant degradation mechanism. The rate of photo degradation is influenced by water depth, turbidity, and temperature. Benzo(a)pyrene is reported to be resistant to photo degradation. PAHs may also be metabolized by microbes under oxygenated conditions (ATSDR, 1997).

The longest PAH half-life of those shown in Table 5–4 is about 4 years in groundwater and 1 year in soil. Thus, PAH concentrations should decrease significantly within a decade and should be effectively degraded in less than 30 years in groundwater and less than 10 years in soil.

Bis(2–ethylhexyl)phthalate is more soluble in water than the PAHs. Chemical hydrolysis is essentially non-existent, but photo degradation in the atmosphere is rapid (ToxNet, 2004). Aerobic degradation can be effected by several soil microorganisms; however, the microbial degradation in the environment has been reported to be slow and temperature dependent (ToxNet, 2004). At temperatures below about 10º C, little degradation takes place. Di–n–octyl phthalate, also detected at LL–6 in soil, is expected to behave similarly to bis(2–ethylhexyl)phthalate with regard to chemical and biochemical transformations. Bis(2–ethylhexyl)phthalate is highly lipophilic and moderately persistent in the environment. The degree of bioaccumulation depends on the capability of an organism to metabolize this compound. The compound accumulates in a variety of aquatic invertebrates, fish, and amphibians. Plant uptake is low (ToxNet, 2004).

4–Nitroaniline is more soluble in water than bis(2–ethylhexyl)phthtalate. However, in general, nitroaromatic compounds degrade relatively slowly in the environment. Recent evidence has shown that certain nitroaromatic compounds have a high affinity for certain types of clay minerals, and this may contribute to their persistence.

5.2.3 Pesticides and Polychlorinated Biphenyls

No pesticides were detected at LL–6 in any of the investigated media, but 4,4–DDE was detected in one sediment sample. This chemical is a degradation product of the pesticide, 4,4–DDT. Its presence indicates that 4,4–DDT is subject to degradation at LL–6. The lack of

pesticide detections, however, indicates that 4,4–DDT and other pesticides are not important as LL–6 contaminants; therefore, they are not discussed further.

PCBs (specifically, aroclor 1254 and aroclor 1260) were detected in one sediment sample LL6SD–010–0001–SD and one surface soil sample LL6SS–010–0001–SO. Aroclor 1254 was selected as an ecological COPC in shallow soil and sediment.

PCBs and aroclors, which are PCB mixtures, are chlorinated aromatic chemicals that are recalcitrant to environmental degradation. Their low solubility and high adsorption coefficients render them immobile in soils, except in surface water runoff. They are transported as adsorbed PCBs in the soil runoff. They have low vapor pressures but can slowly evaporate from surface soils and sediments exposed to the atmosphere (Erickson, 2001).

Being lypophillic, these chemicals tend to accumulate in fatty tissues of animals, including aquatic organisms. PCBs appear to partition between aqueous and lipid compartments of the body. After first distributing preferentially to the liver and muscle tissue, PCBs are subsequently redistributed to other tissues and organs that contain fat. PCB excretion is very slow; so bioaccumulation occurs even at low exposure levels. As long as exposure continues, a true steady state is never achieved (ATSDR, 2004a).

Under certain aerobic (oxidizing) or anaerobic (reducing) conditions, PCBs can be degraded through biological processes. Partial dechlorination of the more highly chlorinated congeners occurs under anaerobic (reducing) conditions. Under aerobic (oxidizing) conditions, microorganisms preferentially attack the lower chlorinated congeners (Erickson, 2001).

5.2.4 Explosive and Propellant Compounds

Two different nitrogen-containing energetic compounds, one explosive and one propellant, were detected in soil samples collected from LL–6; nitrocellulose and HMX. Nitrocellulose was also detected in surface water, groundwater, and sediment. Nitrocellulose was selected as a human health COPC in soil, sediment, surface water and groundwater and as an ecological COPC in soil, sediment, and surface water. HMX was selected as an ecological COPC in soil.

Although nitrocellulose (cellulose nitrate) may be incorporated into propellant mixtures, it has a very low solubility and, consequently, exhibits very limited mobility. It is a fibrous material composed essentially of cellulose fibers that have been modified to contain nitrate (NO_3) functional groups. The chemical composition, however, suggests that any environmental degradation of this chemical could release nitrates or nitrites to the environment. Because of its low solubility, relatively slow degradation rates in the environment are expected. Thus, any nitrates or nitrites detected at the site are presumably related to other nitrates that are much more soluble, such as sodium or potassium nitrate. These metal salts, especially sodium nitrate, are used in large quantities in the manufacture of black powder.

No other energetic compounds were detected at LL–6, and HMX was detected in one surface soil location only; hence, only the nitrocellulose is considered to be a potential environmental concern. That concern is minor because of its low solubility and, therefore, its low biochemical availability and migration potential.

5.2.5 Metals

Metals are highly persistent environmental contaminants because they do not biodegrade. However, their valence states can readily change based on pH and Eh conditions, biotic uptake and assimilation into living organisms, and decay and decomposition of dead plant matter. The major fate mechanisms for metals are adsorption to the soil matrix or precipitation as a mineral coating, uptake and bioaccumulation in plants, or transport through the hydrologic system. Table 5–2 presents a qualitative characterization of select metal mobilities in the environment as a function of ambient conditions. Because their chemical properties can vary significantly from metal to metal, only those metals detected at LL–6 are discussed here. Metals that have similar properties (as presented in Table 5–2 or discussed in the text) will behave similarly with regard to fate and transport.

Metals commonly form carbonates, silicates, oxides, and hydroxides after they have been released to the environment and interact with carbon dioxide, oxygen, and water in their surroundings. The carbonate, oxide, and hydroxide equilibria, which dictate whether one species predominates over another, are sensitive to the surrounding pH and oxidation-reduction (redox) potentials. At high pH values, oxides and hydroxides form readily. At pH values less than about 4, these species are essentially non-existent, except under highly oxidizing conditions.

The Earth serves as an almost limitless reservoir of metals. Soils, surface water, groundwater, and sediments are typically well-buffered with respect to pH (i.e., pH is not easily changed). Based on geotechnical data from other RVAAP load line soil samples, the pH of soils measured at RVAAP load lines is typically in the range of 5.5 to 7.4 (USACE, 2003a, 20003b, 2003c). The same pH range is expected for LL–6. Soil samples occasionally exhibit pH values less than 5.0, but they are rare (USACE, 2003a, 20003b, 2003c). Therefore, it is assumed that low pH values are limited to small soil volumes. The pH buffering capacity near neutral to slightly acidic pH values tends to limit the ability of most metals to migrate rapidly because the metals tend to precipitate as solids or to bind tightly to soil particles through cation exchange. The positively charged metals or oxocation metal ions adsorb to negatively charged hydroxyl groups at the surface of the soil or sediment particles, which are often silicate minerals. In general, the more highly positive a cation the more tightly bound it will be to the soil. Hence, monovalent ions (i.e., potassium, sodium) are not tightly bound whereas the trivalent aluminum is.

Each of the metals detected at LL–6 (except for the macronutrients: calcium, magnesium, potassium, and sodium) is described briefly below regarding its most important environmental

chemistry characteristics and information concerning plant uptake. These factors affect the mobility and, hence, the fate of metals in the environment.

Aluminum, atomic symbol Al, (not listed in Table 5–2) is a human health COPC in LL–6 soil, sediment, and surface water and an ecological COPC in soil and surface water. This metal is a naturally occurring component of silicate minerals and other minerals. It does not migrate readily because its aqueous ion has a positive charge of "+3". This high charge causes aluminum ions in solution to bind preferentially to negatively charged soil adsorption sites such as OH- groups located at the surfaces of silicate minerals. Aluminum also readily precipitates from solutions as aluminum hydroxides. Aluminum does dissolve in infiltrating precipitation, however, and may be taken up by plants from the resulting subsurface and surface soil solutions. Any industrial releases of this metal to soils are not expected to migrate significantly. Releases to surface water will have the greatest mobility because aluminum adsorbed to sediments is transported this way, and aluminum in the dissolved phase can move for long distances before being completely removed from solution by binding to sediments and soils. Aluminum that is taken up by plants will be redeposited to soils when the vegetation dies or releases leaves, and branches. Aluminum is not known to be transformed biologically.

Antimony, atomic symbol Sb, (not listed in Table 5–2) is similar to arsenic (described below) in chemistry. This metal, commonly classified as a metalloid because its chemical properties lie between those of true metals and non-metals, has a mean concentration in soils around the world of approximately 1 mg/kg (Emsley, 2001). Stibnite (Sb_2S_3), a sulfide, is the predominant mineral of antimony found in native ores (Van Nostrand, 1976). The two prevalent valence states of antimony are Sb(III) and Sb(V). These relatively high oxidation charges tend to limit the mobility of antimony in the environment. This metal was selected as a human health COPC in LL–6 groundwater.

Arsenic, atomic symbol As, is a COPC in LL–6 surface and subsurface soils, sediments, groundwater, and surface water because its concentrations exceed human health screening levels in those media. It was selected as an ecological COPC in surface soil and sediment because its maximum concentration exceeded the ecological screening criteria for soil and sediment. This metal is naturally occurring, commonly classified as a metalloid because it has properties that are transitional between metallic and non-metallic chemical elements. In minerals, this element commonly appears as a sulfide (NIH, 2004), which implies that this form of arsenic is a particularly abundant or persistent form. In water, inorganic arsenic occurs primarily in the "+5" valence state when conditions are oxidizing, such as in surface water. Under reducing conditions, such as may be found in groundwater, the inorganic form of arsenic is predominantly in the "+3" valence state. In acidic or neutral waters, As(V) is extensively adsorbed, but As(III) is not. At high pH (i.e., pH > 9), neither species of arsenic is tightly adsorbed (NIH, 2004). The mobility of arsenic is low to moderate in clay but higher in loamy or sandy soils. As(V) is adsorbed most strongly at pH 5 in clay minerals. As pH increases, more As(III) is adsorbed. Arsenic adsorbs strongly to sediments. If conditions change sufficiently from oxidizing to reducing, arsenic may be released from sediments.

Bacterial and fungal activity can convert inorganic arsenic to methyl arsines. These volatile organometallic compounds are mobile and can transfer from sediments to the surrounding water and ultimately to the atmosphere. The potential for volatilization from moist surfaces varies greatly with local conditions. Tightly sorbed arsenic or complexed arsenic species will be unlikely to volatilize, whereas methylated arsenic species can volatilize fairly readily (NIH, 2004).

Barium, atomic symbol Ba, is not a COPC in any LL–6 media. This metal is commonly found in nature as sulfate (Emsley, 2001). It forms hydroxides, carbonates, and sulfates in soils. Barium carbonates and sulfates are relatively insoluble (negative logarithm of solubility product, pK_{sp}, constants near 9). By contrast, barium hydroxides (pK_{sp} near 2), and especially nitrates and chlorides of barium, are quite soluble (Lang, 1985). Thus, over time, barium is expected to precipitate out of solution as it migrates to areas containing high carbonate or sulfate concentrations and high concentrations of other anions that form barium precipitates. In the absence of these anions, barium is likely to be moderately mobile. Barium is generally classified as a metal of low mobility (see Table 5–2).

Beryllium, atomic symbol Be, was detected in most LL–6 soil samples with a maximum detection site-wide of 2.1 mg/kg. This metal is reported to have a typical concentration of 6 mg/kg in soils and was not selected as a human health COPC for LL–6 (Emsley, 2001). The 6– mg/kg beryllium concentration represents a typical expected soil concentration based on soil samples collected around the globe. Regional variations are expected. It was, however, selected as an ecological COPC in sediment. Beryllium can be taken up by plants. Typical concentrations in plants are too low to exhibit any effects on animals that live off of them, even in plants that have the ability to concentrate the beryllium (Emsley, 2001). The divalent Be^{+2} ion dominates environmental beryllium chemistry at pH values less than approximately 4. Above that pH, it forms insoluble hydroxides (Dragun, 1988). Consequently, this metal generally exhibits low mobility under typical environmental conditions.

Cadmium, atomic symbol Cd, was detected at a concentration that is about two times the residential screening value for surface soil in sample LL6SS–002–0001–SO and its duplicate. The next two highest surface soil cadmium concentrations were 1.5 and 1.1 mg/kg, and all other values were less than 1.0 mg/kg. While cadmium concentrations are typically less then 1 mg/kg in worldwide soils, local hot spots have been shown to contain cadmium concentrations as high as 40 mg/kg (Emsley, 2001). This element is widely present in food crops at low levels and can be concentrated by the fungus *Amanita muscaria*, even when grown in soils containing low cadmium levels. Tobacco and other large leaf crops are also known to contain cadmium. Cadmium is present in sewage, and crops grown in sewage land farms can lead to an accumulation of cadmium in animals that eat the crops, including humans. This metal mimics zinc in its chemical behavior, especially in the human body. The lifetime in the human body is reported to be about 30 years (Emsley, 2001). Cadmium is expected to be moderately mobile in soil because it is present under most naturally occurring redox and pH conditions as the “+2” ion. If it is combined with anions such as sulfide, it can be very immobile. At pH values greater

than about 8, cadmium tends to form insoluble hydroxides. These conditions are not expected at LL–6, therefore the cadmium mobility is expected to be moderate. Cadmium was selected as a human health COPC for soil and an ecological COPC for surface soil and sediment.

Chromium, atomic symbol Cr, exists primarily as two oxidation states – Cr(III) and Cr(VI). Cr(IV) is very mobile in the environment under oxidizing conditions, but Cr(III) is less mobile except at pH values less than about 4. The trivalent metal predominates under most conditions, except those that are low pH (i.e., less than 4) and high oxidation potential (i.e., greater than 0.4). This element forms insoluble hydroxides under low to moderately reducing conditions. Under highly oxidizing conditions, it forms the soluble chromate ion at pH values greater than about 6 and the bichromate ion at lower pH values (Dragun, 1988). Concentration values in soils worldwide are reported to range from 1-3,450 mg/kg (Emsley, 2001). Chromium is mobile in ground and surface water under oxidizing conditions and can move in sediments when adsorbed to sediment grains. The concentrations of this metal were less than human health screening levels in soil, sediment and groundwater. Chromium was selected as a human health COPC for LL–6 surface water. It was also selected as an ecological COPC for surface soil.

Cobalt, atomic symbol Co, (not listed in Table 5–1) is not a human health COPC in any LL–6 media, but it was retained as an ecological COPC in soil. This metal is an essential nutrient and is found in relatively low abundance (0.1 to 70 mg/kg) in the Earth's crust (Emsley, 2001). Terrestrial plants absorb this element from soils. Based on its mean Kd equal to 4 (Dragun, 1988), this element has moderate to low mobility in soils and sediments. It forms insoluble oxides and hydroxides in the environment at pH values greater than about 8, but is otherwise generally present as the Co (II) ion at most oxidation-reduction potentials (Dragun, 1988).

Copper, atomic symbol Cu, is a relatively immobile element in soils (Emsley, 2001). Its affinity for organic matter causes it to be bound tightly in surface soils. Where subsurface releases of copper occur, this binding mechanism may not be as important because the most organic-rich layer of soils is generally the surface layer. Plant uptake varies widely for this element, and it is transmitted through the food chain. Most of the copper taken up by plants, however, remains in the roots (Emsley, 2001). At low pH values, this metal is prevalent as the divalent ion under most redox conditions. Under reducing conditions, the metal may appear as pure metal. At high pH, the metal tends to form hydroxides and oxides (Dragun, 1988). The concentrations of this metal were less than human health screening levels except in surface soil; therefore, copper was selected as a human health COPC for LL–6 surface soil. It was also selected as an ecological COPC for surface soil, sediment, and surface water.

Iron, atomic symbol Fe, is a major component of the Earth's crust, being the fourth most abundant element (Emsley, 2001). It occurs widely as in oxide forms and is rarely found in the pure metal state. Iron in soil is readily transformed by organic matter into various oxides and other compounds. The most common oxidation state is "+3". This valence state can, however, be readily altered to the "+2" valence in groundwater and other aqueous environs under chemically reducing conditions. Fe (II) is more mobile than Fe (III). An abundance of iron in the

Fe (II) state can serve as a large electron reservoir for electron acceptors during redox reactions. Iron in soil is not expected to be mobile, but under reducing conditions iron can be mobilized. In sediments, iron is expected to travel primarily as an adsorbed or particulate species in surface drainage channels because the water is mixed with oxygen in the air to maintain the Fe (III) state. The most prevalent occurrence of Fe (II), then, is groundwater under reducing conditions. Pure metal can be found at very low oxidation potentials and neutral to high pH. Iron was not selected as a human health COPC in any media at LL–6. It was selected as an ecological COPC in surface soil and surface water.

Lead, atomic symbol Pb, is a very immobile element in the environment. This metal has a relatively high soil-water distribution coefficient, ranging from 4.5 to 7,640 mL/g (Dragun, 1988). This indicates that it preferentially binds to soils rather than dissolving in water. When adsorbed to sediments this metal will be transported with the sediment as a bound species. This metal appears in the divalent ("+2") state under most pH and redox conditions. At high pH values (i.e., greater than 8), it readily forms hydroxides and oxides. The concentrations of this metal were less than human health screening levels in soil, sediment and groundwater. Lead was selected as a COPC for LL–6 surface water. It was also selected as an ecological COPC for surface soil, surface water, and sediment.

Manganese, atomic symbol Mn, (not shown in Table 5–2) exhibits chemistry similar to that of iron. This essential nutrient, the twelfth most abundant element in the Earth's crust, occurs primarily in the "+2" valence state. In soil, manganese occurs as hydroxides and oxides and microbial action plays a role in valence state alteration. The least stable form of manganese, Mn (III), is the most biologically active (Emsley, 2001). Manganese can also exist as Mn (IV). Manganese is most soluble in water in the Mn (II) form, thus its mobility is greatest under reducing conditions. Under these conditions, it is most susceptible to migration in groundwater or uptake by plants (Emsley, 2001). When adsorbed to soil or sediment particles, manganese may migrate in surface water. Manganese was selected as a human health COPC for groundwater and surface water and as an ecological COPC in surface soil and surface water.

Mercury, atomic symbol Hg, has a complex environmental chemistry. This metal, under most redox conditions, persists as an immobile species. It can be converted to organometallic species that are much more volatile, especially in wet sediments. The two common valence states are the "+1" and the "+2" states with Hg (II) predominating under typical environmental conditions. Mercury, when deposited as the pure liquid metal (i.e., from barometers, manometers, and thermometers), will persist for decades in the environment. Liquid mercury coalesces into globules that can slowly release dissolved mercury to the environment. However, the mercury thus released would be expected to precipitate as a chloride, carbonate, hydroxide, or oxide over time. Worldwide, concentrations of mercury in uncontaminated soil are reported to be 0.01 to 0.05 or 0.08 µg/kg (Dragun, 1988; Emsley, 2001). The concentrations of this metal were less than human health screening levels, and mercury was not selected as a human health COPC for LL–6; but it was selected as an ecological COPC for surface soil and sediment.

Nickel, atomic symbol Ni, predominates under typical environmental conditions as the Ni (II) species. Under high pH conditions (i.e., pH greater than 8), this metal will tend to precipitate as an oxide or hydroxide, except under very reducing conditions where pure metal may exist (Dragun, 1988). Typical soil concentrations are reported to be approximately 50 mg/kg (Emsley, 2001) or even as high as 1,000 mg/kg (Dragun, 1988). The concentrations of this metal were less than human health screening levels, and nickel was not selected as a COPC for LL–6; but it was selected as an ecological COPC for surface soil. The mobility of nickel is low in neutral or alkaline conditions and high in acidic environments (see Table 5–2).

Selenium, atomic symbol Se, has chemistry similar to arsenic. This bioaccuulative essential nutrient is a metalloid, thus exhibiting properties similar to both metals and non-metals. Methyl and dimethyl selenide gases have been determined to be produced by anaerobic soils and sediments. Selenium is also taken up and concentrated by some plants that, in turn, may be ingested with ill effect by herbivorous or omnivorous animal species (Emsley, 2001). Selenium, however, is essential for life and participates in an endless cycle of transfer from soil and water to the atmosphere and back to soil and water. This chemical was detected at concentrations greater than ecological screening values in surface soil and surface water and was, therefore, selected as an ecological COPC. Detected concentrations did not exceed human health risk screening values; therefore, it was not selected as a human health COPC.

Thallium (atomic symbol Tl) minerals are rare, although thallium (not listed in Table 5–2) is ten times more abundant than silver. This metal commonly appears in two different valence states: Tl (I) and Tl (III). When in the “+1” valence state, it has a behavior similar to potassium and sodium. Thallium salts are used in chemical research, and thallium sulfate has been banned as a pesticide in the western countries (Emsley, 2001). Thallium is absorbed easily by plants, and the degree of absorption is proportional to the concentration of thallium in the associated soil. Tl (III) is easily reduced to Tl (I) (oxidation-reduction potential = 1.25 V). Thus, thallium is a strong oxidizer, and the ease of reduction of Tl (III) explains its rarity in nature. Metallic ions of a single positive charge are characteristically mobile in the environment; thus, thallium is not expected to be strongly bound to soils or sediments and it should move easily in aqueous media. LL–6 thallium concentrations did not exceed the human health and ecological screening levels for any media, and this metal was not selected as a COPC for LL–6.

Vanadium, atomic symbol V, has a very complex environmental chemistry. It exists as numerous species with an array of oxidation states, depending on ambient conditions. Generally, this element is expected to be immobile at neutral to high pH values when redox potentials are negative. Vanadium is expected to exist as soluble vanadate or other oxoanions when the redox potential is moderately positive (i.e., greater than 0.2 V) and the pH values are not low. At pH values less than 4, this metal exists predominantly as positively charged oxocations (Dragun, 1988). LL–6 vanadium concentrations exceeded the human health screening values for surface water and sediments, and this metal was selected as a COPC for LL–6 in those media. It was selected as an ecological COPC for soil.

Zinc, atomic symbol Zn, is widely detected in soils at concentrations ranging from 5 to 770 mg/kg (Emsley, 2001). The 5 to 770 mg/kg concentration range represents soil samples collected around the globe. Regional variations are expected within this range and occasionally outside the range. Soil concentrations have also been reported to vary from 10 to 300 mg/kg (Dragun, 1988). Plants can take up zinc from surrounding soil. The amount taken up is dependent on the amount in the soil (Emsley, 2001). This essential nutrient is vital to proper functioning of enzymes. Zinc is found in the environment only as the divalent Zn (II) ion. At high pH (greater than 8), zinc precipitates as a hydroxide. This metal, is moderately to very mobile in soils under most conditions (Table 5–2). Zinc concentrations were less than human health screening criteria in soil, sediment, surface water and groundwater; hence, this metal was not selected as a COPC for LL–6. Zinc was selected as an ecological COPC in surface soil and surface water.

5.3 Contaminant Transport Pathways

A contaminant transport pathway represents the physical path or the mechanism by which a contaminant moves or may move from one location (i.e., the source area) to another. A transport pathway may also involve a phase change for the contaminant (i.e., a contaminant is absorbed to soil, volatilizes to soil gas in the vadose zone, and then migrates into a basement as a gas). In addition, contaminant transport pathways provide mechanisms and conduits for contaminants to migrate to a new location where they may contribute to a human health or ecological risk. The determination of whether a pathway is currently causing a risk or could potentially cause a future risk depends on the combination of chemical characteristics, the existence of a potential pathway, the physical site conditions, and the potential for exposure to occur now or in the future.

This section presents a brief summary of contaminant fate and transport pathways that exist at LL–6. Based on the evaluation of existing conditions, the following potential contaminant transport pathways may exist:

- Leaching of soil contaminants to groundwater;
- Migration of groundwater contaminants within the soil and bedrock strata;
- Mixing of groundwater (i.e., creek bed seepage) with surface water in adjacent stream channels during storm events;
- Erosion and runoff of contaminated particles from soil and deposition in surface water bodies;
- Leaching of contaminants from creek sediment to surface water;
- Migration of contaminants in surface water as dissolved or sorbed phases during storm events; and
- Volatilization from soil, groundwater, or surface water.

Sewer lines containing detectable levels of contaminants are no longer in use. Sewers were sampled for sediment and water at readily accessible locations at the manholes. The integrity of the sewer lines is not completely known. Sumps at LL–6 were removed during the thermal decontamination and demolition operations, which were conducted before the RI began. These man-made structures typically represent potential contaminant migration pathways. The potential for migration has been reduced by the sump removal.

5.3.1 Leaching of Soil Contaminants to Groundwater

Contaminants that adhere to soil particles or have accumulated in soil pore spaces at LL–6 can leach and migrate vertically to the groundwater as a result of infiltration of precipitation. The rate and extent of this leaching is influenced by the amount of precipitation, rate of infiltration, the physical and chemical properties of the soil, the physical and chemical properties of the contaminant, and the depth of the water table.

During the selection of COPCs in soil (Section 6.2.3), the maximum detected concentrations of individual soil contaminants were compared against screening levels and RVAAP installation background criteria concentrations. The soil screening levels (SSLs) included levels protective of groundwater. SSLs are derived from assumptions regarding aquifer hydraulic conductivity, hydraulic gradient, infiltration rate, mixing zone height, aquifer thickness, source length, and chemical-specific soil-water Kds. These SSLs for protection of groundwater are used to estimate conservatively whether a chemical could leach from soil, migrate to groundwater, and raise the groundwater concentration above the pertinent risk-based screening level for groundwater.

Based on the results of LL–6 soil analyses, three metals (aluminum, arsenic, and cobalt) exhibited concentrations in excess of the soil-to-groundwater SSLs (Appendix V, Tables 2–1 and 2–2). However, only arsenic was detected in groundwater samples. Hence, leaching of the aluminum and cobalt from soil to groundwater is not considered to be significant. Arsenic was detected in only two groundwater samples and only at concentrations in excess of RVAAP installation background criteria levels in one sample. This indicates that leaching of arsenic from soil to groundwater is not significant.

Groundwater arsenic concentrations exceeded the groundwater RVAAP installation background criteria of 11.7 µg/L and the MCL (10 µg/L) in just one sample (LL6MW–005–0001–GW). In that sample, taken from well LL6MW–005, the arsenic concentration was 13 µg/L, an exceedance of the RVAAP installation background criteria by about 10% [= 100% (13/11.7-1)]: This is a very slight exceedance and is well within the experimental uncertainty of sampling and measurement. Furthermore, several factors limit the significance of the exceedance and render the soil-to-groundwater migration pathway insignificant at LL–6. These factors are described in more detail below.

The rates of metal leaching from soils to groundwater will not increase unless geological conditions, such as pH or oxidation-reduction potentials, are changed. This is an unlikely event because it involves changes to soils and bedrock that would require massive influxes of chemical before a meaningful change would occur. If it were to occur, the reservoir of metals in the native minerals would vastly outweigh the amount of site-related contamination.

Aside from geological conditions such as pH and oxidation-reduction potentials, a major factor affecting metal leaching rates is the length of time that the site has been non-operational. Metals are generally most mobile in soil soon after they are released. As time progresses, the assimilation of the metals into the mineral matrix renders them less mobile. If an excess of metals is not present beyond what the soil can readily bind, a steady state sets up. This steady state limits the leaching rates of the metals. Over time, the rates of leaching decrease as the excess metal reservoir is depleted and the more tightly bound metals are the only metals available for leaching. LL–6 has not been operational for about 35 years, which means that no new contaminants have been generated in the last 35 years and the previously released contaminants have had some time to bind to the mineral matrix. Thus, leaching rates cannot be any greater than at the current time unless geologic conditions change.

A second factor affecting the soil-to-groundwater migration is the relatively low concentrations of metal contaminants in soil compared to RVAAP installation background criteria concentrations. Using arsenic as the example, the site concentrations are only slightly greater than the RVAAP installation background criteria. The RVAAP installation background criteria concentrations for arsenic range from 15.4 to 19.8 mg/kg, depending on soil depth. The maximum arsenic concentration in any LL–6 soil sample was 41 mg/kg. This is about two to three times the maximum RVAAP installation background criteria concentration. This may indicate that the arsenic is not a site contaminant or, if it is, that the total mass of arsenic contamination is not much greater than what is present naturally. However, arsenic is retained and considered a site-related contaminant until these uncertainties are evaluated in Section 7.8.

A third factor affecting the soil-to-groundwater migration is the arsenic spatial distribution. Because many of the LL–6 soil concentrations were less than the 19.8 mg/kg RVAAP installation background criteria, the data available suggest arsenic contamination is limited. Furthermore, the isolated occurrences of screening value exceedances provides a very limited reservoir of contamination that could be transferred to groundwater. In addition, when the vertical profile of arsenic concentrations in soil is considered, it is clear that arsenic concentrations generally do not differ appreciably with soil depth (Tables 4–6 through 4–10). Instead, the concentration values, after allowing for natural soil sample heterogeneity, appear to be randomly distributed with depth over the entire observed concentration range up to 41 mg/kg in LL6SS–007–0001–SO. Concentrations as high as 40 mg/kg, however, are not normally observed in soil, so this one value and perhaps the two others that exceed 19.8 mg/kg to 26 mg/kg could represent true contamination. The data available suggest contamination is isolated. Also, the evidence is strong that LL–6 soils are in a steady-state condition whereby the rate of leaching of metals into the groundwater will not increase over time.

The fourth factor affecting the soil-to-groundwater migration is the observed groundwater metal concentrations in MW–005 in comparison to soil concentrations and other well concentrations. The well with the greatest arsenic concentration (13 µg/L) was MW–005. This well is located downgradient of, and several hundred feet away from, the most contaminated soil sampling location, LL6SS–007–0001–SO. Furthermore, soil samples upgradient of MW–005 are generally within the expected RVAAP installation background criteria concentrations range. MW–004, which is hydraulically closer to LL6SS–007–0001–SO, did not have detectable concentrations of arsenic. The arsenic detection limit was 0.73 µg/L, which is well below the RVAAP installation background screening value for groundwater.

This last factor affecting the soil-to-groundwater migration indicates that the site is in a steady state in which there is no significant release of metals contamination except that which is available in the natural soils and bedrock. Variations in groundwater arsenic concentrations are likely to be caused by natural fluctuations, such as changes in rainfall. The rates will not increase because contaminants are no longer being released to LL–6.

The age of the historical operations at LL-6 and the lack of significant wide-spread metals contamination in either soils or groundwater suggest that the LL-6 soils are in likely in steady-state condition whereby the rate of leaching of metals into the groundwater will not increase over time. Although the factors discussed above affecting the soil-to-groundwater migration are focused on arsenic, similar arguments can be made for other metals whose concentrations may have exceeded soil screening levels at isolated locations.

As indicated in Section 5.2.5, many metals detected in LL–6 soils were not selected as COPCs in groundwater. This is additional evidence that the soil-to-groundwater leaching pathway is of limited applicability. Furthermore, the leaching potential of metals is expected to decrease over time as the available metals are leached from soils but are not replenished. Because the metal COPC concentrations are not currently much greater than RVAAP installation background criteria concentrations, however, it would be difficult or impossible to measure any such rates of decrease.

All analyzed metals were detected in at least one groundwater sample. Essential human nutrients (magnesium, potassium, calcium, and sodium) are considered toxic only at very high doses and do not have screening levels referenced in this report. These nutrients were eliminated from consideration as COPCs. All of the metals in the AOC monitoring wells were present in concentrations that are similar to concentrations in the AOC upgradient well (contaminated or not) or are similar to RVAAP installation background criteria concentrations. Zinc, atomic symbol Zn, is an essential nutrient at low concentrations. The concentration of this element in worldwide soils is reported to range from 5 mg/kg to 770 mg/kg. It is taken up by plants in amounts that are proportional to the concentration in the surrounding soil. At levels in excess of 500 mg/kg, zinc can interfere with the uptake of other essential nutrients such as iron and manganese in plants (Emsley, 2001). Zinc only appears in the divalent oxidation state, Zn

(II). The metal is mobile under most conditions, although it forms hydroxide precipitates in aqueous solutions at pH values greater than 8 (Dragun, 1988).

Several organic chemicals (acetone, methylene chloride, several different PAHs, aroclor 1254, and two di–n–octylphthalate, and dibenzofuran) were detected in soil, but were not detected in groundwater (Appendix V, Tables 2–1, 2–2, and 2–3). This indicates the levels of these chemicals detected in soil do not present enough total mass to yield detectable groundwater concentrations after dilution, dispersion, and other natural mechanisms reduce their concentrations. The USEPA considers acetone, 2–butanone (methyl–ethyl ketone), methylene chloride, and the phthalate esters to be common laboratory contaminants (USEPA,1989a). It is possible that detections of these chemicals do not represent site conditions, but simply reflect lab contamination.

5.3.2 Migration of Groundwater Contaminants

Organic groundwater contaminants will alternately adsorb to and desorb from organic matter in the soil and bedrock at the molecular level as they migrate with groundwater toward the southeast of LL–6. Because general groundwater flow is toward the drainage creek to the south, contaminants in groundwater will ultimately flow in that direction. Inorganic groundwater contaminants will follow a pathway similar to the organic contaminants. The relative migration rates will depend on individual contaminant adsorption characteristics and rates of degradation that may occur, as described in Sections 5.1 and 5.2.

The reservoir of organic contamination in soil that could feed groundwater is small, based on soil concentrations reported in Appendix V (Tables 2–1 and 2–2). Therefore, the level of importance of groundwater migration is expected to be minor. This is borne out by the low frequencies of organic contaminant detections for groundwater (Appendix V, Table 2–3).

Volatilization of VOCs, or precipitation of metals as a mineral phase, may physically transform contaminants. Contaminants may be chemically transformed through hydrolysis, oxidation/reduction, or biodegradation. Besides biodegradation, dilution from surface recharge is also a factor that causes the concentrations of contaminants to decrease in the downgradient directions.

Bis(2–ethylhexyl)phthalate was detected in three out of seven wells, but none of the downgradient well concentrations exceeded the upgradient concentration. The USEPA considers acetone, 2–butanone (methyl–ethyl ketone), methylene chloride, and the phthalate esters (bis (2-ethylyhexyl) phthalate) to be common laboratory contaminants (USEPA,1989a). Hence, this contaminant does not appear to be site-related and is not viewed to be an important LL–6 contaminant. However, migration would follow the same path as the groundwater with a retardation of the bis(2–ethylheyl)phthalate as it alternately adsorbs to, and desorbs from, soil and bedrock. Because the highest contamination was detected in the upgradient well, it is possible this indicates contamination upgradient from LL–6. Bis(2ethylhexyl)phthalate is a

common laboratory contaminant, and it is possible that these detections do not represent actual site conditions.

Nitrocellulose was detected in 12 surface and subsurface soil samples (including two duplicate field samples), five groundwater samples (including one duplicate sample), three sediment samples (including one duplicate sample), and one duplicate surface water sample scattered across LL–6. Most soil detections occurred in the central portion of the site near the locations of former operational buildings. Nitrocellulose is relatively insoluble, so it is expected to persist in soil and sediment for a long time. Half-life information could not be found for this chemical. Therefore, groundwater dissolution of nitrocellulose followed by groundwater transport does not appear to be a significant transport pathway.

Metals in groundwater will follow groundwater flow patterns just as the organic contaminants do. The metals may migrate in soluble form or as ions or non-ionized organometallic complexes bound to colloidal particles. Migration of soluble metals would be retarded by ion exchange with bedrock, and the rate of colloidal flow through the bedrock would depend on particle size with smaller particles moving more quickly than larger particles. In general, highly charged (+3 or greater) metals and complexes will be retarded to the greatest degree and weakly charged species (+1) will be the most mobile. Lead, chemical symbol Pb, is a notable exception. This metal binds tightly to soil as the Pb^{+2} ion and is essentially immobile despite its moderate charge of "+2". This ion also binds tightly to sediments but is mobile when the sediments, themselves, migrate.

As explained in Section 5.3.1, however, the amount of metals leaching into groundwater and, hence, the migration of groundwater metal contaminants, will remain steady or decrease over time relative to the current concentrations.

5.3.3 Mixing of Groundwater (i.e., Creek Bed Seepage) with Surface Water in Adjacent Stream Channels During Storm Events

Groundwater may recharge nearby drainage channels, but knowledge of site conditions suggests that the primary source of drainage channel water is precipitation. Any contaminants that are in the groundwater would be transported to the creek with the groundwater. Rates of transport cannot be predicted; but because the concentrations of organic and metal contaminants are low in LL–6 groundwater, the rates are not significant. Precipitation tends to further dilute any groundwater seepage that enters the drainage channels.

5.3.4 Migration of Contaminants from Surface Soil to Surface Water

Rainfall, snowmelt, and surface water runoff that come into direct contact with surface soils can leach contaminants from the soils and transport them to drainage channels via runoff during storm events. Soil particles containing sorbed contaminants can also be dislodged from the soil

surface and physically transported to the creek via overland runoff. The topographic relief at LL–6 is minor, so the amount of overland runoff from this site is expected to be very small.

Few organic chemicals (HMX in samples LL6SW–006–0001–SW and LL6SW–008–0001–SW at 5.2 µg/L and 5.4 µg/L, respectively; RDX in the same samples at 15 µg/L and 14 µg/L, respectively; nitrocellulose at 0.1 mg/L in sample LL6SW–002–0001–DUP, 4–methylphenol in LL6SW–002–0001–SW and its duplicate at 0.26 µg/L and 0.36 µg/L, respectively; and acetone in samples LL6SW–002–0001–SW and its duplicate at 2.2 µg/L and 8.2 µg/L, respectively) were detected in surface water. These few detections at low concentrations indicate that surface runoff is not a significant migration pathway. Nitrocellulose, which is not expected to be soluble to any significant degree in surface water, will be transported as suspended particulates.

5.3.5 Leaching of Contaminants from Creek Sediment to Surface Water

The reservoir of organic and inorganic contamination in drainage channels and creek sediments is low; therefore, this migration pathway is insignificant. Precipitation is the source of water in the LL–6 drainage channels. The opportunity for transfer from drainage channel sediments to surface water is limited by the frequency of precipitation. This insignificant transport pathway is not discussed further.

5.3.6 Migration of Contaminants in Surface Water as Dissolved or Sorbed Phases During Storm Events

Once contaminants are dislodged from surface soil particles, some of which then become dissolved, they may flow with surface water and entrained sediments to downgradient areas. The masses and concentrations of organic and inorganic contamination available in surface soils and sediments are generally low. Therefore, while the drainage channels represent potential migration pathways, it does not appear that these migration pathways are significant.

5.3.7 Volatilization from Soil, Groundwater, or Surface Water

No VOCs were detected in soil except the common laboratory contaminants, acetone and methylene chloride. Concentrations of 2.0 and 3.0 µg/L were detected in 2 of 11 groundwater samples. Other detected compounds in soil were SVOCs or other relatively non-volatile chemicals; therefore, volatilization from soil is an insignificant transport pathway. A similar situation exists for the other media; therefore, volatilitzation from any of these media is considered to be insignificant. This is further supported by the small reservoir of contamination present in any of the investigated media. When small masses of contaminants are coupled with slow rates of release, the migration pathway of interest is insignificant.

5.4 Conceptual Site Model

The conceptual site model (CSM) is a description of known site conditions. It explains how contaminants were or could have been deposited, how these contaminants can or do move in the environment, and the impact they may have on receptors. The focus of this section is on the physical model. Effects and potential effects on environmental organisms, including humans, are discussed in the risk assessment sections.

Primary explosives lead azide and mercury fulminate were used in the manufacture of fuzes at LL–6 which operated primarily as a fuze assembly line until deactivation after World War II. LL–6 was also used by Firestone Defense Research, a subsidiary of Firestone Tire and Rubber Company, for defense work under contract to Picatinny Arsenal. Firestone Defense Research used the load line for research and development of various kinds of charges (i.e., shaped and fragmenting disc) for armor penetration. During the shaped charge research at LL-6, secondary explosives (TNT, RDX, Octol) were processed and used at selected buildings and test chambers. Contaminants were detected in several environmental media, although at low concentrations, which represent small total masses of contaminants that are sparsely scattered across the site:

- There were analytical detections of metals, VOCs, SVOCs, energetic compounds, and some miscellaneous inorganic chemicals. Metal contaminants were detected throughout the site, but primarily in the immediate vicinity of the production buildings. Organic compounds were also detected throughout the site. Nitrocellulose, which has an expected long half-life in the environment, was detected in several surface soil samples.
- In soils, metals, nitrocellulose, VOCs, SVOCs, and a PCB (aroclor 1254) were detected. Aroclor 1254 was detected in just one surface soil sample. The metals were detected throughout the site including the periphery areas. Nitrocellulose, VOCs, SVOCs, and aroclor 1254 detections were more closely confined to the production area or associated infrastructure. When detected, these organic chemicals were generally detected at the greatest concentrations in surface soil, which is consistent with an aerial deposition mechanism.
- In sediment, metals, nitrocellulose, two SVOCs, and aroclor 1260 were detected. Aroclor 1260 was detected in one sediment sample (LL6SD–010–0001–SD). The distribution is similar to the distribution in soil: metals were spread throughout the AOC including the periphery areas. The other contaminants were found near production areas or near associated infrastructure.
- In surface water sampling locations, only metals and nitrocellulose were detected at concentrations exceeding either an Region 9 residential soil PRG or an RVAAP-specific background concentration. No pattern of distribution could be discerned.
- Exceedances of RVAAP installation background criteria, Region 9 residential soil PRG, or both values were reported in 6 of the 10 groundwater samples. Analytes included metals, one detection of 4–nitroaniline, and two detections of bis(2–ethylhexyl)phthalate.

The well located downgradient of the production area (MW–007) had exceedances for metals only.

The observed spatial contamination patterns are consistent with expectations that operationally related activities increased the concentrations of chemicals near site operations. However, the concentrations of contaminants are low. For example, many metals detected in soil are within two to five times the background concentrations established for RVAAP and fall within worldwide background concentration ranges (See Section 5.2.5). Further consideration of environmental significance is provided in the risk assessment sections (6.0 and 7.0).

Sumps might have been a primary contamination source from operations water that was routinely diverted to them; however, sumps were removed during the LL–6 thermal decontamination and demolition. Sewer lines may provide a contaminant transport pathway.

Contamination at LL–6 is sparsely dispersed across the site with some elevated chemical concentrations occurring near operational activities. Most metals appear to be fairly uniformly distributed across the site. This is an indication that, although exceedances of screening values were noted, the exceedances would probably have occurred in RVAAP installation background criteria soils as well as site soils. However, additional investigation will be needed to better understand the extent of explosive contamination.

Metals do not degrade in the environment, but they can be assimilated into minerals. Their oxidation states can change over time as they migrate from one location to another. Metals in general, however, are relatively immobile, except for those with predominantly single positive charges such as sodium and potassium. A few other metals, such as calcium and magnesium, are also relatively mobile. These four metals, however, generally pose little to no environmental risks to receptors. Receptor exposure and risk are treated more completely in the risk assessment sections (6.0 and 7.0).

Few organic chemicals that are directly related to site operations were selected as COPCs, indicating that the concentrations of detected organic chemicals are generally low enough not to pose a significant threat to the health of receptors.

The primary contaminant migration pathways for contaminants at LL–6 are:

- Leaching from soils to groundwater,
- Leaching from sediments to surface water,
- Leaching from sewer lines to groundwater, and
- Transport in surface drainage channels.

Leaching from soils would be expected to occur around sumps if contaminated soil remained in place after the sump removals. This is not expected to be a significant concern. The sump

removal is complete. Given that the quantities of contamination present at LL–6 are generally low elsewhere, even if contaminated soil is in place from the sump removal, the mass of contaminants transported by this migration pathway is expected to be low. All the sumps were holding water and appeared to be structurally intact. No staining was observed. Dilution effects should be large in drainage channels. This is reflected in the low concentrations of contaminants detected in surface waters. Similar effects are observed in groundwater. Nitrocellulose, which has evidently been widely distributed in surface and subsurface soils at low concentrations across LL–6, is notably recalcitrant to dissolution; hence, its persistence is expected to be long.

Any soil or sediment contaminants that leach into groundwater would flow to the center of LL–6. General groundwater flow appears to be toward the southeast. Each contaminant will be retarded in its movement. The degree of retardation depends largely on the adsorption tendency of each contaminant and the amount of organic material in the soils and bedrock. Because the concentrations of chlorinated organic solvents do not indicate the presence of dense non-aqueous phase liquids (DNAPL), there is no expectation that these chemicals will be present in a pure phase. In addition, there will be no particular tendency for these chemicals to migrate vertically except as dissolved contaminants in groundwater.

Surface water drainage channels can transport surface soil contaminants and sediments to downgradient locations. However, the topographical relief is moderate at LL–6 so transport pathways are not expected to move sediments rapidly. An exception to this could take place during storm events when flow rates increase significantly. Contaminants detected at LL–6 will tend to adsorb to sediments. The total organic carbon content (approximately 3,500 to 28,000 mg/kg) observed in LL–6 sediments is typical of environmental sediments, so adsorption would also be typical.

In summary, the low concentrations and small total amounts of energetic compounds at LL–6 are consistent with historically good health and safety practices. In particular, primary explosives, such as metal azides (i.e., lead azide) and fulminates (i.e., mercury fulminate), which are very unstable with respect to physical shock, would not be expected to be released indiscriminately to non-operational areas. To do so would result in extreme safety hazards. The small reservoir of contamination in soil provides little total contaminant mass for migration to groundwater or other media. The metals will persist and the organics will degrade over time, albeit some of them (i.e., nitrocellulose) will do so slowly. Given the low concentrations observed at this site, modeling to estimate the degradation rates would not be fruitful. SESOIL and AT123D modeling was not performed for six metals (aluminum, arsenic, chromium, cobalt, manganese, and mercury) because aluminum, chromium, and manganese had concentrations that exceeded background less than 5% of the time. Arsenic exceeded background 26% of the time, and mercury 44% of the time. Cobalt exceeded background 18% of the time. The concentrations of the metals listed above were generally less than three times background, and the total volume of any contaminated soil is so small that impacts on groundwater would not be measurable, either through a modeling exercise or through actual groundwater monitoring.

6.0 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section presents the results of the BHHRA conducted to characterize the risks to humans associated with the potential current or future exposures to chemicals in surface soil, subsurface soil, groundwater, surface water, and sediment within LL–6. This assessment evaluated the potential risks to human health if no remedial action were taken and provides a list of potential COCs to be further evaluated by the risk managers.

6.1 Introduction

As described in previous sections, LL–6 is located in the south-central area of the facility on Fuze and Booster Road and consists of approximately 51 acres. From 1941 to 1945, LL–6 operated primarily as a fuze assembly line with fulminate mixing at Building 2F–4. In 1945, the load line was deactivated and the equipment was removed. In 1950, LL–6 was used by Firestone Defense Research, a subsidiary of Firestone Tire and Rubber Company, for defense work under contract to Picatinny Arsenal. Firestone Defense Research used the load line for research and development of various kinds of charges (i.e., shaped, fragmenting disc, etc.) for armor penetration. Frequency of firing was approximately 1 to 2 charges per week. The most recent activity at LL–6 occurred during the late 1970s, when it was again used for applied research and development on shaped charges by Firestone Defense Corporation for the Department of Defense. The amount of explosives involved during the research and development of these shaped charges was minimal − not more than 900 kg per year.

The methods used in the LL–6 BHHRA are based on the protocol established in the *Facility-Wide Human Health Risk Assessment Manual* (*FWHHRAM*), (USACE, 2004). Additional protocol is summarized in the *White Paper - Human Health Risk Assessment Approach for Load Lines 6, 9, and 11 Remedial Investigations*, Ravenna Army Ammunition Plant, Ravenna, Ohio (TtNUS, 2004) (Appendix W). Technical directions provided during March 2004 teleconferences with the USACE and Ohio EPA have also been incorporated into the LL–6 RI.

There are six steps in the BHHRA process:

- **Step 1** – Data evaluation – The selection SRCs and COPCs for environmental media at LL–6. The COPCs identified in Step 1 are evaluated quantitatively (when possible) and discussed qualitatively otherwise.
- **Step 2** – Exposure assessment – The identification of potential current and future human receptors that may be exposed to the COPCs, the evaluation of the pathways by which the receptors may be exposed, and the estimation of chemical intake resulting from exposure.

- **Step 3** – Toxicity assessment – An assessment of toxicity of each COPC including the presentation of the toxicity criteria (i.e., cancer slope factors, reference doses) typically used by USEPA to estimate risk.
- **Step 4** – Risk characterization – The estimation of cancer and non–cancer risk using the intakes and toxicity criteria presented in the exposure assessment and toxicity assessment, respectively.
- **Step 5** – Uncertainty analysis – The identification of major uncertainties affecting the interpretation of the BHHRA results.
- **Step 6** – Summary and conclusions.

The results of the BHHRA are used to (1) document and evaluate risks to human health; (2) determine the need, if any, for remedial action; and (3) identify chemicals of concern (COCs). COCs are those chemicals determined by the BHHRA to pose (or significantly contribute to) a potential risk to human receptors in excess of target risk benchmarks. The development of chemical-specific remediation levels may be required for these chemicals. Per the protocol established in the White Paper for LLs 6, 9, and 11 (TtNUS, 2004), potential COCs are identified for an environmental medium when the receptor risk exceeds a cumulative cancer risk benchmark of 1E-05 or a total non-cancer HI benchmark of 1.

Three conditions of chemical contamination and exposure pathways are considered when evaluating potential risks: (1) contaminants with toxic characteristics must be found in environmental media and must be released by either natural processes or by human action; (2) potential exposure points must exist; and (3) human receptors must be present at the point of exposure. If any of the conditions listed above are absent, risks are not quantitatively evaluated for that exposure pathway.

The quantitative BHHRA for LL–6 is presented using tables based on *RAGS Part D* (USEPA, 2001a). In preparing the tables presented in this BHHRA, RVAAP specifications were taken into consideration. There are minor formatting differences between the tables and the suggested Rags Part D tables.

6.2 Data Evaluation

Data evaluation involves the gathering, evaluation, and organization of data into a form that is appropriate for a baseline risk assessment. The data gathering step involves the compilation of all available data and the sorting of data by medium. The quality of the data is evaluated with respect to qualifiers and codes applied as a consequence of the data validation process and via other quality measures (e.g., the adequacy of the analytical methods used in the site investigation, the adequacy of the sample quantitation limits, etc). COPCs are selected for evaluation in the BHHRA using protocols that include a comparison of site concentrations to facility background concentrations and to conservative toxicity screening concentrations.

Section 6.2.1 describes the data that were used in the BHHRA, and Section 6.2.2 summarizes the results of the COPC screening process. Section 6.2.3 reviews the selected COPCs by medium – surface soil, subsurface soil, deep surface soils, groundwater, surface water, and sediment.

6.2.1 Data Collection and Evaluation

The data used in the BHHRA represents current conditions. For groundwater, filtered samples were collected and analyzed for TAL metals, per OEPA direction. Unfiltered samples were collected and analyzed for volatile and semi-volatile compounds. The analytical laboratory selected the most appropriate analytical result if re-analyses/dilutions were necessary and that result was evaluated in the determination of the SRCs for this risk assessment.

Chemical analyses were performed in accordance with SW–846 methods. The analytical results were evaluated, using the *National Functional Guidelines* (USEPA, 1994a and 1994b) to assess data usability and the laboratory's compliance with the analytical methods. The analytical data were reviewed, validated, and evaluated using the criteria specified in the data quality objectives. Validated data (and qualifiers) are presented in Appendix U. Unqualified positive detections and "J" qualified detections (estimated values) were considered as detected concentrations for this BHHRA. Non-detect results (indicated with a "U" qualifier) were retained in the BHHRA data set. No analytical data evaluated in the BHHRA were rejected as a consequence of the data validation process. A complete data quality summary is presented in Appendix U.

The data evaluation included the calculation of basic descriptive statistics for each data set evaluated in the BHHRA. Basic statistics included frequency of detection, range of positive detections, arithmetic mean, normal 95% Upper Confidence Level (95% UCL-N) of the mean, and log-normal 95% Upper Confidence Level (95% UCL-L) of the mean. Appendix V provides the equations used to determine the 95% UCL-L and the 95% UCL-N of the mean. These descriptive statistics were also used in the determination of the exposure point concentration (EPC) selected in the exposure assessment.

6.2.2 Selection of COPCs

COPCs for LL–6 were selected in two steps. First, SRCs were identified for each medium, then a toxicity screen was conducted to determine which SRCs would be selected as COPCs. The purpose of the screening process was to eliminate chemicals for which no further risk evaluation is needed. The premise of this screening step when assessing risk is that potential risks typically are attributed from the concentrations of a few contaminants. Although dozens of contaminants may actually be detected, many of the detected contaminants contribute only minimally to the total risk. Section 6.2.2.1 describes the SRC selection process, and Section 6.2.2.2 describes the COPC screening process.

6.2.2.1 SRC Screens

Physical chemical data (i.e., alkalinity and pH) are not SRCs and therefore, are not considered to be COPCs for LL–6.

- Groundwater samples were filtered in the field for TAL metals analysis, so filtered metals data were used to determine the groundwater SRCs. Filtered data represent the soluble or dissolved chemical concentrations in groundwater. Filtered metals data are generally assumed to be more representative of the actual, dissolved metals in a groundwater aquifer (i.e., the metal concentrations that are likely to migrate in the aquifer unit and be consumed by a receptor of concern).
- Soil data are subdivided into three data sets based on the sampling depths for LL–6 and the receptors to be evaluated at LL–6. In accordance with the FWHHRAM, the surface soil data set is composed of data for samples collected from the 0-1 ft bgs interval. The deep surface soil data set is composed of soil samples collected within the 0-4 ft interval. Subsurface soil data is composed of sample results for soil samples collected below 1 ft bgs. Consequently, data from the surface soil data set are compared to the surface soil RVAAP installation background criteria and data from the subsurface soil data set are compared to the subsurface soil RVAAP installation background criteria. The chemical concentrations in the deep surface soil samples are compared to the lower of the RVAAP installation background criteria benchmarks available for the background surface and subsurface soil data sets.

The LL–6 SRC screening process involved two steps: comparing results to already established RVAAP-specific background concentrations, and weight-of-evidence screening. The weight of evidence screen is defined as the evaluation of a contaminant in terms of how frequently it is detected in an environmental media and in terms of whether or not the chemical is an essential element. The background comparison was conducted to determine whether the metals detected in the environmental media were naturally occurring or were potentially site-related. Per the protocol established in the White Paper, the RVAAP-specific background values are those presented in the Phase II Remedial Investigation Report for the Winklepeck Burning Ground at Ravenna Army Ammunition Plant, Ravenna, Ohio (USACE, April 2001). These values are either the 95% upper tolerance limit (UTL) for the background data set for each environmental media, or they are the maximum detected concentration if the calculated UTL exceeds the maximum detected concentration reported for the RVAAP background samples. Inorganics, primarily metals that may be present naturally in the environment, were selected as potential SRCs if their maximum detected concentrations exceeded the RVAAP installation background criteria. This background screen was applied to inorganic chemicals only; organic chemicals were not eliminated as SRCs based on background comparisons.

Two weight-of-evidence screens (a frequency-of-detection screen and a screen for naturally occurring essential elements) were also used to eliminate chemicals from further consideration:

Frequency of Detection Screen

- If a data subset contained 20 or more data points, a frequency-of-detection screen was applied. Chemicals with a frequency of detection of less than 5% of the samples analyzed in any medium may not be considered to be site-related for that medium if:

  1) The chemical was not detected at high concentrations relative to the detection limit or to the established RVAAP installation background criteria;
  2) The chemical was not detected in another medium; and
  3) Knowledge of LL–6's history and LL–6 processes did not suggest that the chemical would be present. For example, any explosive or propellant detected in any LL–6 medium was considered to be site-related regardless of frequency of detection.

Naturally Occurring Essential Elements Screen

- Naturally occurring essential elements, including calcium, chloride, iodine, iron, magnesium, potassium, phosphorous, and sodium, are typically considered to be toxic at high concentrations only and are typically not selected as SRCs. As detailed in the FWHHRAM, these metals are an integral part of the human food supply and are often added to food as supplements. USEPA recommends that these chemicals not be evaluated as COPCs as long as they are (1) present at concentrations only slightly elevated above naturally occurring levels, and (2) only toxic at doses much higher than those that could be associated with contact at a site. Recommended daily allowance (RDA) and recommended daily intake (RDI) values are available for seven of these metals. Based on the RDA/RDI values, a receptor ingesting 100 mg of soil per day would receive less than the RDA/RDI of calcium, magnesium, phosphorous, potassium, and sodium, even if the soil consisted of the pure mineral (i.e., soil concentrations greater than 1,000,000 mg/kg). Receptors ingesting 100 mg of soil per day would require soil concentrations of 1,500 mg/kg of iodine and 100,000 to 180,000 mg/kg of iron to meet their RDA/RDI for these metals. Concentrations of these metals in the environmental media at LL–6 do not exceed these levels. Consequently, these essential nutrients were not selected as potential SRCs.

The results of the SRC screen are shown for each medium and are presented in Appendix V (Tables 2–1 through 2–6).

6.2.2.2 COPC Toxicity Screen

Once the list of SRCs was compiled, the list was further evaluated using a toxicity screen to develop a list of human health COPCs. For this risk assessment, risk-based and health-based criteria were used to reduce the number of chemicals and exposure routes considered in the LL–6

risk assessment. This toxicity screening reduces the number of chemicals evaluated in the BHHRA. More importantly, the screening focuses the risk assessment on those chemicals most likely to be significant in terms of risk. The COPCs were defined as chemicals that were positively detected in an environmental medium at a maximum concentration exceeding screening values.

Environmental sampling results were compared to risk-based screening concentrations (RBSCs) based on USEPA Region 9 residential soil PRGs (USEPA, 2004c) and, for groundwater only, federal Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs). The USEPA Region 9 residential risk-based PRGs represent a risk level of 1E-06 for carcinogenic effects (i.e., 1 in 1,000,000 excess chance of developing cancer over a lifetime) and a HI level of 1.0 for non-carcinogenic effects (i.e., adverse non-carcinogenic health effects are not anticipated at or below this expected exposure concentrations for the COPC). The PRGs for soil were calculated for a human receptor, hypothetically exposed to chemicals in soil, assuming a residential land use scenario. Region 9 PRGs for tap water were calculated for a human receptor, hypothetically using a groundwater or surface water resource as a domestic water supply. Conservatively, RBSCs for non-carcinogens are one-tenth these Region 9 residential PRGs to further account for potential cumulative non-carcinogenic effects. The RBSCs for carcinogens are the Region 9 residential PRGs and represent the 1E-06 cancer risk level. If RBSCs exist for a chemical for both carcinogenic and non-carcinogenic effects, the lower of the two values is used as the COPC selection criteria.

The maximum detected concentration for each SRC in each medium was compared to the risk screens as follows:

- Chemicals in surface soil, subsurface soil, and sediment were screened against their respective RBSCs. The RBSCs used were the adjusted soil PRGs that reflect residential land use. Data from the same three media were also compared to their respective adjusted industrial soil Region 9 PRGs; that comparison is presented for informational purposes only.
- Chemicals in groundwater are screened against the lesser of the RBSCs based on Region 9 tap water PRGs and federal SDWA MCLs. Region 9 PRGs can be found at http://www.epa.gov/region09/waste/sfund/prg/index. html. Drinking water MCLs are obtained from http://www.epa.gov/safewater/mcl.html.
- Chemicals in surface water are screened against the RBSCs based on Region 9 tap water PRGs.

SRCs that exceed toxicity screening levels and those lacking screening levels are retained as COPCs. Conversely, chemicals that were not detected or were not detected at maximum concentrations exceeding toxicity screening levels were not selected as SRCs and not retained as COPCs.

If USEPA approved toxicity information, such as cancer slope factors or reference doses, is available, the COPCs are then classified as quantitative COPCs. If no toxicity information exists, the COPCs are considered to be qualitative COPCs. The qualitative COPCs identified for LL–6 are further evaluated in Section 6.7.1 Uncertainties Associated with COPC Selection. The quantitative COPCs are further discussed in the toxicity assessment section (Section 6.4). Toxicity profiles for COPCs are presented in Section 6.4.

Appendix V, Tables 2–1 through 2–6 present the COPC screens for surface soil, deep surface soil (0-4 ft interval), subsurface soil, groundwater, surface water, and sediments, respectively. These tables include:

- Summary statistics, including the frequency of detection, maximum and minimum detected concentrations, location of maximum concentration, arithmetic average concentration, and 95% UCL-N of the mean concentration;
- Screening values RVAAP installation background criteria concentrations, RBSCs, and MCLs, as appropriate);
- SRC determination; and
- COPC determination.

The data sets evaluated for each environmental medium are presented in Tables 6–1 through 6–6. Table 6–7 summarizes the COPC list for each medium and indicates which COPCs will be addressed quantitatively and qualitatively for each medium.

6.2.2.3 Screening for Lead

Toxicity criteria (i.e., cancer slope factors, reference doses) have not been published for lead. Consequently, a calculated, toxicity-criteria-based PRG is not available for this inorganic. For this risk assessment, the lead concentrations in soil and sediment at LL–6 (see Appendix V, Tables 2.1, 2.2, 2.3, and 2.6) have been compared to the lead soil screening guidance concentration of 400 mg/kg for residential soil published in OSWER Directive 9355.4–12 (USEPA, 1994c). This value is presented as the PRG in the USEPA Region 9 residential table. Lead was not detected in soils or sediments at concentrations exceeding 400 mg/kg and, therefore, is not a COPC for LL–6. Lead was also not detected in groundwater at LL–6. Consequently, a COPC screening level for lead in groundwater was not required for this BHHRA. Lead was detected in surface water and the SDWA Action Level of 15 µg/L was used as the screening level.

Table 6–1
Human Health Risk Assessment
Dataset for Surface Soils

Sample ID	Depth ft bgs*
LL6SS-004	0-1
LL6SS-005	0-1
LL6SS-006	0-1
LL6SS-007	0-1
LL6SS-008	0-1
LL6SS-009	0-1
LL6SS-010	0-1
LL6SS-011	0-1
LL6SS-012	0-1
LL6SS-013	0-1
LL6SS-014	0-1
LL6SS-015	0-1
LL6SS-016	0-1
LL6SS-017	0-1
LL6SS-018	0-1
LL6SS-019	0-1
LL6SS-020	0-1
LL6SS-021	0-1
LL6SS-022	0-1
LL6SS-023	0-1
LL6SS-024	0-1
LL6SS-025	0-1
LL6SS-026	0-1
LL6SS-027	0-1
LL6SS-028	0-1
LL6SS-029	0-1
LL6SS-030	0-1
LL6SS-031	0-1
LL6SS-032	0-1
LL6SS-033	0-1
LL6SS-034	0-1
LL6SS-035	0-1
LL6SS-036	0-1
LL6SS-037	0-1
LL6SS-038	0-1
LL6SS-039	0-1
LL6SS-040	0-1
LL6SS-056	0-1
LL6SD-011	0-1
LL6SD-012	0-1

*ft bgs = feet below ground surface

Table 6–2
Human Health Risk Assessment
Dataset for Subsurface Soils

Sample ID	Depth ft bgs*
LL6SB-001	1-3
LL6SB-002	1-3
LL6SB-003	1-3
LL6SB-004	1-3
LL6SB-005	1-3
LL6SB-006	1-3
LL6SB-007	1-3
LL6SB-008	1-3
LL6SB-009	1-3
LL6SB-010	1-3
LL6SB-011	1-3
LL6SB-012	1-3
LL6SB-013	1-3
LL6SB-014	1-3
LL6SB-015	1-3
LL6SB-016	1-3
LL6SB-017	1-3
LL6SB-018	1-3
LL6SB-019	1-3
LL6SB-020	1-3
LL6SB-021	1-3
LL6SB-022	refusal at 1.5
LL6SB-023	1-3
LL6SB-024	1-3
LL6SB-025	1-3
LL6SB-026	1-3
LL6SB-027	1-3
LL6SB-028	1-3
LL6SB-029	refusal at 1-3
LL6SB-030	1-3
LL6SB-031	6-8
LL6SB-032	14-15
LL6SB-033	6-8
LL6SB-034	15-17
LL6SB-035	11-13
LL6SB-036	6-8
LL6SB-037	12-14
LL6SB-038	8-10
LL6SB-039	8-10
LL6SB-040	4-6
LL6SB-041	approx 7
LL6SB-042	1-3
LL6SB-044	1-3
LL6SB-045	1-3
LL6SB-049	4-6
LL6SB-050	6-8
LL6SB-051	6-8
LL6SB-055	3-5
LL6SB-056	1-3

*ft bgs = feet below ground surface

Table 6–3
Human Health Risk Assessment
Dataset For Deep Surface Soils

Sample ID	Depth ft bgs*
LL6SS-004	0-1
LL6SS-005	0-1
LL6SS-006	0-1
LL6SS-007	0-1
LL6SS-008	0-1
LL6SS-009	0-1
LL6SS-010	0-1
LL6SS-011	0-1
LL6SS-012	0-1
LL6SS-013	0-1
LL6SS-014	0-1
LL6SS-015	0-1
LL6SS-016	0-1
LL6SS-017	0-1
LL6SS-018	0-1
LL6SS-019	0-1
LL6SS-020	0-1
LL6SS-021	0-1
LL6SS-022	0-1
LL6SS-023	0-1
LL6SS-024	0-1
LL6SS-025	0-1
LL6SS-026	0-1
LL6SS-027	0-1
LL6SS-028	0-1
LL6SS-029	0-1
LL6SS-030	0-1
LL6SS-031	0-1
LL6SS-032	0-1
LL6SS-033	0-1
LL6SS-034	0-1
LL6SS-035	0-1
LL6SS-036	0-1
LL6SS-037	0-1
LL6SS-038	0-1
LL6SS-039	0-1
LL6SS-040	0-1
LL6SS-056	0-1

Table 6–3
Human Health Risk Assessment
Dataset For Deep Surface Soils

Sample ID	Depth ft bgs*
LL6SD-011	0-1
LL6SD-012	0-1
LL6SB-001	1-3
LL6SB-002	1-3
LL6SB-003	1-3
LL6SB-004	1-3
LL6SB-005	1-3
LL6SB-006	1-3
LL6SB-007	1-3
LL6SB-008	1-3
LL6SB-009	1-3
LL6SB-010	1-3
LL6SB-011	1-3
LL6SB-012	1-3
LL6SB-013	1-3
LL6SB-014	1-3
LL6SB-015	1-3
LL6SB-016	1-3
LL6SB-017	1-3
LL6SB-018	1-3
LL6SB-019	1-3
LL6SB-020	1-3
LL6SB-021	1-3
LL6SB-022	refusal at 1.5
LL6SB-023	1-3
LL6SB-024	1-3
LL6SB-025	1-3
LL6SB-026	1-3
LL6SB-027	1-3
LL6SB-028	1-3
LL6SB-029	refusal at 1-3
LL6SB-030	1-3
LL6SB-042	1-3
LL6SB-044	1-3
LL6SB-045	1-3
LL6SB-056	1-3

*ft bgs = feet below ground surface

Table 6–4

**Human Health Risk Assessment
Dataset for Groundwater**

Sample ID	Depth ft bgs*
LL6GW–002	21
LL6GW–003	18
LL6GW–004	17
LL6GW–005	15
LL6GW–006	15
LL6GW–007	10

*ft bgs = feet below ground surface

1

Table 6–5

**Human Health Risk Assessment
Dataset for Surface Water**

Sample Numbers
LL6SW–002
LL6SW–003
LL6SW–004
LL6SW–005

2

Table 6–6

**Human Health Risk Assessment
Dataset for Sediments**

Sample ID	Depth ft bgs*
LL6SD–002	0–0.5
LL6SD–003	0–0.5
LL6SD–004	0–0.5
LL6SD–005	0–0.5
LL6SD–010	0–0.5
LL6SD–013	0–0.5
LL6SD–014	0–0.5
LL6SD–015	0–0.5

*ft bgs = feet below ground surface

3

4

Table 6–7

Summary of Quantitative and Qualitative COPCs for Environmental Media

	Surface Soil	Subsurface Soil	Deep Surface Soil	Ground–water	Surface Water	Sediment
Quantitative COPCs						
Metals						
aluminum	X	X	X		X	X
antimony				X		
arsenic	X	X	X	X	X	X
chromium					X	
lead					X	
manganese	X		X		X	
vanadium			X		X	X
Organics						
4–nitroaniline				X		
benzo(a)pyrene		X	X			
bis(2–ethylhexyl)phthalate				X		
Qualitative COPCs						
Organics						
nitrocellulose	X	X	X	X	X	X

COPC = Chemical of Potential Concern.

Quantitative COPCs are those COPCs for which risks and/or hazards have been calculated.

Qualitative COPCs are those COPCs for which risks and/or hazards have not been calculated, because of a lack of reliable toxicity data.

6.2.2.4 COPC Screening Assumptions

The following assumptions have been made regarding the use of PRGs:

- LL–6 environmental media samples were analyzed for total chromium. The maximum detected concentrations for chromium results were screened against the PRGs for hexavalent chromium. This is a conservative screening approach, because hexavalent chromium is more toxic than trivalent chromium and is a less commonly occurring form of the metal.

- As recommended by Ohio EPA, Region 9 Cal-modified PRG for trichloroethene was used as the basis for the RBSC for trichloroethene. Cal-modified refers to the State of California modified toxicity criteria that are presented on the USEPA Region 9 PRG table, 1998 (USEPA, 2004c).

6.2.3 COPCs for LL–6

Sections 6.2.3.1 through 6.2.3.6 identify LL–6 COPCs in surface soil (0–1 ft), subsurface soil (0–3 ft), deep surface soil (0–4 ft), groundwater, surface water, and sediment, respectively. Arsenic was determined to be a COPC in soil, sediment, surface water and groundwater at LL–6. SVOCs 4–nitroaniline and bis(2–ethylhexyl)phthalate were selected as COPCs only for groundwater. Carcinogenic PAH benzo[a]pyrene was determined to be a COPC only in subsurface soil and deep surface soil.

6.2.3.1 Surface Soil

Twenty-two metals, 14 SVOCs, nitrocellulose, octahydro–1,3,5,7–tetranitro–1,3,5,7–tetrazocine (HMX), and aroclor 1254 were detected in the surface soil samples collected at LL–6. The samples evaluated in this BHHRA are listed in Table 6–1. The results of the COPC selection for surface soils are summarized in Appendix V, Table 2.1. Several site-related chemicals listed in Appendix V, Table 2.1 (e.g, HMX) were not selected as COPCs based on the screening criteria (e.g., toxicity, background, etc) defined in the preceding sections. The following chemicals were identified as COPCs:

- Metals (aluminum, arsenic, manganese) and
- Nitrocellulose.

Of 43 samples, 2 aluminum detections and 1 manganese detection exceeded their respective RVAAP installation background criteria. The exceedance for both aluminum and manganese occurred in a duplicate sample pair. In the case of both metals, averages of the original sample and duplicate were below the RVAAP installation background criteria. Aluminum and manganese were retained as COPCs.

Arsenic was detected in 3 of 43 samples at concentrations exceeding the RVAAP installation background criteria for surface soil. Arsenic was retained as a COPC for surface soil. Uncertainties with its selection as a COPC, noted here for informational purposes, will be further discussed in Section 6.7, Uncertainty Analysis. The concentrations detected are within the literature background values (less than 0.1 to 97 mg/kg) reported (USEPA, 2004c). Arsenic is a component of herbicides commonly used in the United States in the past and is, consequently, often detected at concentrations exceeding RVAAP background concentrations.

Nitrocellulose (detected in 5 of 5 samples) was selected as a COPC only because Region 9 residential PRGs are not available for this chemical. However, according to the USEPA (2004d), nitrocellulose is essentially non-toxic. Nitrocellulose is further discussed in Section 6.7, Uncertainty Analysis.

No chemicals were eliminated as COPCs for surface soil on the basis of frequency of detection.

6.2.3.2 Subsurface Soil

Twenty-two metals, 2 VOCs, 20 SVOCs, and nitrocellulose were detected in the subsurface soil samples collected at LL–6. The samples evaluated in this BHHRA are listed in Table 6–2. The results of the COPC selection for subsurface soils are summarized in Appendix V, Table 2.2. The following chemicals were identified as COPCs:

- Metals (aluminum, arsenic),
- Organics (benzo[a]pyrene), and
- Nitrocellulose.

One aluminum detection in 43 samples exceeded the RVAAP's background benchmarks for subsurface soil. This maximum detected concentration of aluminum exceeds the RBSCs (HI equal to 0.1); however, it does not exceed the PRGs for soil set at an HI of 1.

Arsenic was detected in 3 of 43 samples at concentrations exceeding the RVAAP installation background criteria benchmark for subsurface soil. Arsenic is retained as a COPC for subsurface soil. It is noted here for the reader, and further discussed in the Section 6.7, that the concentrations detected are within the literature background values reported in the PRG guidance document (USEPA, 2004c) and that arsenic is a component of herbicides commonly used in the United States in the past.

Benzo(a)pyrene (detected in 2 of 9 samples) was selected as a COPC for subsurface soil and is likely associated with routine, historic operations at LL–6 (equipment/vehicle usage). It is noted here for the reader, and further discussed in the Section 6.7, that the maximum concentration detected (0.2 mg/kg) is similar to anthropogenic background concentrations (ATSDR, 1995) and concentrations reported for background soil samples collected at RVAAP. Anthropogenic background considerations that potentially influence COPC selection for LL–6 are further discussed in Section 6.7, Uncertainty Analysis.

Nitrocellulose (detected in 5 of 5 samples) was selected as a COPC only because PRGs are not available for this chemical. However, according to the USEPA Office of Drinking Water, nitrocellulose is essentially non-toxic (USEPA, 2004d). Nitrocellulose is further discussed in Section 6.7, Uncertainty Analysis.

Manganese was the only chemical eliminated as a COPC for subsurface soil solely on the basis of the background screen. The maximum detected manganese concentration exceeded the RBSC (set at an HI equal to 0.1) but was less than the Region 9 residential PRG. No chemicals were eliminated as COPCs on the basis of frequency of detection.

6.2.3.3 Deep Surface (0-4 foot bgs) Soils

Twenty-two metals, 2 VOCs, 19 SVOCs, nitrocellulose, HMX, and aroclor 1254 were detected in the deep surface (0-4 ft) soil samples collected at LL–6. The samples evaluated in this BHHRA are listed in Table 6–3. The results of the COPC selection for deep surface soil are summarized in Appendix V, Table 2.3. The following chemicals were identified as COPCs:

- Metals (aluminum, arsenic, manganese, vanadium),
- Organics (benzo[a]pyrene), and
- Nitrocellulose.

Of 75 samples, two manganese detections and one vanadium detection exceeded their respective RVAAP installation background criteria. Each was part of a duplicate sample pair where the average of original and duplicate was below the RVAAP installation background criteria. Both were retained as COPCs.

Five aluminum detections of 75 samples exceeded the RVAAP installation background criteria for surface/subsurface soil. The maximum detected concentration of aluminum exceeds the RBSC (HI equal to 0.1).

Arsenic was detected in 11 of 75 samples at concentrations exceeding the RVAAP installation background criteria benchmark for surface soil.

Benzo(a)pyrene (detected in 8 of 11 samples) was selected as a COPC for the deep surface soil and is likely associated with routine operations at LL–6 (equipment/vehicle usage). See Section 6.7 for discussion of the comparison of the maximum detected concentration to anthropogenic background concentrations.

Nitrocellulose (detected in 10 of 10 samples) was selected as a COPC only because Region 9 residential PRGs are not available for this chemical. However, as noted in Section 6.2.3.2, nitrocellulose is essentially non-toxic (USEPA, 2004d). Nitrocellulose is further discussed in Section 6.7.

6.2.3.4 Groundwater

Eleven metals, 4–nitroaniline, bis(2–ethylhexyl)phthalate, and nitrocellulose were detected in the six groundwater samples collected at LL–6. The samples evaluated in this BHHRA are listed in Table 6–4. The results of the COPC selection for groundwater are summarized in Appendix V, Table 2–4. The following chemicals were identified as COPCs:

- Metals (antimony, arsenic),
- Organics (4–nitroaniline, bis(2–ethylhexyl)phthalate), and

- Nitrocellulose.

One arsenic detection in 6 monitoring wells exceeds the RBSC, and the maximum detected concentration (13 µg/L) only slightly exceeds the SDWA primary MCL (10 µg/L).

The maximum detection (4.2 µg/L) of antimony (detected in 3 of 6 monitoring wells) does not exceed the SDWA primary MCL of 6 µg/L. The maximum detection exceeds the RBSC (HI equal to 0.1).

Bis(2–ethylhexyl)phthalate was detected in 2 of 6 monitoring wells at concentrations exceeding both the RBSC and the SDWA primary MCL (6 µg/L); and 4–nitroaniline was detected in one monitoring well at a concentration exceeding the RBSC. See Section 6.7 for discussion of the uncertainties associated with 4–nitroaniline and bis(2–ethylhexyl)phthalate and potential for laboratory contamination. Upon validation of the laboratory data, bis(2–ethylhexyl)phthalate and 4-Nitroaniline were retained as COPCs.

Manganese was the only chemical eliminated as a COPC for groundwater solely on the basis of the background screen. No chemicals were eliminated as COPCs on the basis of frequency of detection.

Nitrocellulose (detected in 5 of 8 samples) was selected as a COPC only because no PRG is available for this chemical. However, according to the USEPA Office of Drinking Water, nitrocellulose is essentially non-toxic (USEPA, 2004d). Nitrocellulose will be further discussed in Section 6.7.

6.2.3.5 Surface Water

Twenty metals, acetone, 4–methylphenol, and nitrocellulose were detected in the 5 surface water samples collected at LL–6. The samples evaluated in this BHHRA are listed in Table 6–5. The results of the COPC selection for surface water are summarized in Appendix V, Table 2–5. The following chemicals were identified as COPCs:

- Metals (aluminum, arsenic, chromium, lead, manganese, and vanadium) and
- Nitrocellulose.

Aluminum was selected as a COPC because the maximum detected concentration exceeded the RBSC (HI equal to 0.1).

Arsenic was selected as a COPC because the maximum detected concentration exceeded the RBSC (HI equal to 0.1).

Three chromium detections in 5 samples exceeded the RBSC values; however, no concentration exceeded the SDWA primary MCL (100 µg/L).

Lead was selected as a COPC because the maximum detected concentration exceeded the RBSC (HI equal to 0.1).

Manganese was selected as a COPC because the maximum detected concentration exceeded the RBSC (HI equal to 0.1).

Vanadium was selected as a COPC because the maximum detected concentration exceeded the RBSC (HI equal to 0.1).

Nitrocellulose (detected in 1 of 1 samples) was selected as a COPC only because no PRG is available for this chemical. However, as noted in Section 6.2.3.2, nitrocellulose is essentially non-toxic (USEPA, 2004d). Nitrocellulose will be further discussed in Section 6.7.

No chemicals were eliminated as COPCs for surface water on the basis of the background screen only.

6.2.3.6 Sediment

Twenty-one metals, 14 SVOCs, nitrocellulose, 4,4–DDE, and aroclor 1254 were detected in the 8 sediment samples collected at LL–6. Eight samples and a duplicate were analyzed for metals, and 2 samples were analyzed for organics. The samples evaluated in this BHHRA are listed in Table 6–6. The results of the COPC selection for sediments are summarized in Appendix V, Table 2–6. The following chemicals were identified as COPCs:

- Metals (aluminum, arsenic, vanadium) and
- Nitrocellulose.

Each inorganic COPC − aluminum, arsenic, and vanadium − had in 9 samples one detection only that exceeded the RVAAP's background benchmarks for sediments. The maximum detected concentrations of aluminum and vanadium exceed the RBSCs (HI equal to 0.1). See Section 6.7 for a discussion of background concentrations of arsenic and herbicide use in the United States in the past.

Nitrocellulose (detected in 8 of 8 samples) was selected as a COPC only because no PRG is available for this chemical. However, as noted in Section 6.2.3.2, nitrocellulose is essentially non-toxic (USEPA, 2004d). Nitrocellulose will be further discussed in Section 6.7.

Manganese was the only chemical eliminated as a COPC for sediment solely on the basis of the background screen. The maximum detected manganese concentration exceeded the RBSC (HI equal to 0.1). No chemicals were eliminated as COPCs on the basis of frequency of detection.

6.2.3.7 Summary of COPC Selection

The COPCs selected for LL–6 are summarized in Table 6–7. Several COPCs were detected at maximum concentrations only slightly above RVAAP installation background criteria and may actually represent background conditions. The average concentrations and the 95% UCL of the mean are less than the RVAAP installation background criteria for many metals in soil (surface soil, subsurface soil, and sediment).

6.3 Exposure Assessment

The exposure assessment defines and evaluates the current and potential future exposures experienced by receptor populations. More specifically, an exposure assessment identifies the pathways by which humans are potentially exposed to COPCs, the magnitude of the potential human exposure, and the frequency and duration of exposure. This process involves several steps:

- Characterization of the exposure setting in terms of physical characteristics and the populations that may potentially be exposed to site-related chemicals;
- Identification of potential exposure pathways and receptors; and
- Quantification of exposure for each receptor in terms of the amount of chemical that is ingested, inhaled, or absorbed through the skin from all potentially complete exposure pathways.

The output of the exposure assessment (an estimate of COPC intake) is used in conjunction with toxicity criteria (i.e., cancer slope factors and reference doses) identified in the toxicity assessment (Section 6.4) to quantify risks and hazards to receptors during risk characterization (Section 6.5).

6.3.1 Exposure Setting

The exposure setting was described in the RVAAP's FWHHRAM and the White Paper for Load Lines 6, 9, and 11 RI (TtNUS, 2004).

The RVAAP installation is located in two counties − Portage and Trumbull − of northeastern Ohio, with a majority of the facility lying in Portage County. According to the 2000 Census, the total populations of Portage and Trumbull counties were 152,061 and 225,116, respectively. The largest population centers in the area are the city of Ravenna (population 11,771), approximately 3.2 km (2 mi) to the west, and Newton Falls (population 5,002), approximately 1.6 km (1 mile) to the southeast (SAIC, 2001).

Approximately 55% of Portage County is either woodland or farmland (Portage County Soil and Water Conservation District Resources Inventory 1985; Census Bureau, 1992). To the south of

the facility across State Route 5, is the Michael J. Kirwan Reservoir, which is used for recreational purposes. The reservoir is fed by the West Branch of the Mahoning River, which flows south along the western edge of the installation. Hinkley Creek flows south across the western portion of the facility and eventually flows into the West Branch of the Mahoning River. The other major surface drainages at RVAAP, Sand Creek and the South Fork of Eagle Creek, exit the facility and eventually flow east to the Mahoning River (SAIC, 2001).

6.3.1.1 Land Use

LL–6 lies within the south-central portion of the facility. Site workers (security guards/maintenance workers) infrequently visit LL–6; the load line is no longer mowed on a routine basis. There are no groundwater/production wells located at LL–6. The topography of LL–6 consists of gently undulating slopes. Elevations range from 341 m (1,120 ft) to 344 m (1,130 ft) above mean sea level. OHARNG may use LL–6 surface water for fire control or dust suppression.

Future recreational goals for RVAAP are hunting (mainly deer), fishing, and trapping anywhere suitable habitat exists. In addition, National Guard training operations are very likely to occur in the LL–6 area in the future. The OHARNG proposed land use for LL–6 is Mounted Training – No Digging. The National Guard trainee is assumed to come in direct contact with soil, surface water, and sediment for 24 days a year on inactive duty and 15 days a year during training. Digging is prohibited in this area, but mounted vehicles (e.g., tanks) are expected to disturb soil up to 4 ft bgs.

As noted above, the most plausible long-term use is a combination of OHARNG training use and controlled recreational use. Although other uses of the LL–6 area are unlikely, this BHHRA also evaluates additional potential future land uses that reflect a broader use of the land, including residential farm use, and a more intensive use of the AOC by the National Guard (i.e., a National Guard resident-trainer). The trainer will be expected to have similar exposures as the trainee, but the days-per-year exposure frequency is anticipated to be greater because the trainer would supervise the training of several groups of trainees. In summary, the land uses and receptors that have been evaluated as part of the BHHRA are listed in Table 6–8.

6.3.1.2 Receptors

The potential receptors listed for each scenario, the exposure pathways for each receptor, environmental media evaluated, and exposure parameters are listed in Table 6–9. These listings reflect the protocol established in the RVAAP FWHHRAM and the White Paper developed for Load Lines 6, 9, and 11 (TtNUS, 2004).

Table 6–8
Potential Receptors for the LL–6 BHHRA

Land Use Designation	Description	Potential Receptors
Modified Caretaker – Managed recreational	Light maintenance and managed hunting/trapping	Security guard/maintenance worker, Permitted visitor, or hunter/trapper
National Guard training area − Managed recreational	Ohio National Guard training activities and managed hunting/ trapping	National Guard trainee, National Guard resident trainer, National Guard fire and dust control personnel, permitted visitor or hunter/ trapper
Open residential	Unrestricted residential housing and farming	On-site resident farmer

Adult and juvenile trespasser receptors tables are presented in Appendix X.

6.3.2 Exposure Pathways

The potential exposure pathways for the receptors for the LL–6 BHHRA are summarized in Section 5. Information in this section addresses sources, release mechanisms, transport pathways, exposure routes, and receptors. The exposure assumptions used to estimate COPC intake for each receptor are shown in Table 6–10. The current and likely future land use scenarios and receptors identified in Section 6.3.1.1 are discussed below.

6.3.2.1 Modified Caretaker – Managed Recreational

This land use scenario describes the current land use at LL–6. Receptor/exposure activities under the current land use scenario are expected to be as described in the FWHHRAM and the White Paper for Load Lines 6, 9, and 11 (TtNUS, 2004). Consequently, the exposure assumptions for the potential receptors (security guard/maintenance worker and hunter/trapper) presented in Table 6–11 for the current land use scenario are those suggested in the FWHHRAM and White Paper. The evaluation of the following authorized receptors provides "worst case" risk estimates that may be used to make risk management decisions assuming that the future land use will not change significantly from what is known now to be the intended future use.

Table 6–9
Receptors and Exposure Pathways

Exposure Pathways		Exposure Media			
		Groundwater	Surface Water	Sediment	Surface Soil[a]
National Guard - Trainee					
Ingestion					
	Incidental	--	X	X	X
	Drinking water	X	--	--	--
Dermal		X	X	X	X
Inhalation					
	Vapor	No VOCs	--	X[b]	X[b]
	Dust	--	--	X	X
Ingestion of food		--	--	--	--
National Guard - Trainer/Resident					
Ingestion					
	Incidental	--	X	X	X
	Drinking water	X	--	--	--
Dermal		X	X	X	X
Inhalation					
	Vapor	No VOCs	--	X[b]	X[b]
	Dust	--	--	X	X
Ingestion of food		--	--	--	--
National Guard - Fire/Dust Suppression					
Ingestion					
	Incidental	--	X	X	X
	Drinking water	--	--	--	--
Dermal		--	X	X	X
Inhalation					
	Vapor	--	--	X[b]	X[b]
	Dust	--	--	X	X
Ingestion of food		--	--	--	--
Future Hypothetical Resident					
Ingestion					
	Incidental	--	X	X	X
	Drinking water	X	--	--	--
Dermal		X	X	X	X
Inhalation					
	Vapor	No VOCs	--	X[b]	X[b]
	Dust	--	--	X	X
Ingestion of beef, milk, and vegetables		X	--	--	X
Ingestion of venison		--	--	--	X
Recreators - Hunter/Trapper					
Ingestion					
	Incidental	--	X	X	X
	Drinking water	--	--	--	--
Dermal		--	X	X	X
Inhalation					
	Vapor	--	--	X[b]	X[b]
	Dust	--	--	X	X
Ingestion of venison		--	--	--	X
Security and Maintenance Personnel					
Ingestion					
	Incidental	--	--	--	X
	Drinking water	--	--	--	--
Dermal		--	--	--	X
Inhalation					
	Vapor	--	--	--	X[b]
	Dust	--	--	--	X
Ingestion of food		--	--	--	--

[a]Surface soil is defined as 0-1 feet for all receptors except the National Guard Trainee, where it is 0 to 4 feet bgs (deep surface soil) owing to nature of ground training activities. No soils were collected > 1 foot bgs; therefore, soil data sets were identical for all receptors

[b] VOCs only, if applicable.

Table 6–10
Exposure Assumptions

Parameter	Units	Security Guard/ Maintenance Worker	National Guard Dust/Fire Control	National Guard Trainee	National Guard Trainer/Resident	Hunter/Trapper	Resident Farmer (child/adult)
Note: Resident farmer is chosen instead of resident because the property would be used for farming in the unlikely event it was released from military use. Further, the resident farmer is expected to result in greater, more conservative exposure intake when compared to the resident.							
Pathway							
Surface Soil is defined as 0-1 for all receptors except the National Guard Trainee, where it is 0 to 4 feet bgs due to nature of ground training activities.							
Incidental ingestion							
Soil ingestion rate (Adult)	kg/day	0.0001[a]	0.0001[a]	0.0001[a]	**0.0001[a]**	0.0001[a]	0.0001[a]
Soil ingestion rate (Child)	kg/day	NA	NA	NA	**NA**	NA	0.0002[a]
Exposure time	hours/day	1[b]	4[b]	24[b]	**24[e]**	6	24[a]
Exposure frequency	days/year	250[a]	15[b]	39[b]	**250[e]**	2	350[a]
Exposure duration (Adult)	years	25[a]	25[b]	25[b]	**25[b]**	30[a]	30[a]
Exposure duration (Child)	years	NA	NA	NA	**NA**	NA	6[a]
Body weight (Adult)	kg	70[a]	70[a]	70[a]	**70[a]**	70[a]	70[a]
Body weight (Child)	kg	NA	NA	NA	**NA**	NA	15[a]
Carcinogen averaging time	days	25550[a]	25550[a]	25550[a]	**25550[a]**	25550[a]	25550[a]
Noncarcinogen averaging time (Adult)	days	9125[a]	9125[a]	9125[a]	**9125[a]**	10950[a]	10950[a]
Noncarcinogen averaging time (Child)	days	NA	NA	NA	**NA**	NA	2190[a]
Fraction ingested	unitless	1[b]	1[b]	1[b]	**1[b]**	1[b]	1[a]
Conversion factor	days/hour	**0.0625[y]**	**0.0625[y]**	0.042	**0.042**	**0.0625[y]**	0.042
Dermal contact							
Skin area	m^2/event	0.33[d]	0.33[d]	0.33[d]	**0.33[d]**	0.57[d]	0.22[h]/0.57[d]
Adherence factor	mg/cm^2	0.7[c]	0.3[c]	0.3[c]	**0.3[c]**	0.3[c]	0.2[h] /0.4[c]
Absorption fraction	Unitless	Chem. Spec[p]	Chem. Spec[p]	Chem. Spec[p]	**Chem. Spec[p]**	Chem. Spec[p]	Chem. Spec[p]
Exposure frequency	events/year	250[a]	15[b]	39[b]	**250[e]**	2	350[a]
Exposure duration	years	25[a]	25[b]	25[b]	**25[b]**	30[a]	6[a] /30[a]
Body weight	kg	70[a]	70[a]	70[a]	**70[a]**	70[a]	15[a] /70[a]
Carcinogen averaging time	days	25550[a]	25550[a]	25550[a]	**25550[a]**	25550[a]	25550[a]
Noncarcinogen averaging time	days	9125[a]	9125[a]	9125[a]	**9125[a]**	10950[a]	2190[a] /10950[a]
Conversion factor	(kg-cm^2)/(mg-m^2)	0.01	0.01	0.01	**0.01**	0.01	0.01
Inhalation of VOCs and dust							
Inhalation rate	--	0.83[a] m^3/hr	1.85[r] m^3/hr	44.4 m^3/day	**44.4 m^3/day**	1.47[r] m^3/hr	10[q] /20[a] m^3/day
Exposure time	hours/day	1[b]	4[b]	24[b]	**24[e]**	6	24/24[a]
Exposure frequency	days/year	250[a]	15[b]	39[b]	**250[e]**	2	350[a]
Exposure duration	years	25[a]	25[b]	25[b]	**25[b]**	30[a]	6[a] /30[a]
Body weight	kg	70[a]	70[a]	70[a]	**70[a]**	70[a]	15[a]/ 70[a]
Carcinogen averaging time	days	25550[a]	25550[a]	25550[a]	**25550[a]**	25550[a]	25550[a]
Noncarcinogen averaging time	days	9125[a]	9125[a]	9125[a]	**9125[a]**	10950[a]	2190[a]/ 10950[a]
Conversion factor	days/hour	**NA**	**NA**	0.042	**0.042**	**NA**	0.042
Particulate Emission Factor	m^3/kg	9.24E+08[v]	NA	1.67E+06[w]	**9.24E+08[v]**	9.24E+08[v]	9.24E+08[v]

Table 6–10
Exposure Assumptions

Parameter	Units	Security Guard/ Maintenance Worker	National Guard Dust/Fire Control	National Guard Trainee	National Guard Trainer/Resident	Hunter/Trapper	Resident Farmer (child/adult)
SUBSURFACE SOIL for the National Guard Resident and Resident Farmer may be 1-30 feet bgs unless rock is encountered at a depth less than 30 ft.							
Incidental ingestion							
Soil ingestion rate (Adult)	kg/day	NA	NA	NA	**0.0001**[a]	NA	0.0001[a]
Soil ingestion rate (Child)	kg/day	NA	NA	NA	**NA**	NA	0.0002[a]
Exposure time	hours/day	NA	NA	NA	**24**[e]	NA	24
Exposure frequency	days/year	NA	NA	NA	**250**[e]	NA	350[a]
Exposure duration (Adult)	years	NA	NA	NA	**25**[b]	NA	30[a]
Exposure duration (Child)	years	NA	NA	NA	**NA**	NA	6[a]
Body weight (Adult)	kg	NA	NA	NA	**70**[a]	NA	70[a]
Body weight (Child)	kg	NA	NA	NA	**NA**	NA	15[a]
Carcinogen averaging time	days	NA	NA	NA	**25550**[a]	NA	25550[a]
Noncarcinogen averaging time (Adult)	days	NA	NA	NA	**9125**[a]	NA	10950[a]
Noncarcinogen averaging time (Child)	days	NA	NA	NA	**NA**	NA	2190[a]
Fraction ingested	unitless	NA	NA	NA	**1**[b]	NA	1[a]
Conversion factor	days/hour	NA	NA	NA	**0.042**	NA	0.042
Dermal contact							
Skin area	m^2/event	NA	NA	NA	**0.33**[d]	NA	0.22[h] /0.57[d]
Adherence factor	mg/cm^2	NA	NA	NA	**0.3**[c]	NA	0.2[h] /0.4[c]
Absorption fraction	unitless	NA	NA	NA	**Chem. Spec**[p]	NA	chem. Spec[p]
Exposure frequency	events/year	NA	NA	NA	**250**[e]	NA	350[a]
Exposure duration	years	NA	NA	NA	**25**[b]	NA	6[a]/30[a]
Body weight	kg	NA	NA	NA	**70**[a]	NA	15[a] /70[a]
Carcinogen averaging time	days	NA	NA	NA	**25550**[a]	NA	25550[a]
Noncarcinogen averaging time	days	NA	NA	NA	**9125**[a]	NA	2190[a] /10950[a]
Conversion factor	($kg\text{-}cm^2$)/($mg\text{-}m^2$)	NA	NA	NA	**0.01**	NA	0.01
Inhalation of VOCs and dust							
Inhalation rate	--	NA	NA	NA	**44.4 m^3/day**	NA	10[q] /20[a] m^3/day
Exposure time	hours/day	NA	NA	NA	**24**[e]	NA	24[a]
Exposure frequency	days/year	NA	NA	NA	**250**[e]	NA	350[a]
Exposure duration	years	NA	NA	NA	**25**[b]	NA	6[a] /30[a]
Body weight	kg	NA	NA	NA	**70**[a]	NA	15[a] /70[a]
Carcinogen averaging time	days	NA	NA	NA	**25550**[a]	NA	25550[a]
Noncarcinogen averaging time	days	NA	NA	NA	**9125**[a]	NA	2190[a] /10950[a]
Conversion factor	days/hour	NA	NA	NA	**0.042**	NA	0.042
Particulate Emission Factor	m^3/kg	NA	NA	NA	**9.24E+08**[v]	NA	9.24E+08[v]

Table 6–10
Exposure Assumptions

Parameter	Units	Security Guard/ Maintenance Worker	National Guard Dust/Fire Control	National Guard Trainee	National Guard Trainer/Resident	Hunter/Trapper	Resident Farmer (child/adult)
SEDIMENT							
Incidental ingestion							
Soil ingestion rate (Adult)	kg/day	NA	0.0001[a]	0.0001[a]	**0.0001[a]**	0.0001[a]	0.0001[a]
Soil ingestion rate (Child)	kg/day	NA	NA	NA	**NA**	NA	0.0002[a]
Exposure time	hours/day	NA	4[b]	24[b]	**24[e]**	6	24[a]
Exposure frequency	days/year	NA	15[b]	39[b]	**250[e]**	2	**75[b]**
Exposure duration (Adult)	years	NA	25[b]	25[b]	**25[b]**	30[a]	30[a]
Exposure duration (Child)	years	NA	NA	NA	**NA**	NA	6[a]
Body weight (Adult)	kg	NA	70[a]	70[a]	**70[a]**	70[a]	70[a]
Body weight (Child)	kg	NA	NA	NA	**NA**	NA	15[a]
Carcinogen averaging time	days	NA	25550[a]	25550[a]	**25550[a]**	25550[a]	25550[a]
Noncarcinogen averaging time (Adult)	days	NA	9125[a]	9125[a]	**9125[a]**	10950[a]	10950[a]
Noncarcinogen averaging time (Child)	days	NA	NA	NA	**NA**	NA	2190[a]
Fraction ingested	unitless	NA	1[b]	1[b]	**1[b]**	1[b]	1[a]
Conversion factor	days/hour	NA	**0.0625[y]**	0.042	**0.042**	**0.0625[y]**	0.042
Dermal contact							
Skin area	m^2/event	NA	0.33[d]	0.33[d]	**0.33[d]**	0.52[d]	0.22[h] /0.57[d]
Adherence factor	mg/cm^2	NA	0.3[c]	0.3[c]	**0.3[c]**	0.3[c]	0.2[h] /0.4[c]
Absorption fraction	unitless	NA	chem. Spec[p]	chem. Spec[p]	**chem. Spec[p]**	chem. Spec[p]	chem. Spec[p]
Exposure frequency	events/year	NA	15[b]	39[b]	**250[e]**	2	**75[b]**
Exposure duration	years	NA	25[b]	25[b]	**25[b]**	30[a]	6[a] /30[a]
Body weight	kg	NA	70[a]	70[a]	**70[a]**	70[a]	15[a] /70[a]
Carcinogen averaging time	days	NA	25550[a]	25550[a]	**25550[a]**	25550[a]	25550[a]
Noncarcinogen averaging time	days	NA	9125[a]	9125[a]	**9125[a]**	10950[a]	2190[a] /10950[a]
Conversion factor	$(kg\text{-}cm^2)/(mg\text{-}m^2)$	NA	0.01	0.01	**0.01**	0.01	0.01
Inhalation of VOCs and dust							
Inhalation rate	--	NA	**1.85[r] m^3/hr**	44.4 m^3/day	**44.4 m^3/day**	0.83[a] m^3/hr	10[q] /20[a] m^3/day
Exposure time	hours/day	NA	4[b]	24[b]	**24[e]**	6	24[a]
Exposure frequency	days/year	NA	15[b]	39[b]	**250[e]**	2	**75[b]**
Exposure duration	years	NA	25[b]	25[b]	**25[b]**	30[a]	6[a] /30[a]
Body weight	kg	NA	70[a]	70[a]	**70[a]**	70[a]	15[a] /70[a]
Carcinogen averaging time	days	NA	25550[a]	25550[a]	**25550[a]**	25550[a]	25550[a]
Noncarcinogen averaging time	days	NA	9125[a]	9125[a]	**9125[a]**	10950[a]	2190[a] /10950[a]
Conversion factor	days/hour	NA	**0.0625[y]**	0.042	**0.042**	**0.0625[y]**	0.042
Particulate Emission Factor	m^3/kg	NA	9.24E+08[v]	1.67E+06[w]	**9.24E+08[v]**	9.24E+08[v]	9.24E+08[v]

Table 6–10
Exposure Assumptions

Parameter	Units	Security Guard/ Maintenance Worker	National Guard Dust/Fire Control	National Guard Trainee	National Guard Trainer/Resident	Hunter/Trapper	Resident Farmer (child/adult)
SURFACE WATER							
Incidental ingestion while wading							
Drinking water ingestion rate	L/hr	NA	NA	NA	**NA**	NA	NA
Incidental water ingestion rate	L/day	NA	0.1[b]	0.1[b]	**0.1[b]**	0.05[b]	0.1[b]
Exposure frequency	days/year	NA	15[b]	39[b]	**250[e]**	2	**45[b]**
Exposure duration	years	NA	25[b]	25[b]	**25[b]**	30[a]	6[a] /30[a]
Body weight	kg	NA	70[b]	70[a]	**70[a]**	70[a]	15[a] /70[a]
Carcinogen averaging time	days	NA	25550[a]	25550[a]	**25550[a]**	25550[a]	25550[a]
Noncarcinogen averaging time	days	NA	9125[a]	9125[a]	**9125[a]**	10950[a]	2190[a] /10950[a]
Dermal contact while wading							
Skin area	m^2	NA	0.33[d]	0.33[d]	**0.33[d]**	0.52[d]	0.22[h] /0.57[d]
Exposure time	hours/day	NA	4[b]	**2[b]**	**2[b]**	**2[b]**	**2[b]**
Exposure frequency	days/year	NA	15[b]	39[b]	**250[e]**	2	**45[b]**
Exposure duration	years	NA	25[b]	25[b]	**25[b]**	30[a]	6[a] /30[a]
Body weight	kg	NA	70[a]	70[a]	**70[a]**	70[a]	15[a] /70[a]
Carcinogen averaging time	days	NA	25550[a]	25550[a]	**25550[a]**	25550[a]	25550[a]
Noncarcinogen averaging time	days	NA	9125[a]	9125[a]	**9125[a]**	10950[a]	2190[a] /10950[a]
Conversion factor	(m/cm)(L/m^3)	NA	10	10	**10**	10	10
GROUNDWATER							
Drinking Water Ingestion							
Drinking water ingestion rate	L/day	NA	NA	2[a]	**2[a]**	NA	1.5[h] /2[a]
Exposure frequency	days/year	NA	NA	39[b]	**250[e]**	NA	350[a]
Exposure duration	years	NA	NA	25[b]	**25[b]**	NA	6[a] /30[a]
Body weight	kg	NA	NA	70[a]	**70[a]**	NA	15[a] /70[a]
Carcinogen averaging time	days	NA	NA	25550[a]	**25550[a]**	NA	25550[a]
Noncarcinogen averaging time	days	NA	NA	9125[a]	**9125[a]**	NA	2190[a] /10950[a]
Dermal contact while showering							
Skin area	m^2	NA	NA	1.94[g]	**1.94[g]**	NA	0.866[s] /1.94[g]
Exposure time	hours/day	NA	NA	0.25[a]	**0.25[a]**	NA	0.25[a]
Exposure frequency	days/year	NA	NA	39[b]	**250[e]**	NA	350[a]
Exposure duration	years	NA	NA	25[b]	**25[b]**	NA	6[a] /30[a]
Body weight	kg	NA	NA	70[a]	**70[a]**	NA	15[a] /70[a]
Carcinogen averaging time	days	NA	NA	25550[a]	**25550[a]**	NA	25550[a]
Noncarcinogen averaging time	days	NA	NA	9125[a]	**9125[a]**	NA	2190[a] /10950[a]
Conversion factor	(m/cm)(L/m^3)	NA	NA	10	**10**	NA	10
Inhalation of VOCs during household water use (Only if applicable)							
Inhalation rate	--	NA	NA	0.83[a] m^3 /hr	**0.83[a] m^3 /hr**	NA	10[q] /20[a]
Exposure time	hours/day	NA	NA	24	**24**	NA	24
Exposure frequency	days/year	NA	NA	39[b]	**250[e]**	NA	350[a]
Exposure duration	years	NA	NA	25[b]	**25[b]**	NA	6[a] /30[a]
Body weight	kg	NA	NA	70[a]	**70[a]**	NA	15[a] /70[a]
Carcinogen averaging time	days	NA	NA	25550[a]	**25550[a]**	NA	25550[a]
Noncarcinogen averaging time	days	NA	NA	9125[a]	**9125[a]**	NA	2190[a] /10950[a]
Volatilization factor	L/m^3	NA	NA	0.5[a]	**0.5[a]**	NA	0.5[a]

Table 6–10
Exposure Assumptions

Parameter	Units	Security Guard/ Maintenance Worker	National Guard Dust/Fire Control	National Guard Trainee	National Guard Trainer/Resident	Hunter/Trapper	Resident Farmer (child/adult)
FOODSTUFFS							
Ingestion of venison							
Conversion factor	unitless	NA	NA	NA	**NA**	**1.25**	1.25
Browse ingestion rate	kg dry weight/day	NA	NA	NA	**NA**	**0.87**[b]	0.87[b]
Fraction browse ingested from site	unitless	NA	NA	NA	**NA**	**0.12**	**0.12**
Fat ratio (venison to beef)	unitless	NA	NA	NA	**NA**	**0.2**	0.2
Venison ingestion rate	kg/day	NA	NA	NA	**NA**	**0.03**[b]	0.03[b]
Fraction ingested	unitless	NA	NA	NA	**NA**	**1**[b]	1[b]
Exposure frequency	days/year	NA	NA	NA	**NA**	**365**[b]	365[b]
Exposure duration	years	NA	NA	NA	**NA**	**30**[a]	6[a] /30[a]
Body weight	kg	NA	NA	NA	**NA**	**70**[a]	15[a] /70[a]
Carcinogen averaging time	days	NA	NA	NA	**NA**	**25550**[a]	25550[a]
Noncarcinogen averaging time	days	NA	NA	NA	**NA**	**10950**[a]	2190[a] /10950[a]
Ingestion of beef							
Resuspension multiplier	unitless	NA	NA	NA	**NA**	NA	0.25[i]
Quantity of pasture ingested	kg dry weight/day	NA	NA	NA	**NA**	NA	7.2[j]
Fraction of year cow is on-site	unitless	NA	NA	NA	**NA**	NA	**1**
Fraction of cow's food from on-site	unitless	NA	NA	NA	**NA**	NA	0.9[b]
Quantity of soil ingested by cow	kg/day	NA	NA	NA	**NA**	NA	1[k]
Beef ingestion rate	kg/day	NA	NA	NA	**NA**	NA	0.0094/0.044[l]
Fraction ingested	unitless	NA	NA	NA	**NA**	NA	1[b]
Exposure frequency	days/year	NA	NA	NA	**NA**	NA	365[b]
Exposure duration	years	NA	NA	NA	**NA**	NA	6[a] /30[a]
Body weight	kg	NA	NA	NA	**NA**	NA	15[a] /70[a]
Carcinogen averaging time	days	NA	NA	NA	**NA**	NA	25550[a]
Noncarcinogen averaging time	days	NA	NA	NA	**NA**	NA	2190[a] /10950[a]
Ingestion of milk products							
Resuspension multiplier	unitless	NA	NA	NA	**NA**	NA	0.25[i]
Quantity of pasture ingested	kg dry weight/day	NA	NA	NA	**NA**	NA	16.1[j]
Fraction of year cow is on-site	unitless	NA	NA	NA	**NA**	NA	1[b]
Fraction of cow's food from on-site	unitless	NA	NA	NA	**NA**	NA	0.6[b]
Quantity of soil ingested by cow	kg/day	NA	NA	NA	**NA**	NA	1[k]
Milk ingestion rate (Adult)	kg/day	NA	NA	NA	**NA**	NA	0.305[l]
Milk ingestion rate (Child)	kg/day	NA	NA	NA	**NA**	NA	0.509[m]
Fraction ingested	unitless	NA	NA	NA	**NA**	NA	1[b]
Exposure frequency	days/year	NA	NA	NA	**NA**	NA	365[b]
Exposure duration (Adult)	years	NA	NA	NA	**NA**	NA	30[a]
Exposure duration (Child)	years	NA	NA	NA	**NA**	NA	6[a]
Body weight (Adult)	kg	NA	NA	NA	**NA**	NA	70[a]
Body weight (Child)	kg	NA	NA	NA	**NA**	NA	15[a]
Carcinogen averaging time	days	NA	NA	NA	**NA**	NA	25550[a]
Noncarcinogen averaging time (Adult)	days	NA	NA	NA	**NA**	NA	10950[a]
Noncarcinogen averaging time (Child)	days	NA	NA	NA	**NA**	NA	2190[a]

Table 6–10
Exposure Assumptions

Parameter	Units	Security Guard/ Maintenance Worker	National Guard Dust/Fire Control	National Guard Trainee	National Guard Trainer/Resident	Hunter/Trapper	Resident Farmer (child/adult)
Ingestion of vegetables							
Resuspension multiplier	unitless	NA	NA	NA	**NA**	NA	0.26[n]
Vegetable ingestion rate	kg/day	NA	NA	NA	**NA**	NA	0.043/0.2[l]
Fraction ingested	unitless	NA	NA	NA	**NA**	NA	0.4[l]
Exposure frequency	days/year	NA	NA	NA	**NA**	NA	365[a]
Exposure duration	years	NA	NA	NA	**NA**	NA	6[a] /30[a]
Body weight	kg	NA	NA	NA	**NA**	NA	15[a] /70[a]
Carcinogen averaging time	days	NA	NA	NA	**NA**	NA	25550[a]
Noncarcinogen averaging time	days	NA	NA	NA	**NA**	NA	2190[a] /10950[a]
Ingestion of fish/waterfowl							
Fish ingestion rate	kg/day	NA	NA	NA	**NA**	**0.0154/0.0132**	**0.054[o]**
Fraction ingested	unitless	NA	NA	NA	**NA**	1[b]	1[a]
Exposure frequency	days/year	NA	NA	NA	**NA**	365[b]	365[b]
Exposure duration	years	NA	NA	NA	**NA**	30[b]	6[a] /30[a]
Body weight	kg	NA	NA	NA	**NA**	70[a]	15[a] /70[a]
Carcinogen averaging time	days	NA	NA	NA	**NA**	25550[a]	25550[a]
Noncarcinogen averaging time	days	NA	NA	NA	**NA**	10950[a]	10950[a]

NOTES:

Shading indicates values that differ from those presented in the *Facility–Wide Human Health Risk Assessors Manual* . (The National Guard Resident is not a receptor included in the Facility–Wide Human Health Risk Assessors Manual).
NA = The exposure parameter is not necessary/applicable to the quantitative risk evaluation of that particular exposure pathway
a RAGS, Part B (EPA 1991a).

b Site-specific (value assumed for site or value obtained from site personnel). National Guard Trainee is assumed to be on –site 24 hrs/d for 24 d/yr for inactive duty training and 24 hrs/d for 15 d/yr for annual training. Both National Guard receptors are assumed to remain at RVAAP and at the AOC of interest for their entire 25 year enlistment. The Hunter is assumed to be on-site 6 hours/day for 2 days/year. The trapper will be exposed less (i.e., 0.5 hours/day for 6 days/year); therefore, the hunter exposure is used as the more conservative scenario. The hunter is assumed to hunt as long as he/she resides in the area, so the residential default exposure duration is used. The Security Guard/Maintenance Worker is assumed to visit each AOC for 1 hour/day for a standard worker default of 250 days/yr and 25 years.

National Guard Trainee, National Guard Resident, and Resident Farmer are assumed to ingest 0.05 L/hour [per RAGS Part A (EPA 1998)] for approximately 2 hours/day spent in the surface water. Hunter/trappers are assumed to ingest 0.05 L/day due to splashing while setting traps.

c Security Guard/Maintenance Worker = Adult Groundskeeper (95th percentile); Hunter/Trapper = Residential Default; National Guard Trainee = Construction Worker (95th percentile); Resident Farmer Adult = Adult Farmer (95th percentile) (RAGS, Vol. 1 Part E, Supplemental Guidance for Dermal Risk Assessment, Interim) EPA/540/R/99/005.

d Security Guard/Maintenance Worker, National Guard Trainee = Industrial Default; Hunter/Trapper and Resident Farmer = Adult Residential Default. Exposure Factors Handbook (EPA 1997a) (Note dermal contact for Hunter/Trapper during wading is 0.52 based on head, hands, forearms and lower legs from Exposure Factors Handbook.)

e National Guard resident is assumed to reside on-site during the week (i.e., 24 hours/day, 5 days/week, 50 weeks/year) and go home on weekends.
f RAGS, Part A (EPA 1989a).
g Average total body surface area for an adult (EPA 1992b).
h Per OEPA comment 2002.
i Plant mass loading factor for pasture (Hinton 1992).
j International Atomic Energy agency 1994.
k Soil ingestion by dairy cattle (Darwin 1990).
l Exposure Factors Handbook (EPA 1997). 50th percentile beef ingestion 0.626 g/kg-day = 44 g/day for a 70 kg adult and 9.4 for a 15 kg child. 50th pecentile vegetable ingestion rate = 2.86 g/kg/day = 200 g/day for a 70 kg adult and 43 g/day for a 15 kg child. Ingestion rates for the total population and not any age-specific group.

m Pao et al. (1982).
n Plant mass loading factor for vegetables (Pinder 1989).
o Based on EPA/FDA Nation Advisory of 1 meal (8 oz uncooked weight) noncommmercial fish per week (EPA-823-F-04-008). Adult or Child
p Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment, Interim), EPA/540/R/99/005.
q Recommended value for child age 6-8 (EPA 1997a).
r The inhalation rate for hunter/trapper is based on an adult engaged in light activities 4 hours/day, moderate activities 1 hour/day, and heavy activities 1 hour/day.
s 50th percentile value for male child age 6-7 (EPA 1997a).
u Ecological Risk Assessment. Ohio EPA/DERR. February 2003
v Default value for Cleveland, Ohio. EPA Soil Screening Calculation Internet Site (http://risk.lsd.ornl.gov/calc_start.shtml).
w Based on a dust loading factor of 600 ug/m^3 (DOE, 1993).
x A site specific value will be developed following methodology in EPA's Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, December 2002, OSWER 9355.4-24.
y Based on a 16 hour day.

Table 6–11
Summary of Cancer Risks and Hazard Indices

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks > 10^{-4}	Chemicals with Cancer Risks > 10^{-5} and ≤ 10^{-4}	Chemicals with Cancer Risks > 10^{-6} and ≤ 10^{-5}	Hazard Index	Chemicals with HI > 1
Security Guard/ Maintenance Worker	Surface Soil	Incidental Ingestion	4E-07	- -	- -	- -	3E-03	- -
		Inhalation	6E-10	- -	- -	- -		- -
		Dermal Contact	5E-06	- -	- -	Arsenic	3E-02	- -
		Total	5E-06	- -	- -	Arsenic	3E-02	- -
National Guard Trainee	Deep Surface Soil	Incidental Ingestion	1E-06	- -	- -	Arsenic	9E-03	- -
		Inhalation	3E-06	- -	- -	Arsenic	6E-01	- -
		Dermal Contact	4E-07	- -	- -	- -	2E-03	- -
		Total	5E-06	- -	- -	Arsenic	6E-01	- -
	Surface Water	Incidental Ingestion	2E-06	- -	- -	Arsenic	3E-02	- -
		Inhalation	0E+00	- -	- -	- -	3E-02	- -
		Dermal Contact	1E-07	- -	- -	- -	7E-03	- -
		Total	2E-06	- -	- -	Arsenic	6E-02	- -
	Sediment	Incidental Ingestion	3E-06	- -	- -	- -	3E-02	- -
		Inhalation	4E-07	- -	- -	- -	3E-02	- -
		Dermal Contact	9E-07	- -	- -	- -	7E-03	- -
		Total	4E-06	- -	- -	- -	6E-02	- -
	Groundwater	Incidental Ingestion	2E-05	- -	Arsenic	- -	2E-01	- -
		Inhalation		- -	- -	- -		- -
		Dermal Contact	3E-07	- -	- -	- -	3E-03	- -
		Total	2E-05	- -	Arsenic	- -	2E-01	- -
		Total All Media	3E-05				9E-01	
National Guard Resident	Surface Soil	Incidental Ingestion	7E-06	- -	- -	Arsenic	4E-02	- -
		Inhalation	6E-07	- -	- -	- -		- -
		Dermal Contact	2E-06	- -	- -	Arsenic	1E-02	- -
		Total	1E-05	- -	- -	Arsenic	6E-02	- -
	Surface Water	Incidental Ingestion	1E-05	- -	Arsenic	- -	6E-01	- -
		Inhalation		- -	- -	- -		- -
		Dermal Contact	9E-07	- -	- -	- -	8E-01	- -
		Total	1E-05	- -	Arsenic	- -	1E+00	Manganese
	Sediment	Incidental Ingestion	2E-05	- -	Arsenic	- -	2E-01	- -
		Inhalation	2E-06	- -	- -	Arsenic	1E-01	- -
		Dermal Contact	6E-06	- -	- -	Arsenic	5E-02	- -
		Total	3E-05	- -	Arsenic	- -	3E-01	- -
	Subsurface Soil	Incidental Ingestion	8E-06	- -	- -	Arsenic	6E-02	- -
		Inhalation	2E-08	- -	- -	- -	4E-03	- -
		Dermal Contact	3E-06	- -	- -	Arsenic	1E-02	- -
		Total	1E-05	- -	- -	Arsenic, Benzo(a)pyrene	8E-02	- -
	Groundwater	Incidental Ingestion	1E-04	Arsenic	- -	Bis(2-ethylhexyl)phthalate	1E+00	- -
		Inhalation		- -	- -	- -		- -
		Dermal Contact	2E-06	- -	- -	Bis(2-ethylhexyl)phthalate	2E-02	- -
		Total	1E-04	Arsenic	- -	Bis(2-ethylhexyl)phthalate	1E+00	- -
		Total All Media	2E-04				3E+00	
National Guard Fire and Dust Control	Surface Soil	Incidental Ingestion	1E-07	- -	- -	- -	7E-04	- -
		Inhalation	4E-06	- -	- -	Arsenic		- -
		Dermal Contact	1E-07	- -	- -	- -	8E-04	- -
		Total	5E-06	- -	- -	Arsenic	1E-03	- -
	Surface Water	Incidental Ingestion	8E-07	- -	- -	- -	4E-02	- -
		Inhalation		- -	- -	- -		- -
		Dermal Contact	5E-08	- -	- -	- -	5E-02	- -
		Total	9E-07	- -	- -	- -	9E-02	- -
	Sediment	Incidental Ingestion	3E-07	- -	- -	- -	2E-03	- -
		Inhalation	9E-10	- -	- -	- -	8E-05	- -
		Dermal Contact	3E-07	- -	- -	- -	3E-03	- -
		Total	6E-07	- -	- -	- -	5E-03	- -
		Total All Media	6E-06				9E-02	

Table 6–11
Summary of Cancer Risks and Hazard Indices

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks > 10^{-4}	Chemicals with Cancer Risks > 10^{-5} and ≤ 10^{-4}	Chemicals with Cancer Risks > 10^{-6} and ≤ 10^{-5}	Hazard Index	Chemicals with HI > 1
Hunter	Surface Soil	Incidental Ingestion	2.5E-08	- -	- -	- -	1E-04	- -
		Inhalation	6.4E-11	- -	- -	- -		- -
		Dermal Contact	3.4E-08	- -	- -	- -	2E-04	- -
		Total	6E-08	- -	- -	- -	3E-04	- -
	Sediment	Incidental Ingestion	7E-08	- -	- -	- -	5E-04	- -
		Inhalation	1E-10	- -	- -	- -	7E-06	- -
		Dermal Contact	9E-08	- -	- -	- -	6E-04	- -
		Total	2E-07	- -	- -	- -	1E-03	- -
	Surface Water	Incidental Ingestion	7E-08	- -	- -	- -	2E-03	- -
		Inhalation		- -	- -	- -		- -
		Dermal Contact	1E-08	- -	- -	- -	1E-02	- -
		Total	8E-08	- -	- -	- -	1E-02	- -
	Venison	Ingestion	3E-09	- -	- -	- -	2E-05	
		Total All Media	3E-07				1E-02	
Child Resident Farmer	Surface Soil	Incidental Ingestion	na	- -	- -	- -	6E-01	- -
		Inhalation	na	- -	- -	- -		- -
		Dermal Contact	na	- -	- -	- -	4E-02	- -
		Total	na	- -	- -	- -	6E-01	- -
	Surface Water	Incidental Ingestion	na	- -	- -	- -	5E-01	- -
		Inhalation	na	- -	- -	- -		- -
		Dermal Contact	na	- -	- -	- -	5E-01	- -
		Total	na	- -	- -	- -	1E+00	- -
	Sediment	Incidental Ingestion	na	- -	- -	- -	5E-01	- -
		Inhalation	na	- -	- -	- -	2E-03	- -
		Dermal Contact	na	- -	- -	- -	3E-02	- -
		Total	na	- -	- -	- -	5E-01	- -
	Subsurface Soil	Incidental Ingestion	na	- -	- -	- -	8E-01	- -
		Inhalation	na	- -	- -	- -	4E-04	- -
		Dermal Contact	na	- -	- -	- -	4E-02	- -
		Total	na	- -	- -	- -	8E-01	- -
	Groundwater	Incidental Ingestion	na	- -	- -	- -	5E+00	Arsenic, Antimony
		Inhalation	na	- -	- -	- -		- -
		Dermal Contact	na	- -	- -	- -	6E-02	- -
		Total	na	- -	- -	- -	5E+00	Arsenic, Antimony
	Venison	Ingestion	na	- -	- -	- -	3E-04	- -
	Beef	Ingestion	na	- -	- -	- -	2E-01	- -
	Milk	Ingestion	na	- -	- -	- -	8E-01	- -
	Vegetables	Ingestion	na	- -	- -	- -	1E+01	Arsenic
		Total All Media	na				2E+01	

Table 6–11
Summary of Cancer Risks and Hazard Indices

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks > 10^{-4}	Chemicals with Cancer Risks > 10^{-5} and ≤ 10^{-4}	Chemicals with Cancer Risks > 10^{-6} and ≤ 10^{-5}	Hazard Index	Chemicals with HI > 1
Adult Resident Farmer	Surface Soil	Incidental Ingestion	na	- -	- -	- -	6E-02	- -
		Inhalation	na	- -	- -	- -	0E+00	- -
		Dermal Contact	na	- -	- -	- -	4E-02	- -
		Total	na	- -	- -	- -	1E-01	- -
	Surface Water	Incidental Ingestion	na	- -	- -	- -	1E-01	- -
		Inhalation	na	- -	- -	- -		- -
		Dermal Contact	na	- -	- -	- -	3E-01	- -
		Total	na	- -	- -	- -	4E-01	- -
	Sediment	Incidental Ingestion	na	- -	- -	- -	5E-02	- -
		Inhalation	na	- -	- -	- -	1E-03	- -
		Dermal Contact	na	- -	- -	- -	3E-02	- -
		Total	na	- -	- -	- -	8E-02	- -
	Subsurface Soil	Incidental Ingestion	na	- -	- -	- -	9E-02	- -
		Inhalation	na	- -	- -	- -	4E-03	- -
		Dermal Contact	na	- -	- -	- -	5E-02	- -
		Total	na	- -	- -	- -	1E-01	- -
	Groundwater	Incidental Ingestion	na	- -	- -	- -	2E+00	- -
		Inhalation	na	- -	- -	- -		- -
		Dermal Contact	na	- -	- -	- -	3E-02	- -
		Total	na	- -	- -	- -	2E+00	Arsenic
	Venison	Ingestion	na	- -	- -	- -	7E-05	- -
	Beef	Ingestion	na	- -	- -	- -	2E-01	- -
	Milk	Ingestion	na	- -	- -	- -	1E-01	- -
	Vegetables	Ingestion	na	- -	- -	- -	1E+01	Arsenic
		Total All Media	na				2E+01	
Lifelong Resident Farmer (Child and Adult)	Surface Soil	Incidental Ingestion	3E-05	- -	Arsenic	- -		- -
		Inhalation	4E-08	- -	- -	- -		- -
		Dermal Contact	9E-06	- -	- -	Arsenic		- -
		Total	4E-05	- -	Arsenic	- -		- -
	Surface Water	Incidental Ingestion	6E-06	- -	- -	Arsenic		- -
		Inhalation		- -	- -	- -		- -
		Dermal Contact	5E-07	- -	- -	- -		- -
		Total	6E-06	- -	- -	Arsenic		- -
	Sediment	Incidental Ingestion	6E-06	- -	Arsenic	- -		- -
		Inhalation	2E-08	- -	- -	- -		- -
		Dermal Contact	6E-06	- -	- -	Arsenic		- -
		Total	1E-05	- -	Arsenic	- -		- -
	Subsurface Soil	Incidental Ingestion	4E-05	- -	Arsenic	Benzo(a)pyrene		- -
		Inhalation	3E-08	- -	Arsenic	Benzo(a)pyrene		- -
		Dermal Contact	1E-05	- -	- -	- -		- -
		Total	5E-05	- -	Arsenic	Benzo(a)pyrene		- -
	Groundwater	Incidental Ingestion	4E-04	Arsenic	- -	Bis(2-ethylhexyl)phthalate, 4-nitroaniline		- -
		Inhalation		- -	- -	Bis(2-ethylhexyl)phthalate		- -
		Dermal Contact	5E-06	- -	- -	- -		- -
		Total	4E-04	Arsenic	- -	Bis(2-ethylhexyl)phthalate, 4-nitroaniline		- -
	Venison	Ingestion	1E-08	- -	- -	- -		- -
	Beef	Ingestion	4E-05	- -	Arsenic	- -		- -
	Milk	Ingestion	2E-05	- -	Arsenic	- -		- -
	Vegetables	Ingestion	3E-03	Arsenic	- -			
		Total All Media	4E-03					

6.3.2.2 Security Guard – Maintenance Worker

Current activities at the LL–6 include maintenance activities and security patrols. Consequently, a security guard or maintenance worker may contact environmental media (i.e., surface soil) at LL–6. However, the contact is likely to be limited because maintenance activities are not routinely scheduled for LL–6 and the individual performing a security patrol is not likely to contact environmental media on a regular basis. Use of the shallow aquifer for a potable water supply and contact with subsurface soil, surface water, and sediment were not considered likely. Therefore, receptor exposure to these environmental media were not evaluated in the BHHRA prepared for LL–-6. Although routine mowing does not currently take place in LL–6, it will occur on a regular basis once the site is turned over to the OHARNG. Exposure parameter values used to assess this receptor in the BHHRA are found in Table 6–11.

6.3.2.3 Hunter/Trapper

Information regarding hunting, trapping, and fishing activities at RVAAP is based on a summary in the FWHHRAM and on-site observations of hunting, trapping and fishing activities. Permitted deer hunting and trapping (coyote) occur at RVAAP. Future uses for the RVAAP include hunting, fishing, and trapping anywhere suitable habitats exist. According to the RVAAP FWHHRAM, a hunter is assumed to be within a particular RVAAP area 6 hours per day 2 days per year. The trapper is assumed to be exposed less intensely at a frequency of 0.5 hours per day 6 days per year; therefore, the hunter exposure is used as the more conservative scenario. The hunter/fisherman is assumed to hunt/fish as long as he/she resides in the area, so 30 years is used as the residential default exposure duration. A hunter/trapper operating in the vicinity of LL–6 may be exposed to COPCs in surface soil, surface water, and sediments as well as through the ingestion of deer meat. Exposure parameter values used to assess the hunter/trapper receptor are found in Table 6–11.

The small pond at LL–6 is not capable of sustaining a fish population. Consequently, fishing does not occur at LL–6. Also, waterfowl hunting is not likely at LL–6 (i.e., the surface water resources at LL–6 are minimal).

6.3.2.4 National Guard – Managed Recreational

Four receptors are expected under the National Guard – Managed Recreational land use scenario: a hunter/trapper, a National Guard training participant, a National Guard resident trainer, and a National Guard fire and dust control participant. Although National Guard units typically participate in training 2 weeks a year with some weekend training, instructors and other National Guard personnel managing the training activities could be expected to be on site more frequently. The National Guard trainee is assumed to be on site 24 hours per day for 24 days/year for inactive duty training and 24 hours per day for 15 days/year for annual training, for a total of 39 days/year. The National Guard resident trainer is assumed to reside on site during the week (i.e., 24 hours/day, 5 days/week, 50 weeks/year) and go home on weekends for a total

of 250 days/year. The National Guard fire and dust control personnel are assumed to be on site 4 hours/day for a total of 15 days/year. The three National Guard receptors are assumed to remain at RVAAP and at the AOC of interest for their entire 25-year enlistment. It should be noted that the National Guard resident trainer receptor is not included in the RVAAP FWHHRAM. Given the anticipated future land use for the LL–6, the National Guard trainee is the primary receptor for LL–6. The National Guard resident trainer was included in this BHHRA after discussions with both the USACE and the Ohio EPA. Risk estimates for this receptor may assist the risk managers for RVAAP when making certain risk management decisions.

The National Guard receptors may be exposed to COPCs in surface soil, subsurface soil, sediment, and surface water during various training activities such as those detailed in the FWHHRAM. The exposure is anticipated to occur while the receptor is actively involved in on-site training structured to reflect potential activities that may occur during military operations. Given the nature of ground training activities (i.e., use of tracked vehicles and other military equipment), surface soil is defined as 0-4 ft bgs for the National Guard trainee. The BHHRA includes risk estimates for the National Guard receptor assuming the receptor is using the groundwater as a potable water resource. The fire and dust suppression National Guard personnel are assumed not to be exposed to groundwater. Exposure parameter values used in this BHHRA to evaluate the National Guard receptors are found in Table 6–11.

6.3.2.5 Open Residential

This potential scenario was evaluated to provide risk information assuming a future residential land use of the LL–6 area. A resident farmer adult and child are the receptors of concern. However, based on current and anticipated future land use information, it is unlikely that the LL–6 area will be used for residential purposes. The evaluation of the hypothetical future resident is required by the Ravenna FFHHRA Manual; the scenario is included principally for purposes of completeness and to provide information to risk managers regarding the need for institutional land use controls.

The adult resident farmer may come into direct contact with COPCs in soil, sediment, surface water and groundwater and may also be exposed via indirect exposure pathways (i.e., ingestion of venison, beef, milk, and vegetables). Exposure parameters used to represent receptor activities patterns are listed in Table 6–10 and generally come from the FWHHRAM, with exceptions as outlined in the White Paper for Load Lines 6, 9 , and 11 (TtNUS, 2004).

6.3.2.6 Trespasser

This potential scenario is evaluated in Appendix W. Adult and juvenile trespassers may come into direct contact with surface soil, sediment, and surface water. Exposure parameters used to represent receptor activity patterns are listed in the 2005 addendum to the FWHHRAM.

6.3.3 Exposure Quantification

Intake or dose is defined as the amount of a COPC that could be in contact with a receptor per unit body weight per unit time. For the LL–6 BHHRA, ingested, dermal, and inhaled intakes of the media for each receptor as well as ingestion of homegrown vegetables, milk, meat, and venison were calculated using standard intake equations from USEPA guidance (i.e., USEPA, 1989a) which are presented in the FWHHRAM with exceptions as outlined in the White Paper for Load Lines 6, 9, and 11 (TtNUS, 2004).

The standard tables published in the USEPA Rags Part D are used to present the exposure assumptions, intake equations, dose estimates, toxicity criteria (i.e., cancer slope factors, reference doses), and cancer and non-cancer risk estimates for receptors evaluated in this BHHRA. These tables also include references for exposure assumptions. The Rags Part D tables and example calculations for each receptor and exposure pathway are presented in Appendix V.

6.3.3.1 Exposure to Surface Soil

Appendix V (Tables 4.1, 4.2, 4.6, 4.11, 4.14, 4.18, and 4.27) provides the dose equations used to estimate chemical intake for the security guard/maintenance worker, National Guard trainee, National Guard resident trainer, National Guard fire/dust suppression worker, hunter/trapper, child resident farmer, and adult resident farmer hypothetically exposed to COPCs in surface soil, respectively. Where available, the exposure assumptions used to calculate COPC intake were those suggested by standard USEPA guidance documents and given in the FWHHRAM. Exposure assumptions for the National Guard resident trainer were presented in the White paper for Load Lines 6, 9, and 11 (TtNUS, 2004). Professional judgment was used to select the exposure parameter values in some cases. For example, it was assumed that the conversion factor for ingestion of soils/sediments should be 0.0625 hour/days (not 0.042 hour/days) for receptors who are not on site for 24 hours a day: the security guard/maintenance workers and the hunter/trapper. The change was made to reflect the fact that the receptors are typically not exposed to soils/dusts while they are sleeping; the suggested parameter *is more conservative* than the value given in the FWHHRAM.

Intake values for the security guard/maintenance worker, National Guard trainee, National Guard resident trainer, hunter/trapper, child resident farmer, and adult resident farmer exposure to LL–6 surface soil COPCs are provided in Appendix V (Tables 7.1, through 7.7, respectively).

6.3.3.2 Exposure to Subsurface Soil

It is assumed two receptors – the National Guard resident trainer and the resident farmer – will be exposed to both surface soil and subsurface soil. The National Guard resident trainer may be exposed to shallow subsurface soil during certain training activities. Although unlikely, this BHHRA was prepared assuming that the future resident farmer may also come in contact with

subsurface soils excavated and spread across the surface of the site. This scenario is included primarily for purposes of completeness and for informing future land use control decisions.

Appendix V, Tables 4.9, 4.21, and 4.30 provide the dose equations used to estimate chemical intake for the National Guard resident trainer, child resident farmer, and adult resident farmer, respectively, exposed to COPCs in subsurface soil. If available, the exposure assumptions used in the equations were those suggested by standard USEPA guidance documents and outlined in the FWHHRAM. Exposure assumptions for the National Guard resident trainer are not found in the FWHHRAM, but were presented in the White paper for Load Lines 6, 9, and 11 (TtNUS, 2004).

Intake values for National Guard resident trainer, child resident farmer, and adult resident farmer exposure to LL–6 subsurface soil COPCs are provided in Appendix V (Tables 7.3, 7.6, and 7.7, respectively).

6.3.3.3 Exposure to Surface Soil and Subsurface Soils

When exposure to both surface and subsurface soils is anticipated, total receptor risk estimates are calculated separately to avoid an overestimation of risk (i.e., risk estimates for COPCs in surface soil will not be added to risk estimates developed for COPCs in subsurface soil).

6.3.3.4 Exposure to Groundwater

Appendix V (Tables 4.5, 4.10, 4.22, and 4.31) provides the dose equations used to estimate chemical intake for National Guard trainees, National Guard resident trainers, child resident farmers, and adult resident farmers, respectively, hypothetically exposed to COPCs in groundwater. Where available, the exposure assumptions used in the equations were those suggested by standard USEPA guidance documents and given in the FWHHRAM. Exposure assumptions for the National Guard resident trainer are presented in the white paper for Load Lines 6, 9, and 11.

Intake values for the National Guard trainee, National Guard resident trainer, child resident farmer, and adult resident farmer exposure to LL–6 groundwater COPCs are provided in Appendix V (Tables 7.2, 7.3, 7.6, and 7.7, respectively).

6.3.3.5 Exposure to Surface Water

Appendix V (Tables 4.4, 4.8, 4.13, 4.16, 4.20, and 4.29) provides the dose equations used to estimate chemical intake for National Guard trainees, National Guard resident trainer, National Guard fire/dust suppression worker, hunter/trappers, child resident farmer, and adult resident farmer, respectively, exposed to COPCs in surface water. Where available, the exposure assumptions used in the equations were those suggested by standard USEPA guidance documents and presented in the FWHHRAM. Exposure assumptions for the National Guard

resident trainer are presented in the White Paper for Load Lines 6, 9, and 11. However, information provided by RVAAP and professional judgment were used to select the exposure values in some cases and presented in the White Paper for Load Lines 6, 9, and 11. For example, it was assumed that:

- The exposure time for the National Guard trainee exposed to surface water should be 2 hours/day. The exposure is anticipated to occur while the trainee is actively involved in on-site training structured to reflect potential activities that may occur during military operations. The exposure time was modified from that presented in the FWHHRAM because, although the trainee is on site for 24 hours a day, it is unlikely that he/she would be exposed to surface water 24 hours a day. While there is no firm data regarding the exposure time a National Guard trainee may be exposed to surface water, at least one USEPA guidance document provides information on exposure times for swimming or wading. A default exposure time for swimming or wading of 1 hour per day is given in *Dermal Exposure Risk Assessment: Principles and Applications*, Interim Report (USEPA, 1992a). Conservatively, this value was increased to 2 hours per day to account for non-recreational exposure that may occur during military training.
- The ingestion of surface water while wading is anticipated to be 0.05 liter (L)/day for the hunter/trapper as a result of splashing while setting traps or wading (USEPA, 1989a).

Intake values for the National Guard trainee, National Guard resident trainer, National Guard fire/dust suppression worker, hunter/trapper, child resident farmer, and adult resident farmer, exposure to LL–6 surface water COPCs are provided in Appendix V (Tables 7.2 through 7.7 respectively).

6.3.3.6 Exposure to Sediment

Appendix V (Tables 4.3, 4.7, 4.12, 4.15, 4.19, and 4.28) provides the dose equations used to estimate chemical intake for National Guard trainees, National Guard resident trainer, National Guard fire/dust suppression workers, hunter/trappers, child resident farmers, and adult resident farmers, respectively, exposed to COPCs in sediments. Where available, the exposure assumptions used in the equations were those suggested by standard USEPA guidance documents and given in the FWHHRAM. Exposure assumptions for the National Guard resident trainer are presented in the White Paper for Load Lines 6, 9, and 11. However, professional judgment was used to select exposure parameter values in some cases. For example, it was assumed that the conversion factor for ingestion of soils/sediments should be 0.0625 hour/days (not 0.042 hour/days) for receptors who are not on site for 24 hours a day: the security guard/maintenance workers and the hunter/trapper. The change was made to reflect the fact that the receptors are typically not exposed to soils/dusts while they are sleeping and is more conservative than the value given in the FWHHRAM.

Intake values for the National Guard trainee, National Guard resident trainer, National Guard fire/dust suppression worker, hunter/trapper, child resident farmer, and adult resident farmer

exposure to LL–6 sediment COPCs are provided in Appendix V (Tables 7.2, through 7.7, respectively).

6.3.3.7 Exposure to Venison

Appendix V (Tables 4.17, 4.23, and 4.32) provides the dose equations used to estimate chemical intake for venison consumption by hunter/trappers, child resident farmers, and adult resident farmers, respectively. Where available, the exposure assumptions used in the equations were those suggested by the FWHHRAM. No exposure assumptions were given in the FWHHRAM for the hunter/trapper; therefore, values recommended in the White Paper for Load Lines 6, 9, and 11 were used. Site-specific information for LL–6 was used to adjust the fraction of the animal's food from the site to 0.11 to reflect the size of the site (approximately 20 ha) compared to the home range of a white-tailed deer (175 ha) (USEPA, 1993a).

Intake values for hunter/trapper, child resident farmer, and adult resident farmer exposure to LL–6 COPCs in venison are provided in Appendix V (Tables 7.5, 7.6, and 7.7, respectively).

6.3.3.8 Exposure to Beef

Appendix V (Tables 4.24 and 4.33) provides the dose equations used to estimate chemical intake for beef consumption by child resident farmers and adult resident farmers, respectively. The exposure assumptions used in the equations were those suggested by the FWHHRAM. Site-specific information for LL–6 was used to determine an exposure parameter as outlined in the FWHHRAM:

- The fraction of the year the animals are on site was presumed to be 1.0 (i.e., the animals are assumed to be on-site year round).
- As explained in the White Paper for Load Lines 6, 9, and 11, the FWHHRAM recommends that COPC concentrations in beef products consider contaminant uptake as a result of the animal ingesting contaminated ground or surface water. The contribution from this pathway is considered minor for LL–6 and was not considered in the BHHRA. Note the water ingestion contribution is shown in the intake equation given in the FWHHRAM, but no exposure parameter is given in Table 5 of the FWHHRAM.

Intake values for child resident farmer and adult resident farmer exposure to LL–6 COPCs in beef are provided in Appendix V (Tables 7.6 and 7.7).

6.3.3.9 Exposure to Milk

Appendix V (Tables 4.25 and 4.34) provides the dose equations used to estimate chemical intake for milk consumption by child resident farmers and adult resident farmers, respectively. The exposure assumptions used in the equations were those suggested by the FWHHRAM. However, as explained in the White Paper for Load Lines 6, 9, and 11, the FWHHRAM

recommends that calculations of COPC concentrations in milk products include contaminant uptake as a result of the animal ingesting contaminated ground or surface water. The contribution from this pathway is considered minor and was not considered in the BHHRA. Note the water ingestion contribution is shown in the intake equation given in the FWHHRAM, but no exposure parameter is given in Table 5 of the FWHHRAM.

Intake values for child resident farmer and adult resident farmer exposure to LL–6 COPCs in milk are provided in Appendix V (Tables 7.6 and 7.7, respectively).

6.3.3.10 Exposure to Vegetables

Appendix V (Tables 4.26 and 4.35) provides the dose equations used to estimate chemical intake for vegetable consumption by child resident farmers and adult resident farmers, respectively. Where available, the exposure assumptions used in the equations were those suggested in the FWHHRAM.

Intake values for child resident farmer and adult resident farmer exposure to LL–6 COPCs in vegetables are provided in Appendix V (Tables 7.6 and 7.7, respectively).

6.3.4 Exposure Point Concentrations

The exposure point concentration (EPC) is the amount of a COPC used to best estimate the intake of a COPC detected in an environmental medium. Ideally, the EPC should be the true average concentration within the exposure unit for the medium. However, because of the uncertainty associated with estimating the true average concentration at a site, the 95% UCL of the arithmetic mean is selected as the EPC. The following procedure was used to determine EPCs in the BHHRA for LL–6:

- If there were fewer than 10 samples or fewer than 50% positive detections of chemicals in the samples, the maximum concentration was chosen as the EPC because the 95% UCL does not provide a good estimation of the upper bound of the mean concentration for small data sets or for data sets that contain a large number of non-detected values.
- If there were more than 10 samples with more than 50% detections, each data set was evaluated using the Shapiro-Wilk W test (Gilbert. 1987) to determine whether the data set more closely reflected a normal or log-normal distribution. If results were inconclusive, the data were assumed to follow a log-normal distribution. The 95% UCL-L and 95% UCL-N were calculated for each analyte in each medium and data set using one-half the reporting limit for non-detect results and both samples of duplicate pairs. Example calculations demonstrating how exposure point concentrations were calculated are found in Appendix V. Because of the amount of detailed calculations and spreadsheets involved in estimating the EPCs, only example calculations are provided herein. The 95% UCL-N was used as the EPC if the Shapiro-Wilk W test indicated a normal distribution, and the 95% UCL-L was used as the EPC if the Shapiro-Wilk W test

indicated a log-normal distribution or if the distribution was undefined. If the calculated 95% UCL exceeded the maximum detected concentration, the maximum detected concentration was selected as the EPC.

EPCs were calculated for analytes detected in surface soil (0–1 ft bgs), deep surface soil (0–4 ft bgs), subsurface soil, groundwater, surface water, and sediment samples located in LL–6. These EPCs are presented in Appendix V (Rags Part D, Tables 3.1.RME through 3.6.RME).

Route-specific EPCs were also calculated for the inhalation of particulates/vapors migrating from soil and sediment to air, the inhalation of VOCs volatilizing from groundwater, and for consumption of foodstuffs. The methods used for calculation of the route-specific EPCs are presented in Appendix V (Tables 4.1 through 4.35).

6.4 Toxicity Assessment

Information concerning the potential human health effects of exposure to COPCs is examined by the risk assessor during the toxicity assessment. For each COPC, the goal of the toxicity assessment is to provide a quantitative estimate of the relationship between the magnitude and type of exposure and the severity or probability of human health effects. The toxicity values presented in this section are integrated with the exposure assessment (Section 6.3) to characterize the potential for the occurrence of adverse health effects.

6.4.1 Toxicity Information and USEPA Guidance for Non-carcinogens

For non-carcinogens, it is assumed that a dose exists below which no adverse health effects will be seen. Below this “threshold” dose, exposure to a chemical can be tolerated without adverse effects. The potential for non-carcinogenic health effects resulting from exposure to chemicals is assessed by comparing the intake dose with this “threshold” dose, or reference dose (RfD) (*RAGS Part A*, 1989). The RfD is determined using available dose-response data for individual chemicals. Uncertainty factors are applied to the highest no-observed-adverse-effect level (NOAEL) to adjust for inter- and intra-species variation, deficiencies in the toxicological data base, and use of subchronic rather than chronic animal studies. Inter-species differences in toxicity responses occur as a consequence of the basic biological differences among the various species. Intra-species differences in toxicity responses occur as a consequence of the varying sensitivities amongst the individuals within a species. Additional uncertainty factors may be applied to estimate a NOAEL from a lowest-observed-adverse-effect level (LOAEL) if the primary study failed to determine a NOAEL. When chemical-specific data are not sufficient, an RfD may be derived from data for a chemical with structural and toxicologic similarity.

The RfD is expressed in units of mg/kg/day and represents a daily intake of contaminant per kilogram of body weight that is not sufficient to cause the adverse non-carcinogenic health effects. An RfD is specific to the chemical, the route of exposure, and the duration over which the exposure occurs. Separate RfDs are presented for ingestion and inhalation pathways.

Dermal RfDs are discussed in Section 6.4.3. An oral RfD is typically used to evaluate receptor exposure via the ingestion or dermal routes of exposure. In contrast, reference concentrations (RfCs) presented in units of mg/m^3 are typically published by the USEPA for the evaluation of concentrations in the air that a receptor inhales. In particular, RfCs in units of mg/m^3 are typically presented for the inhalation pathway. Because characterization of non-carcinogenic effects requires an estimate of dose in units of mg/kg/day, the inhalation RfC must be converted to an inhalation RfD. The conversion is performed by assuming that humans weigh 70 kg and inhale 20 m^3 of air per day (i.e., the inhalation RfC mg/m^3 is multiplied by 20 m^3/day and divided by 70 kg to yield an inhalation RfD with units of mg/kg–day) (USEPA, 1995a). The RfDs used to evaluate the COPCs at LL–6 are presented in Appendix V, Table 5.1. The toxicity values were selected using the hierarchy from the FWHHRAM:

- **Tier 1 – USEPA's IRIS**
- **Tier 2 – USEPA's Provisional Peer–Reviewed Toxicity Values (PPRTVs)** – The Office of Research and Development/National Center for Environmental Assessment/Superfund Health Risk Technical Support Center (STSC) develops PPRTVs on a chemical-specific basis when requested by USEPA's Superfund program.
- **Tier 3 - Other Toxicity Values** – Tier 3 includes additional USEPA and non-USEPA sources of toxicity information. Priority should be given to those sources of information that are the most current, the basis for which is transparent and publicly available, and which have been peer-reviewed.

6.4.2 Toxicity Information and USEPA Guidance for Carcinogens

The toxicity information considered in the assessment of potential carcinogenic risks includes a weight-of-evidence classification and a slope factor. The weight-of-evidence classification qualitatively describes the likelihood that a chemical is a human carcinogen, based on an evaluation of the available data from human and animal studies. Historically, a chemical was placed in one of three groups in USEPA's classification system to denote its potential for carcinogenic effects:

- Group A – known human carcinogen,
- Group B1 or B2 – probable human carcinogen, or
- Group C – possible human carcinogen.

Chemicals that cannot be classified as human carcinogens because of a lack of data are placed in Group D, and those for which there is evidence of non-carcinogenicity in humans are in Group E. More recently, the USEPA is evaluating the use of the following categories to describe the carcinogenic potential of a chemical:

- Carcinogenic to humans,

- Likely to be carcinogenic to humans,
- Suggestive evidence of carcinogenic potential,
- Inadequate information to assess carcinogenic potential, or
- Not likely to be carcinogenic to humans.

For carcinogens, risks are estimated as the probability that an individual will develop cancer over a lifetime as a result of exposure to the carcinogen. The cancer slope factor (CSF) is the toxicity value used to express quantitatively the carcinogenic hazard of cancer-causing chemicals. It is defined as the upper-bound estimate of the probability of cancer incidence per unit dose averaged over a lifetime. Slope factors are specific to a chemical and route of exposure and are expressed in units of $[mg/kg–day]^{-1}$ for both oral and inhalation routes. Dermal RfDs are discussed in Section 6.4.3. Inhalation cancer toxicity values are usually expressed as inhalation unit risks in units of reciprocal $\mu g/m^3$ $[1/(\mu g/m^3)]$. The inhalation unit risk must be converted to an inhalation slope factor. This is done by assuming that humans weigh 70 kg and inhale 20 m^3 of air per day (i.e., the inhalation unit risk $[1/\mu g/m^3]$ is divided by 20 m^3/day, multiplied by 70 kg, and multiplied by 1,000 µg/mg to yield the mathematical equivalent of an inhalation slope factor $[mg/kg–day]^{-1}$) (USEPA, 1995a). Thus:

$$\text{Unit risk } (\mu g/m^3)^{-1} \times 70 \text{ kg} \times (20\ m^3/\text{day})^{-1} \times 1000\ \mu g/mg = \text{SFI } (mg/kg*day)^{-1}$$

CSFs used to evaluate the COPCs at LL–6 are presented in Appendix V, Table 6.1, and were selected using the hierarchy listed in Section 6.4.1.

6.4.3 Estimation of Toxicity Values for Dermal Exposure

Dermal RfDs and dermal CSFs are derived from the corresponding oral values. In the derivation of a dermal CSF, the oral CSF is divided by the gastrointestinal absorption factor (GAF) to determine a CSF based on an absorbed dose rather than an administered dose. The oral CSF is divided by the GAF because CSFs are expressed as reciprocal doses. A dermal RfD is derived by multiplying an oral RfD by the GAF. Dermal CSFs and RfDs are in Appendix V (Tables 5.1 and 6.1). Values for GAF or gastrointestinal absorption fraction (ABS_{GI}) were taken from *RAGS Part E, Supplemental Guidance for Dermal Risk Assessment* (USEPA, 2004a). For chemicals with greater than 50% ABS_{GI} absorption, it is recommended that the default value of complete (i.e., 100%) oral absorption be assumed, thereby eliminating the need for oral toxicity value adjustment. Dermal adjustments to the oral CSF or RfD were made for antimony, cadmium, chromium, manganese, and vanadium.

6.4.4 Toxicity Criteria Assumptions

A provisional RfD is available for aluminum from the National Center for Environmental Assessment (NCEA). However, this value is based on typical allowable intakes rather than adverse effect levels and is not considered risk-based.

6.4.5 Chemicals Lacking USEPA Toxicity Criteria

No toxicity criterion is available for one LL–6 COPC, nitrocellulose. According to the USEPA Office of Drinking Water, nitrocellulose is essentially non-toxic (USEPA, 2004d). Therefore, cancer and non-cancer risk estimates are not provided for this COPC.

6.5 Risk Characterization

The risk assessor evaluates information obtained through the exposure and toxicity assessments to estimate cancer risks and hazard indices in the risk characterization. Total non-carcinogenic and carcinogenic risk estimates for each exposure route, as well as the cumulative risks for each receptor, are presented in Appendix V (Tables 9.1 through 9.7).

This risk characterization is presented in three sections. The methods are presented in Section 6.5.1. The results are presented in Section 6.5.2. Remedial goal options (RGOs) are presented for potential chemicals of concern in Section 6.5.3.

6.5.1 Methods

Two methods were employed to evaluate risk: Method one determines potential carcinogenic risks and the other method estimates non-carcinogenic risks.

6.5.1.1 Methods for Estimation of Carcinogenic Risks

Carcinogenic risks can be estimated by combining information on the strength or potency of a known or suspected carcinogen (carcinogenic slope factor [CSF]) with an estimate of the individual exposure doses (or intakes) of a chemical. Carcinogenic risk may be estimated as follows:

$$Risk = CSF \times Dose$$

where:

CSF = carcinogenic slope factor $(mg/kg–day)^{-1}$

Dose = amount of a contaminant absorbed by a receptor in mg/kg–day

The equation presented above, however, is valid only at risk levels less than or equal to 1E-02. When the risk estimate is expected to be greater than 1E-02, an alternate equation, such as the following one-hit equation may be used to estimate risk (USEPA, 1989a):

$$Risk = 1 - exp(-Dose \times CSF)$$

where:

exp = exponential

The resultant cancer risk value (i.e., a 1E-06 or 1-in-1,000,000 incremental or excess chance or probability of an individual developing cancer) can be applied to a given population to determine

the number of excess cases of cancer that could be expected to result from exposure to environmental contaminants at the site (i.e., 1E-06 is one additional or excess case of cancer in 1,000,000 exposed persons).

The total risk resulting from exposure to multiple compounds in a particular medium is the sum of the cancer risks for the contaminants in that medium. Cancer risks will be summed for each medium for an individual receptor if the following assumptions are met:

- There are no antagonist/synergistic effects between chemicals;
- All chemicals produce the same result (cancer); and
- Cancer risks from various exposure routes (i.e., ingestion and dermal) are additive, if the exposed populations are the same (USEPA, 1989a).

To interpret the quantitative risk estimates and to aid risk managers in determining the need for remediation, quantitative risk estimates are compared to typical USEPA and Ohio EPA risk benchmarks. The USEPA has defined a "target cancer risk" range of 1E-06 to 1E-04. Incremental lifetime cancer risks (ILCRs) below 1E-06 are generally considered acceptable risks. ILCRs above 1E-04 are considered unacceptable risks. Risk management decisions are necessary for ILCRs between 1E-06 and 1E-04. The Ohio EPA cumulative cancer risk benchmark is 1E-05 and will be considered by the risk managers when making risk decisions for sites at RVAAP.

6.5.1.2 Methods for Estimation of Non-carcinogenic Risks

Potential health risks resulting from exposure to non-carcinogenic compounds are estimated by comparing the reasonable maximum daily intake dose calculated for an exposure to an acceptable intake dose, such as a chronic or subchronic RfD. The ratio of the exposure dose (intake) to the RfD is referred to as the hazard quotient (HQ):

$$HQ = Dose/RfD$$

If HQ exceeds unity, there is a potential health risk associated with exposure to that chemical (USEPA, 1989a). The Dose/RfD ratio is not a mathematical prediction of the severity or probability of toxic effects; it is simply a numerical indicator of the potential for adverse effects. The summation of HQs for several compounds is referred to as the Hazard Index (HI).

The summation of HQs for several compounds (i.e., the summing of the Dose/RfD ratios for those compounds) is referred to as the Hazard Index (HI) (USEPA, 1989a). The HI provides an indication of the potential impact of receptor exposure to multiple non-carcinogenic compounds (i.e., the cumulative risk). This is important in human health risk assessment because receptors are rarely exposed to one chemical only at a time. HIs calculated on a target organ/target effect basis provide the most accurate estimation of the potential for adverse non-carcinogenic risk. .For example, the Dose/RfD ratios for those chemicals affecting the liver should be summed

separately from those chemicals affecting the central nervous system. Target organ/target effect specific HIs are most appropriate because the RfD which is the basis of the HQ is also determined on a target organ/target effect basis. RfDs are typically based on the most sensitive target organ or target effect identified in the toxicity studies conducted to develop the criteria. A HI greater than 1 (developed on a target organ/target effect specific basis) indicates potential adverse non-carcinogenic health effects (USEPA, 1989a).

The chemicals of concern (COCs) for a given medium are defined as those contaminants that contribute total cancer risk for a receptor greater than 1E-05 and/or HIs greater than 1.0 within a land use scenario, and that are not eliminated by risk managers after considering the information in the uncertainty analysis.

6.5.2 Risk Characterization Results

A summary of the risk characterization for LL–6 is presented in this section. Total non-carcinogenic and carcinogenic risks for each exposure route, as well as the cumulative risks for each receptor, are presented in Appendix V (Tables 9.1 through 9.7) and summarized in Table 6–12. The following receptors were evaluated:

- Security guard/maintenance worker,
- National Guard resident trainer,
- National Guard fire/dust suppression worker,
- Hunter/trapper, and
- Hypothetical future resident farmer (adult and child).

Example calculations and relevant risk calculation spreadsheets are presented in Appendix V. It should be noted that, although the risk estimates provided in Appendix V are presented using two significant figures, final receptor risk estimates are presented in the following narrative in terms of one significant figure as recommended by *RAGS Part A* (USEPA , 1989a).

6.5.2.1 Non-carcinogenic Risks for LL–6

HIs developed for the aforementioned receptors and presented in the referenced tables were as shown in Table 6–12:

Table 6–12
Non-Carcinogenic Risks for LL–6

Receptor[(1)]	Media	Hazard Index	Table in Appendix V
Security Guard			
Maintenance Worker	Surface soil	4E-02	9.1
(Current/Future)			
National Guard Trainee	Deep surface soil	2E+00	9.2
(Future)	Sediments	6E-02	9.2
	Surface Water	1E-01	9.2
	Groundwater	2E-01	9.2
Total (All Media)		2E+00	9.2
Total (Minus deep surface soils)		4E-01	9.2
National Guard Resident Trainer	Surface soils	5E-01	9.3
(Future)	Subsurface soils	8E-02	9.3
	Sediment	3E-01	9.3
	Surface water	8E-01	9.3
	Groundwater	1E+00	9.3
Total (All Media)		3E+00	9.3
Total (All Media minus groundwater and surface water)		8E-01	9.3
National Guard Fire and Dust	Surface soils	8E-03	9.4
(Future)	Sediment	5E-03	9.4
	Surface water	5E-02	9.4
Total (All Media)		6E-02	9.4
Hunter/Trapper	Surface soils	4E-04	9.5
(Current/Future)	Sediments	1E-03	9.5
	Surface waters	8E-03	9.5
	Venison	6E-05	9.5
Total (All Media)		8E-03	9.5
Hypothetical Child Resident	Surface soils	9E-01	9.6
Farmer (Future)	Subsurface	8E-01	9.6
	Sediments	2E+00	9.6
	Surface water	3E+00	9.6
	Groundwater	5E+00	9.6
Total (All Media)		1E+01	9.6
Total (Minus GW)		6E+00	9.6
Total (Minus GW, SW, SD)		9E-01	9.6
Hypothetical Adult Resident	Surface soils	2E-01	9.7
Farmer (Future)	Subsurface soils	1E-01	9.7
	Sediments	4E-01	9.7
	Surface waters	7E-01	9.7
	Groundwater	2E+00	9.7
Total (All Media)		3E+00	9.7
Total (Minus GW)		1E+00	9.7
Total (Minus GW and SW)		5E-01	9.7

(1) More than one total risk estimate has been presented for several receptors to demonstrate the relative contribution of an environmental medium to the total risk for a receptor and because of the potential overestimation of risk that may occur when a receptor is assumed to be exposed to both surface and subsurface soils and sediments at a similar daily ingestion rate (i.e., the

National Guard Trainee, National Guard Resident Trainer, the hypothetical future farm resident). Also, risk estimates have been presented for domestic use of groundwater; however, it is very unlikely that the shallow groundwater resource at LL–6 would be used for domestic purposes.

(2) The total and subtotals for various combinations of media are provided for informational purposes to help illustrate which medium or media are responsible for the risk exceedance(s) or the majority of the exceedance.

HIs calculated for the security guard/maintenance worker, the National Guard fire/dust suppression worker, and the hunter/trapper are less than 1, indicating that adverse non-carcinogenic health effects are not anticipated under the conditions established in the exposure assessment.

HI totals are shown for all media, as well as subtotals omitting one or more media. These subtotals help illustrate which medium or media are responsible for any exceedances.

The HI for the National Guard trainee exposed to COPCs in shallow soils (0-4 foot bgs) is 2. Manganese (inhalation of air particulates route of exposure) was the only significant contributor to the non-carcinogenic risk (i.e., risk driver) for the trainee. The HI calculated by summing the HIs for all other COPCs does not exceed 1; only the HI calculated for the central nervous system (the target organ for manganese) exceeds 1. The non-cancer risk estimates for manganese are strongly affected by the particular emission factor (PEF) specified for the National Guard trainee receptor in the RVAAP FWHHRAM. This PEF and the inhalation reference dose for manganese are further discussed in Section 6.7.

HIs calculated for the National Guard resident trainer exceed 1 if it is assumed the receptor is using the shallow groundwater resource for domestic purposes and is exposed to surface water. The use of the shallow groundwater at LL–6 for domestic purposes is currently considered unlikely, although the OHARNG has expressed interest in drilling potable and non-potable wells at RVAAP. Arsenic in groundwater and manganese in surface water are the main risk drivers (i.e. the COPCs most responsible for unacceptable risk to the receptor). The National Guard Resident Trainer receptor was not required by the RVAAP FWHHRAM. This receptor was added to this HHRA following discussions with USACE and Ohio EPA because risk estimates for this receptor may assist the risk management team when making decisions for LL–6.

The HIs calculated for the child resident farmer routinely exposed to COPCs in surface soil, subsurface soil, sediment, surface water, and groundwater via the direct contact exposure pathways exceed 1. The HIs calculated for surface soil and subsurface soils do not exceed 1. Arsenic and antimony are the primary contributors to risk; HIs calculated for other COPCs evaluated do not exceed 1. The target-organ-specific HI calculated for the skin and cardiovascular system (the target organs for arsenic) exceed 1, and the target-organ-specific HIs for antimony equal 1. The HIs calculated for the child resident farmer routinely ingesting foodstuffs (also presented in Appendix V, Table 9.6) do exceed 1 for vegetable consumption only. However, there are significant sources of uncertainty attached to the risk estimates

developed for the food ingestion exposure pathway. Uncertainty Analysis of the risk estimates in discussed in Section 6.7.

The HIs calculated for the adult resident farmer routinely exposed to COPCs in surface soil, surface water, sediment, and groundwater or routinely exposed to COPCs in subsurface soil, surface water, sediment, and groundwater via the direct contact pathways exceed 1 only when it is assumed that the shallow groundwater is used for domestic purposes and the resident is exposed to surface water. The HIs calculated for the adult resident farmer routinely ingesting foodstuffs (also presented in Appendix V, Table 9.7) do exceed 1 for vegetable consumption only. However, there are significant sources of uncertainty attached to the risk estimates developed for the food ingestion exposure pathway. Uncertainty Analysis of the risk estimates in discussed in Section 6.7.

6.5.2.2 Carcinogenic Risks for LL–6

Incremental lifetime cancer risk (ILCR) estimates calculated for the aforementioned receptors are presented in Table 6–13.

Table 6–13
Incremental Lifetime Cancer Risk Results

Receptor[(1)]	Media	Cancer Risk Estimate	Table in Appendix V
Security Guard	Surface Soil	5E-06	9.1
Maintenance Worker			
(Current/Future)			
National Guard Trainee	Deep surface Soil	5E-05	9.2
(Future)	Sediment	4E-06	9.2
	Surface Water	2E-06	9.2
	Groundwater	2E-05	9.2
Total (All Media)		8E-05	9.2
National Guard	Surface Soil	1E-07	9.3
Resident Trainer (Future)	Subsurface Soil	1E-05	9.3
	Sediment	3E-05	9.3
	Surface Water	2E-05	9.3
	Groundwater	1E-04	9.3
[1]Total (All Media)		2E-04	9.3
Total (Minus GW)		5E-05	9.3
National Guard Fire	Surface Soil	2E-07	9.4
Dust/Suppression (Future)	Sediment	6E-07	9.4
	Surface Water	9E-07	9.4
Total (All Media)		2E-06	9.4
Hunter/Trapper	Surface Soil	6E-08	9.5
(Current/Future)	Sediment	2E-07	9.5
	Surface Water	8E-08	9.5
	Venison	8E-09	9.5

Table 6–13 (Continued)
Incremental Lifetime Cancer Risk Results

Receptor[1]	Media	Cancer Risk Estimate	Table in Appendix V
Total (All Media)		3E-07	9.5
Hypothetical Resident	Surface Soil	4E-05	9.8
(Future)	Subsurface Soil	5E-05	9.8
	Sediment	1E-04	9.8
	Surface Water	5E-05	9.8
	Groundwater	4E-04	9.8
Total (All media)		6E-04	9.8
Total (Minus GW)		2E-04	9.8
Total (Minus GW and SD)		9E-05	9.8

(1) More than one total risk estimate has been presented for several receptors to demonstrate the relative contribution of an environmental medium to the total risk for a receptor and because of the potential overestimation of risk that may occur when a receptor is assumed to be exposed to both surface and subsurface soils and sediments at a similar daily ingestion rate (i.e., the National Guard Trainee, National Guard Resident Trainer, the hypothetical future farm resident). Also, risk estimates have been presented for domestic use of groundwater; however, it is very unlikely that the shallow groundwater resource at LL–6 would be used for domestic purposes.

(2) The total and subtotals for various combinations of media are provided for informational purposes to help illustrate which medium or media are responsible for the risk exceedance(s) or the majority of the exceedance.

ILCR estimates calculated for the hunter/trapper do not exceed 1E-06, the conservative end of the USEPA target risk range. The cancer risk estimates for the security guard/maintenance worker and the National Guard fire/dust suppression worker are within the USEPA target risk range of 1E-06 to 1E-04 and do not exceed the Ohio EPA cancer risk benchmark of 1E-05. Only the cancer risk estimate calculated for arsenic exceeds 1E-06.

Cancer risk estimates for the National Guard resident trainer are within the USEPA target risk range of 1E-06 to 1E-04, but they exceed the Ohio EPA cancer risk benchmark of 1E-05 when groundwater and surface soil are evaluated as media of concern. Risk estimates summed for receptor exposure to sediment and surface water do not exceed 1E-05. Ingestion of arsenic in groundwater account for 2.1E-05 of the total cancer risk estimate for the National Guard trainee. The estimates for inhalation of arsenic in deep surface soil are strongly affected by the PEF specified for the National Guard resident trainer receptor in the RVAAP FWHHRAM. The RVAAP recommends a PEF of 1.67E+06 m^3/kg for the National Guard trainee, whose activities are considered likely to generate more airborne dust than normal. This PEF was calculated from a dust loading factor (DLF) of 600 µg/m^3. This DLF value greatly exceeds the National Ambient Air Quality Standards (NAAQS) particulate matter ≤10 microns in diameter (PM10), 24 hr and annual standards of 150 µg/m^3 and 50 µg/m^3, respectively. While it is possible that National Guard activities could generate significant PM10 concentrations for short periods of time and at locations adjacent to vehicles, it is very unlikely that these activities would generate

such concentrations for extended periods of time and across the entire site. This PEF is further discussed in Section 6.7. Although arsenic, antimony, bis(2–ethylhexyl)phthalate, and 4–nitroaniline were evaluated as COPCs, only the cancer risk estimates for arsenic exceed 1E-06.

Cancer risk estimates for the hypothetical future resident farmer (combined adult and child) exceed the USEPA target risk. Combined adult and child describe a child who matures and remains on site for an entire lifetime. Risk estimates developed for groundwater, surface soils, subsurface soils, surface water, or sediment equal or exceed the Ohio EPA 1E-05 risk benchmark. The risk estimates developed for groundwater and sediment exceed 1E-04. A review of the media and chemical-specific risk results indicate the following chemicals are primary contributors to the estimated cancer risk:

- Arsenic is the primary risk driver in soil, sediment, surface water and groundwater. Risk drivers are the most significant risk contributors and are typically those COPCs whose contribution to the risk estimates causes the overall receptor or media risk to exceed federal or state risk benchmarks. However, only the risk estimates calculated for arsenic in groundwater and sediment exceed 1E-04. The risk estimate for arsenic in soils exceeds 1E-05; the risk estimate for arsenic in surface water equals 1E-06. EPCs of arsenic in surface soil (13.2 mg/kg), subsurface soil (14.4 mg/kg), and deep surface soil (13.3 mg/kg) were less than their respective RVAAP installation background criteria concentrations (15.4 mg/kg, 19.8 mg/kg, and 15.4 mg/kg). The maximum arsenic concentration in groundwater (13 µg/L) only slightly exceeded the RVAAP installation background criteria of 11.7 µg/L.
- The risk estimates for benzo(a)pyrene in subsurface soil and groundwater exceed 1E-06, but do not exceed 1E-05.

The ILCR calculated for the National Guard resident trainer exceeds the USEPA target cancer risk range of 1E-06 to 1E-04 only when it is assumed the shallow groundwater is used as a domestic water supply and arsenic is evaluated as a COPC for groundwater. The cancer risk estimate developed for COPC concentrations in surface soil does not exceed 1E-05. Although arsenic, antimony, benzo(a)pyrene, bis(2–ethylhexyl)phthalate, and 4–nitroaniline are evaluated as COPCs, only the risk estimates for arsenic (surface soil, sediment, surface water) and benzo(a)pyrene (subsurface soils, groundwater) exceed 1E-06. Only the risk estimates developed for arsenic exceed 1E-05. The National Guard resident trainer receptor was not required by the RVAAP FWHHRAM. This receptor was added to this HHRA following discussions with the USACE and Ohio EPA because risk estimates for this receptor may assist the risk management team when making decisions for LL–6.

The cancer risk estimates presented for the environmental media are subject to several significant sources of uncertainty. These are further discussed in Section 6.7. Section 6.7 also presents an evaluation of the ingestion of foodstuffs exposure pathways. There is a significant amount of uncertainty attached to the risk assessment evaluation of the foodstuffs ingestion

exposure pathway. Frequently, risk estimates based on RVAAP installation background criteria concentrations of chemicals exceed the risk benchmarks when these pathways are evaluated.

6.5.2.3 Summary of COCs for All Media/Receptors

Chemicals of concern (COCs) are the COPCs that significantly contribute to a pathway in a use scenario for a receptor that either exceeds the 1E-05 cumulative cancer risk benchmark or exceeds a non-carcinogenic HI (target-organ-specific) of 1.0. A summary of COCs for each of the land use/receptor/medium combinations with COCs is presented in Table 6–14. Remedial goal options (RGOs) are calculated and presented in Section 6.6 for the potential COCs identified in the risk evaluation.

6.5.2.4 Lead Exposure Analysis

The maximum lead concentration (83 µg/L) in surface water exceeded the SDWA action level of 15 µg/L for residential land use. Lead was not selected as a COPC in any other medium. Concentrations of lead exceeded the action level in two samples. Exposures to lead are evaluated using arithmetic mean concentrations (USEPA, 1994c). The mean concentration of lead in surface water (23.1 µg/L) is slightly above the action level of 15 µg/L, indicating that using surface water as a drinking water source may be of some concern at LL–6. However, surface water in the ditches and the small pond at LL–6 will not be used as a drinking water source. Dermal contact − bathing and showering, and washing dishes or clothes − should be safe even if the water contains lead concentrations that exceed the USEPA action level. Human skin does not absorb lead from the water (MWCOG, 2004).

6.6 Remedial Goal Options

RGOs are developed for each direct-contact exposure COC (i.e., not for COCs identified for the foodstuff exposure pathways). RGOs are risk-based concentrations that may be used in future risk-based decision making. RGOs are estimated using the methods, equations, and parameters for estimating COPC intake shown in Appendix V (Tables 4.1 through 4.31) as well as the CSFs and RfDs shown in Appendix V (Tables 5.1 and 6.1.). The cancer risk (or hazard quotient) equation was rearranged to determine (i.e., to solve for) the concentration that would result in a specified risk or hazard. As discussed in Section 6.5.1, the cancer risk estimate and non-cancer hazard indices are calculated as:

$$\text{Cancer Risk Estimate} = \text{Intake} \times \text{CSF}$$

$$\text{Hazard Index} = \text{Intake} / \text{RfD}$$

Therefore, for a specified risk or hazard, the allowable intake may be determined as follows:

$$\text{Intake} = \text{Cancer Risk Estimate} / \text{CSF}$$

$$\text{Intake} = \text{Hazard Index} \times \text{RfD}$$

Table 6–14
Potential Land Use/Receptor/Medium Pathways for COCs

Pathway	Surface Soil		Subsurface Soil	Surface Water		Sediment	Groundwater	Soil - Beef	Soil - Milk	Soil - Vegetables		
	As	Mn	As	As	Mn	As	As	As	As	Al	As	Mn
Security Guard/Maintenance Worker			--	--	--	--	--	--	--	--	--	--
National Guard Trainee	--	X	--				X	--	--	--	--	--
National Guard Resident				X		X	X	--	--	--	--	--
National Guard Fire/Dust			--				--	--	--	--	--	--
Hunter			--				--	--	--	--	--	--
Child Resident Farmer					X	X	X			X	X	X
Adult Resident Farmer							X			X	X	X
Lifelong Resident Farmer	X		X	X		X	X	X	X		X	

No COCs were identified for direct contact with surface water and ingestion of venison.

As - Arsenic
Mn - Manganese
"X" indicates chemical is a COC for receptor/medium
"--" indicates pathway not applicable in this BHHRA.
A blank indicates chemical is not identified as a COC for receptor/medium.

The COPC intake equations shown in Appendix V (Tables 4.1 through 4.31) are then rearranged to determine the allowable concentration, or RGO, for a specified risk level (i.e., the RGO associated with the 1E-06 risk level).

RGOs are determined for each medium and land use/receptor scenario. For example, the RGO for arsenic in surface soil at the cancer risk level of 1E-04 for the National Guard trainee receptor is the concentration of arsenic that produces a risk of 1E-04 when using the exposure parameters specified for the National Guard trainee receptor, as shown in Appendix V, Table 4.1.

Direct-contact soil RGOs were not evaluated with regard to residual soil contaminants leaching to groundwater. This pathway is considered not to be significant, as discussed in Section 5.3.2.

For example, the ingestion of surface soil, the RGO is determined as:

$$Cs = \frac{TR \times BW \times AT}{IR \times FI \times ET \times EF \times ED \times (CSF \text{ or } 1/RfD)}$$

Where:
- Cs = concentration in soil (RGO)
- TR = target risk (or hazard)
- BW = body weight
- AT = averaging time
- IR = ingestion rate of soil
- FI = fraction ingested
- ET = exposure time
- EF = exposure frequency
- ED = exposure duration
- CSF = cancer slope factor
- RfD = reference dose

Calculated RGOs that are not physically possible are adjusted accordingly. For example, a concentration of 1E+06 indicates a 100 percent pure substance; thus, a calculated RGO can not exceed 1,000,000 parts per million. RGOs are calculated for each exposure route (i.e., ingestion), as well as the total risk or hazard for each chemical identified as a COC in an environmental medium. Carcinogenic RGOs are calculated for risk levels of 1E-04, 1E-05, and 1E-06. Non-carcinogenic RGOs are calculated for hazard quotients of 0.1 and 1.0.

The potential COCs identified for groundwater, subsurface soil, sediment, and surface soil are shown in Table 6–11. RGOs are calculated for all receptor/medium combinations that have been evaluated in this BHHRA. For example, although manganese is not a surface water COC for the resident farmer receptor, surface water RGOs for manganese are calculated for the resident farmer.

RGOs for the surface soil COC for direct-contact exposure (arsenic) were calculated for all receptors and presented in Table 6–15. There are no COCs for the direct-contact exposure for the National Guard trainee exposed to deep surface soil (0-4 ft bgs). RGOs for the surface water COCs [arsenic and manganese] were calculated for the hunter/trapper, the National Guard trainee, the National Guard resident trainer, the National Guard fire/dust suppression worker, and the resident farmer receptors and presented in Table 6–16. RGOs for the subsurface soil COC [arsenic] were calculated for the National Guard resident trainer, and the resident farmer receptors and presented in Table 6–17. RGOs for the groundwater COC [arsenic] were calculated for the National Guard trainee, the National Guard resident trainer, and the resident farmer receptors and presented in Table 6–18. RGOs for the sediment COC [arsenic] were calculated for the hunter/trapper, the National Guard trainee, the National Guard resident trainer, the National Guard fire/dust suppression worker, and the resident farmer receptors and presented in Table 6–19. RGOs for the deep surface soil COC [arsenic] were calculated for the National Guard trainee and presented in Table 6–20.

6.7 Uncertainty Analysis

A significant uncertainty is the fact that the nature and extent of the contamination in soil, sediment, surface water, and groundwater at LL-6 have not been completely defined. Therefore, the results of the human health risk assessment presented in Section 6 (and the associated uncertainties) are preliminary and subject to change based on the data collected in the Phase II RI. This section summarizes uncertainties inherent in the risk assessment and includes a discussion of how they may affect the quantitative risk estimates and conclusions of the risk analysis. This BHHRA for LL–6 was performed in accordance with current USEPA and RVAAP guidance and the aforementioned White Paper developed for LL–6. However, there are varying degrees of uncertainty associated with the BHHRA. The following subsections discuss general uncertainties in risk assessment and uncertainties specific to the risk assessment for LL–6.

Uncertainty in the selection of COPCs is related to the current status of the predictive databases, the grouping of samples, and the procedures used to include or exclude constituents as COPCs. Uncertainty associated with the exposure assessment includes the values used as input variables for a given intake route/scenario, the assumptions made to determine exposure point concentrations, and the predictions regarding future land use and population characteristics. Uncertainty in the toxicity assessment includes the quality of the existing toxicity data needed to support dose-response relationships and the weight-of-evidence used for determining the carcinogenicity of COPCs. Uncertainty in the risk characterization includes that associated with exposure to multiple chemicals and the cumulative uncertainty arising from combining conservative assumptions made in earlier steps of the risk assessment process.

Table 6–15
Surface Soil (0–1 ft bgs) RGOs

	Ingestion					Dermal					Inhalation					Total Across All Pathways				
COC	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4
Security Guard/Maintenance Worker																				
Arsenic	4.91E+02	4.91E+03	3.05E+01	3.05E+02	3.05E+03	4.42E+01	4.42E+02	2.75E+00	2.75E+01	2.75E+02			2.12E+04	2.12E+05	1.00E+06	4.06E+01	4.06E+02	2.52E+00	2.52E+01	2.52E+02
Hunter/Trapper																				
Arsenic	1.02E+04	1.02E+05	5.30E+02	5.30E+03	5.30E+04	7.47E+03	7.47E+04	3.87E+02	3.87E+03	3.87E+04			2.07E+05	1.00E+06	1.00E+06	4.32E+03	4.32E+04	2.24E+02	2.24E+03	2.24E+04
National Guard Resident																				
Arsenic	3.04E+01	3.04E+02	1.89E+00	1.89E+01	1.89E+02	1.03E+02	1.03E+03	6.42E+00	6.42E+01	6.42E+02			5.73E+02	5.73E+03	5.73E+04	2.35E+01	2.35E+02	1.46E+00	1.46E+01	1.46E+02
National Guard Fire Dust																				
Arsenic	2.04E+03	2.04E+04	1.27E+02	1.27E+03	1.27E+04	1.72E+03	1.72E+04	1.07E+02	1.07E+03	1.07E+04			7.09E+01	7.09E+02	7.09E+03	9.34E+02	9.34E+03	3.20E+01	3.20E+02	3.20E+03
Resident Child Farmer																				
Arsenic	2.33E+00	2.33E+01				3.56E+01	3.56E+02									2.18E+00	2.18E+01			
Resident Adult Farmer																				
Arsenic	2.17E+01	2.17E+02				3.20E+01	3.20E+02									1.29E+01	1.29E+02			
Resident Farmer																				
Arsenic			3.93E-01	3.93E+00	3.93E+01			1.41E+00	1.41E+01	1.41E+02			3.54E+02	3.54E+03	3.54E+04			3.07E-01	3.07E+00	3.07E+01

RGO = Remedial Goal Option
COC = Chemical of Concern
HQ = Hazard Quotient
HI = Hazard Index
All units in mg/kg

Table 6–16
Surface Water RGOs

	Ingestion					Dermal					Inhalation					Total Across All Pathways				
COC	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4
National Guard Trainee																				
Arsenic	1.97E+02	1.97E+03	1.22E+01	1.22E+02	1.22E+03	3.10E+03	3.10E+04	1.90E+02	1.90E+03	1.90E+04						1.85E+02	1.85E+03	1.15E+01	1.15E+02	1.15E+03
Manganese	1.57E+04	1.57E+05				9.60E+03	9.60E+04									5.96E+03	5.96E+04			
National Guard Resident																				
Arsenic	3.07E+01	3.07E+02	1.91E+00	1.91E+01	1.91E+02	4.70E+02	4.70E+03	3.00E+01	3.00E+02	3.00E+03						2.88E+01	2.88E+02	1.79E+00	1.79E+01	1.79E+02
Manganese	2.45E+03	2.45E+04				1.50E+03	1.50E+04									9.31E+02	9.31E+03			
National Guard Fire Dust																				
Arsenic	5.11E+02	5.11E+03	3.18E+01	3.18E+02	3.18E+03	4.00E+03	4.00E+04	2.50E+02	2.50E+03	2.50E+04						4.53E+02	4.53E+03	2.82E+01	2.82E+02	2.82E+03
Manganese	4.09E+04	4.09E+05				1.30E+04	1.30E+05									9.86E+03	9.86E+04			
Hunter/Trapper/Fisher																				
Arsenic	7.67E+03	7.67E+04	3.97E+02	3.97E+03	3.97E+04	3.80E+04	3.80E+05	2.00E+03	2.00E+04	2.00E+05						6.38E+03	6.38E+04	3.32E+02	3.32E+03	3.32E+04
Manganese	1.00E+05	1.00E+06				1.00E+05	1.00E+06									5.00E+04	5.00E+05			
Resident Child Farmer																				
Arsenic	4.69E+00	4.69E+01				8.53E+02	8.53E+03									4.67E+00	4.67E+01			
Manganese	7.29E+02	7.29E+03				5.35E+03	5.35E+04									6.42E+02	6.42E+03			
Resident Adult Farmer																				
Arsenic	2.18E+01	2.18E+02				1.54E+03	1.54E+04									2.15E+01	2.15E+02			
Manganese	3.41E+03	3.41E+04				9.55E+03	9.55E+04									2.51E+03	2.51E+04			
Resident Farmer																				
Arsenic			5.99E-01	5.99E+00	5.99E+01			5.87E+01	5.87E+02	5.87E+03								5.93E-01	5.93E+00	5.93E+01
Manganese																				

RGO = Remedial Goal Option
COC = Chemical of Concern
HQ = Hazard Quotient
HI = Hazard Index
All units in ug/L

Table 6–17
Subsurface Soil RGOs

	Ingestion					Dermal					Inhalation					Total Across All Pathways				
COC	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4
National Guard Resident																				
Arsenic	3.04E+01	3.04E+02	1.89E+00	1.89E+01	1.89E+02	1.03E+02	1.03E+03	6.42E+00	6.42E+01	6.42E+02			5.88E+02	5.88E+03	5.88E+04	2.35E+01	2.35E+02	1.46E+00	1.46E+01	1.46E+02
Resident Child Farmer																				
Arsenic	2.33E+00	2.33E+01				3.56E+01	3.56E+02									2.18E+00	2.18E+01			
Resident Adult Farmer																				
Arsenic	2.17E+01	2.17E+02				3.20E+01	3.20E+02									1.29E+01	1.29E+02			
Resident Farmer																				
Arsenic			3.93E-01	3.93E+00	3.93E+01			1.41E+00	1.41E+01	1.41E+02			3.54E+02	3.54E+03	3.54E+04			3.07E-01	3.07E+00	3.07E+01

RGO = Remedial Goal Option
COC = Chemical of Concern
HQ = Hazard Quotient
HI = Hazard Index
All units in mg/kg

Table 6–18
Groundwater RGOs

	Ingestion					Dermal					Inhalation					Total Across All Pathways				
COC	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4
National Guard Trainee																				
Arsenic	9.83E+00	9.83E+01	6.11E-01	6.11E+00	6.11E+01	4.10E+03	4.10E+04	2.60E+02	2.60E+03	2.60E+04						9.80E+00	9.80E+01	6.10E-01	6.10E+00	6.10E+01
National Guard Trainer																				
Arsenic	1.53E+00	1.53E+01	9.54E-02	9.54E-01	9.54E+00	6.50E+02	6.50E+03	4.00E+01	4.00E+02	4.00E+03						1.53E+00	1.53E+01	9.52E-02	9.52E-01	9.52E+00
Resident Child Farmer																				
Arsenic	3.13E-01	3.13E+00				2.17E+02	2.17E+03									3.12E-01	3.12E+00			
Resident Adult Farmer																				
Arsenic	1.10E+00	1.10E+01				4.60E+02	4.60E+03									1.09E+00	1.09E+01	5.66E-02	5.66E-01	5.66E+00
Resident Farmer																				
Arsenic			3.34E-02	3.34E-01	3.34E+00			1.69E+01	1.69E+02	1.69E+03								3.33E-02	3.33E-01	3.33E+00

RGO = Remedial Goal Option
COC = Chemical of Concern
HQ = Hazard Quotient
HI = Hazard Index
All units in ug/L

Table 6–19
Sediment RGOs

	Ingestion					Dermal					Inhalation					Total Across All Pathways				
COC	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4
Hunter/Trapper																				
Arsenic	1.02E+04	1.02E+05	5.30E+02	5.30E+03	5.30E+04	8.19E+03	8.19E+04	4.25E+02	4.25E+03	4.25E+04			3.67E+05	1.00E+06	1.00E+06	4.55E+03	4.55E+04	2.36E+02	2.36E+03	2.36E+04
National Guard Trainee																				
Arsenic	1.95E+02	1.95E+03	1.21E+01	1.21E+02	1.21E+03	6.62E+02	6.62E+03	4.12E+01	4.12E+02	4.12E+03			2.52E+03	2.52E+04	2.52E+05	1.51E+02	1.51E+03	9.34E+00	9.34E+01	9.34E+02
National Guard Trainer																				
Arsenic	3.04E+01	3.04E+02	1.89E+00	1.89E+01	1.89E+02	1.03E+02	1.03E+03	6.42E+00	6.42E+01	6.42E+02			5.73E+02	5.73E+03	5.73E+04	2.35E+01	2.35E+02	1.46E+00	1.46E+01	1.46E+02
National Guard Fire Dust																				
Arsenic	2.04E+03	2.04E+04	1.27E+02	1.27E+03	1.27E+04	1.72E+03	1.72E+04	1.07E+02	1.07E+03	1.07E+04			3.93E+04	3.93E+05	1.00E+06	9.34E+02	9.34E+03	5.80E+01	5.80E+02	5.80E+03
Resident Child Farmer																				
Arsenic	2.33E+00	2.33E+01				3.56E+01	3.56E+02									2.18E+00	2.18E+01			
Resident Adult Farmer																				
Arsenic	2.17E+01	2.17E+02				3.20E+01	3.20E+02									1.29E+01	1.29E+02			
Resident Farmer																				
Arsenic			3.93E-01	3.93E+00	3.93E+01			1.41E+00	1.41E+01	1.41E+02			3.54E+02	3.54E+03	3.54E+04			3.07E-01	3.07E+00	3.07E+01

RGO = Remedial Goal Option
COC = Chemical of Concern
HQ = Hazard Quotient
HI = Hazard Index
All units in mg/kg

Table 6–20
Deep Surface Soil (0–4ft)
RGOs for National Guard Trainee

Ingestion					
COC	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4
National Guard Trainee					
Arsenic	1.95E+02	1.95E+03	1.21E+01	1.21E+02	1.21E+03

Dermal					
COC	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4
National Guard Trainee					
Arsenic	6.62E+02	6.62E+03	4.12E+01	4.12E+02	4.12E+03

Inhalation					
COC	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4
National Guard Trainee					
Arsenic			4.55E+00	4.55E+01	4.55E+02

Total Across All Pathways					
COC	HQ = 0.1	HQ = 1.0	Risk = 10-6	Risk = 10-5	Risk = 10-4
National Guard Trainee					
Arsenic	1.51E+02	1.51E+03	3.06E+00	3.06E+01	3.06E+02

RGO = Remedial Goal Option
COC = Chemical of Concern
HQ = Hazard Quotient
HI = Hazard Index
All units in mg/kg

There are various sources of uncertainty, whether this uncertainty will lead to an underestimation or an overestimation of risk can be influenced by the assumptions made throughout the risk assessment, including selection of COPCs and selection of values for dose-response relationships. In general, assumptions, which are often based (in part) on safety factors, are made so that the final calculated risks are overestimated.

Once the risk assessment is complete, the results must be reviewed and evaluated to identify the type and magnitude of uncertainty involved. Reliance on results from a risk assessment without consideration of uncertainties, limitations, and assumptions inherent in the process can be misleading. For example, to account for uncertainties in the development of exposure assumptions, conservative estimates must be made to ensure that the particular assumptions made are protective of sensitive subpopulations or the individuals experiencing maximum exposure.

It should be noted that the COCs discussed in this section should be considered only potential COCs at this time. The final list of COCs for LL–6 will be determined in consultation with the risk management team for RVAAP.

If a number of conservative assumptions are combined in an exposure model, the resulting calculations can propagate the uncertainties associated with those assumptions, thereby producing a much larger uncertainty for the final result. This uncertainty is biased toward overpredicting both carcinogenic and non-carcinogenic risks. Thus, both the results of the risk assessment and the uncertainties associated with those results must be considered when making risk management decisions.

The evaluation of uncertainty is especially relevant when risk estimates exceed the point of regulatory departure for defining “acceptable” risk. For example, when risks calculated using a high degree of uncertainty are less than an acceptable risk level (i.e., 1E-06), the interpretation of “no significant risk” is typically straightforward. However, when risk calculated using a high degree of uncertainty exceeds an “acceptable” risk level, a conclusion can be difficult unless uncertainty is considered, especially when the exceedance of acceptable risk is relatively “marginal.”

6.7.1 Uncertainties Associated with COPC Selection

The following issues may contribute to uncertainty in COPC selection for LL–6: the existing database, the inclusion of chemicals potentially attributable to background, the screening levels used, the absence of screening levels for a few chemicals detected in the site media, and frequency of detection. Each of these issues is briefly discussed in the remainder of this subsection.

6.7.1.1 Existing Databases

All data used for this evaluation have been validated according to guidelines. Therefore, uncertainties associated with the quality of the data are considered to be minimal. The field sampling program was biased toward areas most likely to demonstrate contamination; thus, risks based on these biased data may be overestimated.

Some media samples collected during the LL–6 investigation were sent to a second laboratory, GPL, for explosive screening analysis, instead of screening for explosives by Jenkins method as outlined in the *SAP Addendum* (MKM, 2003b). Because the GPL method is unproven, data results from this screening are presented in appendices, but were not used in any risk evaluations. Surface soil data are presented in Appendix E. Subsurface soil data are presented in Appendix J. Sediment data are presented in Appendix P. There were no detections of chemicals in the GPL data; therefore, omission of the GPL method data from risk evaluations does not alter any conclusions or results.

6.7.1.2 Chemicals Potentially Attributable to Background

The concentrations of chemicals in background samples collected for RVAAP were determined as described in RVAAP WBG Phase II Remedial Investigation (SAIC, 2001). Outliers – results exceeding an upper cutoff limit – were removed from the RVAAP installation background criteria data set. The upper cutoff limit was the third quartile (the 75th percentile) plus 1.5 times the inter-quartile range. An outlier might indicate a mistake in the data set; however, it might also represent a perfectly valid but rare result. Therefore, some greater background values were conservatively removed from the data set. This omission could result in facility background screening values that are overly conservative and a chemical being be selected as a COPC even though it is not present at concentrations exceeding RVAAP installation background criteria.

The maximum concentrations of some of the COPCs exceed the RVAAP installation background criteria only slightly and may actually reflect background conditions. For example, EPCs of arsenic in surface soil (13.2mg/kg), subsurface soil (14.4 mg/kg), and deep surface soil (13.3 mg/kg) were less than their respective RVAAP installation background criteria concentrations (15.4 mg/kg, 19.8 mg/kg, and 15.4 mg/kg). The maximum arsenic concentration in groundwater (13 µg/L) only slightly exceeded the RVAAP installation background criteria of 11.7 µg/L. Only 5 of 75 samples in deep surface soil had detected aluminum concentrations above RVAAP installation background criteria, and the EPC for aluminum in deep surface soil was less that its RVAAP installation background criteria concentration. Finally, benzo(a)pyrene was detected in RVAAP installation background criteria soil samples at a maximum concentration of 100 µg/kg. The maximum detected concentration in subsurface soils was 200 µg/kg. As indicated previously, the PAH concentrations detected in LL–6 soils and sediments are within the range of background anthropogenic concentrations reported in the literature (ATSDR, 1995). However, for purposes of human health risk assessment, it was assumed that

benzo(a)pyrene was not detected in the background soil data set for the RVAAP. In addition, the background for benzo(a)pyrene at RVAAP was set at zero.

6.7.1.3 COPC Screening Levels

The use of risk-based screening values should ensure that the significant contributors to risk from a site are not eliminated but are retained for risk evaluation. COPC screening values were based on conservative land use scenarios (i.e., residential land use for soil) and protective levels of risk corresponding to an ILCR of 1E-06 and an HI of 0.1. For example, as discussed in Section 6.2, several non-carcinogenic chemicals (i.e., aluminum and vanadium in surface soils) selected as COPCs were not detected in environmental media at concentrations exceeding the PRGs.

In addition, the toxicity values used in the derivation of PRGs are subject to change as additional information (from scientific research) becomes available. These periodic changes in toxicity values may cause the PRG values to change as well.

6.7.1.4 Absence of COPC Screening Levels

Essential human nutrients (i.e., magnesium, potassium, calcium, and sodium) do not have screening levels in this report and in general. These nutrients were eliminated from consideration as COPCs. Exclusion of these chemicals as COPCs is not expected to add significant uncertainty to the risk estimates.

6.7.1.5 Frequency of Detection

No chemicals were eliminated as SRCs or COPCs on the basis of frequency of detection. However, a few chemicals with low frequency of detection (FOD), although greater than 5%, were retained as SRCs and COPCs. These include 4–nitroaniline and bis(2–ethylhexyl)phthalate detected in 1 of 6 groundwater samples and 2 of 6 groundwater samples, respectively. These were retained as COPCs, leading to possible overestimation of risk.

6.7.1.6 Data Analysis

Uncertainty can be added to the risk estimates by limitations in the analytical methods. Some current analytical methods are limited in their ability to achieve detection limits at or below the PRG concentrations. Risks may be overestimated when some analyte concentrations are reported as non-detected at the method detection limit, but the actual concentration is much less than the method detection limit. Conversely, risks may be underestimated when some analytes are present, even at concentrations exceeding the PRG, but are not detected because of limitations in the analytical methods and are therefore removed from the SRC list.

6.7.2 Uncertainties Associated with the Exposure Assessment

Uncertainty in the exposure assessment arises because of the methods used to calculate exposure point concentrations, the selection of receptors, the selection of land use scenarios to be evaluated, and the selection of exposure parameters.

6.7.2.1 Land Use

The current land use patterns of LL–6 are established, thereby reducing the uncertainty associated with current land use assumptions. The potential future land use patterns of LL-6 include those described in the RVAAP FWHHRAM or the use of the area for an engineering school. This BHHRA is based on these known and anticipated future land use scenarios; therefore, the land use assumptions presented herein are not expected to lead to an underestimation of risk.

Many of the exposure parameters for the resident farmer are unrealistic. It is assumed that all beef, milk, and vegetables eaten by the resident will come from the site, i.e., that none will be provided by outside sources.

6.7.2.2 Exposure Point Concentration

The maximum concentration of some COPCs was used as the EPC to quantify potential risks (i.e., all COPCs in sediments, surface water, groundwater; and benzo[a]pyrene in soils). Risk estimates are likely to be overestimated when the maximum detected concentration is selected as the EPC because it is unlikely that potential receptors would be exposed to the maximum concentration over the entire site for the assumed exposure period.

For most media (groundwater, surface water, sediment, and organics in surface soil and subsurface soil), few samples (less than 10) were collected. The use of small data sets may introduce an additional uncertainty both in the COPC selection and in the calculated risks.

6.7.2.3 Exposure Parameters

The exposure assessment factors (i.e., exposure frequency and duration) are based on reasonable maximum exposure (RME) assumptions. Generally, exposure factors are based on surveys of physiological and lifestyle profiles across the United States. The attributes and activities studied in these surveys generally have a broad distribution. To avoid underestimation of potential risks, RME exposure factors values were used in this risk evaluation. Therefore, the risk is not likely to be underestimated for reasonably maximum exposed individuals and is more likely to be overestimated for the general populations exposed to the chemicals in the environmental media at the sites.

A PEF of 9.24E+08 m^3/kg was calculated using the methods in USEPA's soil screening guidance (USEPA, 1996) and site-specific factors for Cleveland, Ohio, the city nearest Ravenna for which USEPA had provided parameters to estimate PEF and volatilization factor (VF) values. This PEF was used to evaluate most receptors in this BHHRA. However, the RVAAP recommends a PEF of 1.67E+06 m^3/kg for the National Guard trainee, whose activities are considered more likely to generate more airborne dust than the activities of other receptors. The FWHHRAM states that this PEF was calculated from a dust loading factor (DLF) of 600 µg/m^3. This value greatly exceeds the NAAQS PM10 24-hour and annual standards of 150 µg/m^3 and 50 µg/m^3, respectively. While it is possible that National Guard activities could generate significant PM10 concentrations for short periods of time and at locations adjacent to vehicles, it is very unlikely that these activities would generate ambient air particulate emissions for extended periods of time and across the entire site, especially at concentrations that exceed the NAAQS. As a point of comparison, the use of the methods and default values for estimating dust emissions associated with construction activities in the USEPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (December, 2002), results in a DLF of 364 µg m^3. The HIs for the National Guard trainee calculated for COPC concentrations in the LL–6 deep surface soil and sediments using this guidance would be approximately half those presented in Section 6.5.

For the dermal-contact-with-soil pathway, no exposure time is included in the equation. This would indicate the receptor did not bathe (i.e., remove the soil on the skin surface) for the full day. This may overestimate the risk associated with dermal contact with soil. This fact is especially important when the dermal pathway is the major contributor to the risks and/or hazards.

Given climatic conditions in the eastern Ohio region, the assumption of 250 days per year and 350 days per year exposure frequency for the National Guard resident trainer and the hypothetical future resident farmer, respectively, for soils and sediments likely results in an overestimation of risk because no exposure is likely to occur when these media are covered with snow or frozen solid. Consequently, risks calculated using these exposure assumptions are likely overestimated. Likewise, the assumption of 250 days per year exposure frequency for the National Guard resident trainer for surface water is very conservative for eastern Ohio and may lead to an overestimation of risk. This is important to note because exposure to surface water was calculated to be a significant contribution to risk for the National Guard resident trainer.

6.7.3 Uncertainties Related to Toxicity Information

Uncertainties associated with the toxicity assessment include the derivation of the RfDs and CSFs from which the PRGs are calculated and limitations associated with the use of available criteria as presented in this section.

6.7.3.1 Derivation of Toxicity Criteria

Uncertainty is associated with hazard assessment and dose-response evaluations. The hazard assessment discusses characterizing the nature and strength of the evidence of causation, or the likelihood that a chemical that induces adverse effects in animals will also induce adverse effects in humans. Hazard assessment of carcinogenicity is evaluated as a weight-of-evidence determination, using the USEPA methods. Positive animal cancer test data suggests that humans contain tissue(s) that may manifest a carcinogenic response; however, the animal data cannot necessarily be used to predict the target tissue in humans. In the hazard assessment of non-cancer effects, however, the positive animal data often suggest the nature of the effects (i.e., the target tissues and type of effects) anticipated for humans.

Uncertainty in hazard assessment arises from the nature and quality of the animal and human data. Uncertainty is reduced when similar effects are observed across species, strain, sex, and exposure route; when the magnitude of the response is clearly dose-related; when pharmacokinetic data indicate a similar fate in humans and animals; when postulated mechanisms of toxicity are similar for humans and animals; and when the COC is structurally similar to other chemicals for which the toxicity is more completely characterized.

Uncertainty in the dose-response evaluation is associated with the determination of a CSF for the carcinogenic assessment and derivation of an RfD or RfC for the non-carcinogenic assessment. Uncertainty introduced from interspecies (animal to human) extrapolation, which, in the absence of quantitative pharmacokinetic or mechanistic data, is usually based on consideration of interspecies differences in basal metabolic rate. Uncertainty also results from intraspecies variation. Most toxicity experiments are performed with animals that are very similar in age and genotype, so that intragroup biological variation is minimal; but the human population of concern may reflect a great deal of heterogeneity including unusual sensitivity or tolerance to the COPC. Even toxicity data from human occupational exposure reflect a bias because only those individuals sufficiently healthy to attend work regularly (the healthy worker effect) and those not unusually sensitive to the chemical are likely to be occupationally exposed.

Finally, uncertainty arises from the quality of the study from which the quantitative estimate is derived and the database. For cancer effects, the uncertainty associated with dose-response factors is mitigated by assuming the 95% upper bound for the slope factor. Another source of uncertainty in carcinogenic assessment is the method by which data from high doses in animal studies are extrapolated to the dose range expected for humans exposed to chemicals in the environment. The linearized multistage model, which is used in most quantitative estimations of human risk from animal data, is based on a non-threshold assumption of carcinogenesis. Evidence suggests, however, that epigenetic carcinogens, as well as many genotoxic carcinogens, have a threshold below which they are non-carcinogenic (Williams and Welsburger, 1991); therefore, the use of the linearized multistage model is conservative for chemicals that exhibit a threshold for carcinogenicity.

For non-cancer effects, additional uncertainty factors may be applied in the derivation of the RfD or RfC to mitigate poor quality of the key study group or gaps in the database. Uncertainty factors are usually applied to the estimate of a no-effects level when lowest-adverse-effect level data are available. Additional uncertainty arises in estimation of an RfD or RfC for chronic exposure from subchronic data. Unless empirical data indicate that effects do not worsen with increasing duration of exposure, an additional uncertainty factor is applied to the no-effect level in the subchronic study. Uncertainty in the derivation of RfDs is mitigated by the use of uncertainty and modifying factors that normally range between 3 and 10. The application of uncertainty and modifying factors decrease the RfD and, therefore, may make the value very conservative. The conservative nature of these adjustments may result in a RfD that is overly protective of receptors evaluated in a HHRA.

The derivation of dermal RfDs and CSFs from oral values may cause uncertainty. This may occur when no gastrointestinal absorption rates are available in the literature or when only qualitative statements regarding absorption are available.

6.7.3.2 Toxicity Criteria for Arsenic

The toxicity criteria for arsenic are a major source of uncertainty for this baseline risk assessment. While conventional risk assessment methods suggest that there is no zero risk concentration for a carcinogen such as arsenic, the human body does have a limited capacity to absorb methylate arsenic, and this limit is not generally reached until the body's intake of arsenic exceeds 500 µg/day. Most environmental exposures result in intakes lower than 500 µg/day. Additionally, the USEPA suggests that an order-of-magnitude adjustment of risk (downward) may be appropriate for arsenic in some cases (USEPA, 1987a).

6.7.4 Uncertainties and Assumptions in the Risk Characterization

Uncertainty in risk characterization often results from the lack of toxicity criteria and from assumptions made regarding additivity of risk effects. For example, high uncertainty exists when summing cancer risks for several substances for different exposure pathways. This assumes that each substance has a similar effect, mode of action, or both. Often, compounds affect different organs, have different mechanisms of action, and differ in the fate in the body; therefore, additivity may not be an appropriate assumption. However, the assumption of additivity is often made to produce a conservative estimate of risk. The risk characterization also does not consider antagonistic or synergistic effects of COPCs. Antagonistic effects could mean the risk is overestimated, whereas synergistic effects could mean the risk is underestimated.

6.7.4.1 Unavailable or Provisional Toxicity Criteria

Risk-based screening levels and toxicity criteria are not available for nitrocellulose detected in LL–6 media. Because of lack of screening criteria, nitrocellulose was originally selected as a

COPC for soil, sediment, surface water and groundwater. It is evaluated qualitatively here because, according to the USEPA Office of Drinking Water, nitrocellulose is considered "relatively nontoxic" unless ingested in enormous quantities such as 10 percent of the total diet (USEPA, 2000d). Therefore, nitrocellulose was dropped from further consideration.

A provisional RfD is available for aluminum (a COPC in soils and sediment) from the National Center for Environmental Assessment (NCEA); however, it is based on typical allowable intakes rather than adverse effect levels and is not considered risk-based. This is unlikely to be a significant source of uncertainty in the risk assessment because aluminum is not a significant COPC for LL–6 (i.e., the maximum detected concentration does not exceed the PRG and the metal was detected infrequently at concentrations exceeding the RVAAP installation background criteria benchmarks). The HI from all other pathways and COPCs in deep surface soil combined is 0.47. Aluminum at a concentration equal to RVAAP installation background criteria would result in an HI of 17, and at a concentration equal to its residential PRG would result in an HI of 74.

6.7.4.2 Foodstuffs Pathway

As indicated in Section 6.5.2, there is a significant amount of uncertainty attached to the risk assessment evaluation of the ingestion-of-foodstuffs exposure pathways discussed in the RVAAP FWHHRAM (i.e., ingestion of homegrown beef, ingestion of milk, ingestion of homegrown vegetables). Frequently, risk estimates based on RVAAP installation background criteria concentrations of chemicals exceed the risk benchmarks when these pathways are evaluated. However, conservatively, risk estimates were developed for the hypothetical future resident farmer, assuming the receptor is routinely consuming homegrown beef and homegrown vegetables, and consuming milk from dairy cattle raised on site. COPC concentrations in these media are modeled based on the COPC concentrations detected in the surface soils at LL–6 and the equations presented in the RVAAP *FWHHRA*. The risk estimates are included in Appendix V (Tables 9.6, 9.7, and 9.8) and discussed in the following paragraphs.

Cancer risk estimates for the ingestion-of-beef, ingestion-of-milk, and ingestion-of-vegetables exposure pathways were 4E-05, 2E-05, and 3E-03, respectively. Chemical-specific risk estimates for arsenic, the carcinogenic COPC selected for surface soil, exceed 1E-05 in all cases presented in Appendix V, Table 9.8.

HIs developed for the adult resident farmer and child resident farmer exposed via the ingestion-of-beef, ingestion-of-milk, and ingestion-of-vegetables exposure pathways are presented in Appendix V (Tables 9.6 and 9.7). HIs calculated for child resident farmer and adult resident farmer exceeded 1 for arsenic in vegetables.

6.7.4.3 Summation of Risk

There are uncertainties concerning the summation of hazards and carcinogenic risk estimates for chemicals and pathways. These include the possibility of synergistic or antagonistic reactions and the varying levels of accuracy and precision of the RfDs or CSFs. In addition, the target organ for carcinogens may be different and, therefore, summation of the risk may not be appropriate in all cases.

6.8 Summary and Conclusions

This section summarizes the BHHRA and discusses conclusions drawn from the assessment.

6.8.1 Summary

The LL–6 BHHRA was performed using analytical data for groundwater, soil, sediment, and surface water collected in 2000 and 2001. The LL–6 BHHRA methods are based on the protocol established in the RVAAP FWHHRAM (USACE, 2004) and the White Paper (TtNUS, 2004).

Five human receptors were evaluated:

- Security Guard/maintenance worker,
- National Guard trainee,
- National Guard resident,
- National Guard fire/dust suppression worker,
- Hunter/trapper, and
- Hypothetical future resident farmer (adult and child).

The National Guard trainee is the primary receptor, based on future land use, because it is anticipated that LL–6 will be used by the OHRANG for training activities described in the FWHHRAM as Mounted Training by Ohio National Guard Soldiers – No Digging Allowed. The planned training activities would involve potential exposure to soils (no deeper than 4 ft bgs), as well as to the other environmental media at LL–6. The National Guard fire and dust suppression receptor is an important receptor because the surface water at LL–6 may be used for fire and dust suppression. The hunter/trapper receptor is an important receptor because a long-term goal for RVAAP is to allow hunting, fishing, and trapping anywhere suitable habitats exist for these recreational activities. (Please note that fishing does not currently occur at LL–6.) The National Guard resident and the hypothetical future resident farmer are included in the BHHRA for purposes of completeness and because risk estimates for these receptors may be useful to the RVAAP risk managers. For example, the need for deed restrictions at LL–6 may be eliminated if minimal risks are established for these receptors. The security

guard/maintenance receptor is included because of the routine activities (i.e., security patrols) currently occurring at the site by personnel who visit the site for short periods of time.

The following chemicals were selected as COPCs for quantitative human health risk assessment:

Soils	***Groundwater***	***Surface Waters***	***Sediment***
aluminum	arsenic	aluminum	aluminum
arsenic	antimony	arsenic	arsenic
benzo(a)pyrene	bis(2–ethyl hexyl)phthalate	chromium	vanadium
manganese	4–nitroaniline	lead	
		manganese	
		vanadium	

These COPCs were selected based on chemical concentrations detected in the environmental media at LL–6. The COPC selection protocol included a conservative toxicity screen (based on the PRGs) and a background screen. The following should be considered when evaluating this list of COPCs:

- The antimony concentration detected in the LL–6 groundwater samples does not exceed current federal SDWA MCLs.
- Bis(2–ethylhexyl) phthalate is both a common environmental contaminant and a common lab/field blank contaminant. This contaminant was not detected in LL–6 soils or sediments, suggesting that it is not a significant site-related contaminant.
- Aluminum, cadmium, copper in soils, and vanadium were selected as COPCs in soils and sediments because these chemicals exceeded conservative COPC screening levels for non-carcinogenic chemicals. However, these chemicals were not detected at concentrations exceeding the PRGs and were detected very infrequently at concentrations exceeding the background benchmarks for RVAAP.
- Benzo(a)pyrene detected at LL–6 may be site-related; however, concentrations detected in soils are similar to anthropogenic background concentrations and concentrations reported for background soil samples collected at RVAAP (For purposes of human health risk assessment, it was assumed that benzo(a)pyrene was not detected in the background soil data set for the RVAAP).
- Maximum arsenic concentrations detected in environmental media at LL–6 do exceed background benchmarks established for RIs at RVAAP. However, the historical widespread use and application of arsenic-based herbicides across many areas of the United States may have contributed to the concentrations detected in soils and sediments. Also, the arsenic concentrations detected at LL–6 are within background concentrations reported by the USEPA (1987a) and in the scientific literature.

- Arsenic was detected in two on-site monitoring wells; only the detection reported for MW–005 (13 µg/L) exceeds the current SDWA MCL. Arsenic is a naturally occurring metal in groundwater. RVAAP installation background criteria benchmarks for arsenic in bedrock and overburden wells are 11 µg/L (filtered overburden), 215 µg/L (unfiltered overburden), 19.1 µg/L (unfiltered bedrock), and 0.0 µg/L (filtered bedrock).

A summary of the risk characterization for LL–6 is presented in Table 6–10 and in the following narrative items:

- Non-cancer risk estimates (HIs) developed for the security guard/maintenance worker, the National Guard fire/dust suppression worker, and the hunter/trapper are less than 1, indicating that adverse non-carcinogenic effects are not anticipated under the exposure conditions considered in the risk assessment. The cancer risk estimates for the security guard/maintenance worker and the National Guard fire/dust suppression worker do not exceed 1E-05 and for the hunter/trapper do not exceed 1E-06. No potential COCs are identified for these receptors.
- The HIs calculated for the National Guard trainee receptor exposed to COPCs in media at LL–6 equal 1, but the HI does not exceed unity for any medium, COPC, or target organ.
- The total cancer risk estimate for National Guard trainee exposure to all media (3E-05) is within the USEPA target risk range of 1E-06 to 1E-04, but exceeds the Ohio EPA cancer risk benchmark of 1E-05 when groundwater and surface soil are evaluated as media of concern. Ingestion of arsenic in groundwater accounts for 2.1E-05 of the total cancer risk estimate (3.3E-05) for the National Guard trainee. The estimates for inhalation of arsenic in deep surface soil are strongly affected by the PEF specified for the National Guard trainee receptor in the RVAAP FWHHRAM. This PEF is further discussed in Section 6.7.
- The total (soil [surface or subsurface], sediment, surface water, and groundwater) HI for the National Guard resident is 3. The HI calculated for receptor exposure to groundwater is 1.1, and the HI for exposure to surface water is 1.4. The HI for exposure to all other media combined (soils and sediments) is 0.4. Manganese in surface water is the only chemical identified as a potential COC.
- The total cancer risk estimate for the National Guard resident trainer (1.9E-04) exceeds the USEPA target risk range (1E-06 to 1E-04) (USEPA, 1989a). However, only the cancer risk estimate for groundwater (2E-04) exceeds 1E-04. The cancer risk estimate for surface water is 1.5E-05. Arsenic is a potential COC for sediment, surface water, and groundwater.
- The total HIs calculated for the adult resident farmer routinely exposed to COPCs in surface soil, surface water, sediment, and groundwater via the direct-contact pathways exceed 1 when it is assumed that the shallow groundwater is used for domestic purposes. Likewise, the total HIs calculated for the adult resident farmer routinely

exposed to COPCs in subsurface soil, surface water, sediment, and groundwater via the direct-contact pathways exceed 1 only when it is assumed that the shallow groundwater is used for domestic purposes. Arsenic in groundwater is the only contributor to risk exceedance. The HIs calculated for the adult resident farmer routinely exposed via indirect exposure pathways (i.e., consumption of foodstuffs) do exceed 1 for vegetable consumption only. Arsenic is the potential COC for the indirect exposure pathways. However, as noted above, the concentrations of arsenic detected in surface soil may reflect RVAAP installation background criteria conditions. Additionally, the contaminant transfer (i.e., from environmental media to food article) and intake calculations used to estimate receptor risk resulting from the ingestion of homegrown foods are very conservative. HIs exceeding 1 would also be predicted for the site background concentrations of these metals.

- The HI calculated for the child resident farmer routinely exposed to COPCs in surface soil, sediment, surface water, and groundwater or routinely exposed to COPCs in subsurface soil, sediment, surface water, and groundwater via the direct-contact exposure pathways exceed 1. The HIs calculated for the COPCs in groundwater exceed 1. The HIs calculated for sediments, surface soil, subsurface soils, or surface waters do not exceed 1. Arsenic and antimony are the primary contributors to risk; HIs calculated for other COPCs evaluated do not exceed 1. The target-organ-specific HI calculated for the skin and cardiovascular system (the target organs for arsenic) exceed 1, and the target-organ-specific HIs for target organs for antimony equal 1. The HIs calculated for the child resident farmer routinely exposed via indirect exposure pathways (i.e., consumption of foodstuffs) do exceed 1 for vegetable consumption only. Arsenic is a potential COC for the indirect exposure pathways. However, as noted above, the detected concentrations of these metals in surface soil may reflect RVAAP installation background criteria conditions. Additionally, the food chain modeling used to characterize risk is very conservative. HIs exceeding 1 would also be predicted for the site background concentrations of these metals.

- The ILCR estimates for the hypothetical future resident farmer are 4.3E-05, 5.2E-05, 2.6E-05, 6.1E-06, and 4.0E-04 for direct-contact exposure pathways for surface soil, subsurface soil, sediment, surface water, and groundwater, respectively. The total cancer risk (summarized for each receptor and each media) for the direct-contact exposure pathways exceeds 1E-04 when it is assumed that the groundwater is used for domestic purposes. Arsenic in soils, sediments, and groundwater is identified as a potential COC for the direct-contact exposure pathway. The cancer risk estimates calculated for the indirect exposure pathways (i.e., consumption of beef, milk, and vegetables raised on site) exceed 1E-04 for vegetable consumption only. Arsenic is identified as a potential COC for vegetable consumption. However, the uncertainties highlighted in the previous items are also relevant for the risk estimates presented for the future hypothetical resident farmer. Ingestion rates (kg/day) for each food group (beef, milk, etc.) were provided in the FWHHRAM. The percentages these amounts encompass of the total farmer's diet are not provided in the FWHHRAM.

Table 6–10 presents a summary of all receptors evaluated in this BHHRA and identifies the contaminants that produce risks greater than 1E-06, 1E-05, and 1E-04 or hazard indices greater than 1.0.

6.8.2 Conclusions

The total cancer risk estimate (summarized for each receptor and each media) for the receptor most likely to be at the site (the National Guard trainee) equals 3E-05, and only the cancer risk estimate developed for ingestion of arsenic in groundwater (assuming domestic use) exceeds 1E-05. The total non-cancer risk (HI) estimate (summarized for each receptor and each media) equals 1, but HIs calculated for target organs and COPCs do not exceed unity. However, as discussed in the preceding narrative, significant uncertainties were identified for the risk estimates for arsenic (in groundwater) and for the inhalation pathway and should be considered by the risk management team for RVAAP when making further risk-based decisions for LL–6. HIs calculated for the security guard/maintenance worker, National Guard fire/dust suppression worker, and the hunter/trapper are less than 1; and total cancer risk estimates for the same receptors do not exceed the Ohio EPA cancer risk benchmark of 1E-05.

The total cancer risk estimate (summarized for each receptor and each media) for the National Guard resident trainer exceeds 1E-04 only when the future domestic use of the shallow groundwater resource is evaluated. The total HI (summarized for each receptor and each media) for the National Guard resident trainer exceeds 1.0 for the future domestic use of the shallow groundwater resource and for exposure to surface water. Cancer risk estimates and HIs for all other media for the National Guard resident trainer do not exceed 1E-04 and 1, respectively. As noted above, significant uncertainties were identified for the risk estimates for arsenic (in groundwater) and should be considered by the risk management team for RVAAP when making further risk-based decisions for LL–6.

The total cancer risk estimate (summarized for each receptor and each media) for the hypothetical future resident farmer exposed by the direct-contact exposure pathways exceeds 1E-04 only when future domestic use of the shallow groundwater resource is evaluated. Cancer risk estimates for soils and sediments evaluated for the direct contact exposure pathways exceed 1E-05, but do not exceed 1E-04. Total non-cancer risk estimates (HI) calculated on a target-organ-specific basis exceed 1 only when future domestic use of the shallow groundwater resource is evaluated for the adult farmer. For the child farmer, total HI calculated on a target-organ-specific basis exceed 1 when future domestic use of the shallow groundwater resource is evaluated and equal 1 for arsenic's target organs when direct exposure to media other than groundwater are evaluated. However, cancer and non-cancer risk estimates developed for the indirect exposure pathways (i.e., consumption of homegrown food stuffs) exceed both cancer and non-cancer risk benchmarks (i.e., 1E-04 and HI = 1, respectively) for consumption of vegetables. Significant uncertainties were identified for the risk estimates for arsenic (in groundwater) and for the evaluation of the indirect exposure pathways, and these should be considered by the risk management team for RVAAP when making further risk-based decisions for LL–6.

7.0 SCREENING ECOLOGICAL RISK ASSESSMENT

7.1 Introduction

The goal of this screening-level ecological risk assessment (SERA) is to determine whether adverse ecological impacts are present as a result of exposure to chemicals released to the environment through past site operations at RVAAP LL–6. This SERA provides information to scientists and managers that will enable them to conclude either that ecological risks at the site are most likely negligible or that further information is necessary to evaluate potential ecological risks at the site. The SERA methodology follows the guidance presented in the RVAAP *Facility-Wide Ecological Risk Work Plan* (USACE, 2003d) and *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA, 2003).

The ERA process consists of the following eight steps that are required by the RVAAP, Ohio EPA (Ohio EPA, 2003), and USEPA (USEPA, 1997b) for any ecological risk assessment:

- Step 1 – Screening-Level Problem Formulation and Ecological Effects Evaluation
- Step 2 – Screening-Level Exposure Estimate and Risk calculation
- Step 3 – Baseline Risk Assessment Problem Formulation
- Step 4 – Study Design and Data Quality Objective Process
- Step 5 – Field Verification of Sampling Design
- Step 6 – Site Investigation and Analysis Phase
- Step 7 – Risk Characterization
- Step 8 – Risk Management

A SERA typically consists of Steps 1 and 2 and a Baseline Ecological Risk Assessment (BERA) consists of Steps 3 through 7. Step 8, Risk Management, is a distinctly different process from risk assessment. In risk management, the results of the risk assessment are integrated with other considerations to make and justify risk management decisions (USEPA, 1997). This SERA for RVAAP LL–6 consists of Steps 1 and 2, along with the first part of Step 3, which is termed Step 3a. Step 3a considers factors other than comparisons of chemical concentrations to screening levels to further refine the list of COPCs (see Section 7.6 for more details). The remaining steps (the rest of Step 3 through Step 7) are conducted only if additional evaluations or investigations are necessary; these steps were not conducted as part of this report. A decision to proceed to a BERA is usually only made after the results of the SERA are evaluated.

7.2 Preliminary Problem Formulation

The problem formulation is the first step of the SERA and includes identification of potential receptor groups; potential contaminants; and the mechanisms for contaminant fate, transport, and toxicity. Determination of the complete exposure pathways that exist at a site is accomplished at this point to facilitate proper problem formulation. Site habitats, exposure pathways, and potential ecological receptors are identified as part of the receptor selection. This information, which is gathered from the field investigation and site visits, is used to focus the SERA on the primary chemicals, receptors, and exposure pathways at the site.

7.2.1 Habitat Types and Ecological Receptors

This information, which is gathered from the field investigation and site visits, was used to focus the SERA on the primary chemicals, receptors, and exposure pathways at the site. The LL–6 site consists of an old-field habitat in various stages of reversion to forestland. The area around the load line buildings has been maintained as grassland by periodic mowing. LL–6 consists mainly of grasses, weeds, and small shrubs surrounded by forested areas to the east, west, and south. Densely populated areas of mature trees surround LL–6. The northern end of LL–6 is bordered by a road. Shallow ditches drain the site, and water flow in the ditches is slow. These same shallow drainage ditches are not perennial, and they are wet only seasonally, depending on precipitation and temperature. Consequently, the drainage ditches provide poor ecological habitat and are not capable of supporting fish. As can be seen in the photographs in Appendix C, surface water sample locations LL6SW-001-0001-SW, LL6SW-003-0001-SW, LL6SW-004-0001-SW, and LL6SW-005-0001-SW appear to be dry drainage ditches with no aquatic habitat, while aquatic receptors may be present at locations LL6SW-002-0001-SW and LL6SW-012-0001-SW. Note that no aquatic plants were present at any of the locations which could indicate that the ditches do not contain water for significant periods of time. Although all of the surface water and associated sediment samples will be evaluated as aquatic habitat because of the potential for contaminants to migrate downstream where aquatic receptors may be more prevalent, the uncertainties in this evaluation at locations where water is only present during rain events are discussed in the uncertainty analysis section of this SERA (Sections 7.8.2 and 7.8.4).

The site also contains a testing pond once used for underwater explosives testing. The pond is approximately 15 to 18 ft in diameter and approximately 12 ft deep. Fish were not observed in the pond during site visits and the field investigation; however, the pond is likely to contain other aquatic organisms, such as benthic macroinvertebrates. No site-specific inventory was available, and no aquatic receptors were observed during field activities; however, the presence of the small ditches and the explosives testing pond indicates limited aquatic habitat is potentially available.

Based on the list of potential receptors presented in Section 2.8 of this report, and based on the habitat at LL–6 which is described above, it is likely that small mammals and birds such as shrews, voles, and robins, are present at the site.

7.2.2 Major Chemical Sources and Migration Pathways

From the historical site data and sampling, the following parameters are among the chemicals detected at LL–6. Note that not all the chemicals mentioned in the following bullets were detected in one or more samples.

- Explosives (surface soil);
- Metals (surface soil, sediment, and surface water);
- Chlorinated VOCs (surface soil and surface water);
- Semi-volatile organic compounds (SVOCs, including PAHs) (surface soil, sediment, and surface water);
- PCBs (surface soil and sediment); and
- Pesticides (sediment).

The results of the surface soil, surface water, and sediment sampling are included in earlier sections of this report. Physical and chemical characteristics of contaminants may affect their mobility, transport, and bioavailability in the environment. These characteristics include the organic carbon partition coefficient, octanol water partition coefficient, and vapor pressure. Table 5–1 presents the physical and chemical characteristics for the chemicals detected at LL–6. The fate and transport of these chemicals is discussed in detail in Section 5.0. Although these physical and chemical characteristics were not used directly in this SERA, many of the characteristics were used to develop some of the values that were used in this SERA. For example, K_{ow} values were used to determine some of the biotransfer factors in Appendix W. Also, some of the sediment screening values are based on equilibrium partitioning which utilizes the K_{oc} of the chemical.

Various bioaccumulation factors (BAFs) and/or bioconcentration factors (BCFs) were used to estimate contaminant loading in plants and soil invertebrates from chemical concentrations in LL–6 surface soil. For soil to plant uptake, two separate BAFs are used to predict the biological transfer of contaminants from soil to vegetative (foliage) or reproductive (berries) and storage (roots) plant parts (Baes et al, 1984; Travis and Arms, 1988).

For soil-to-plant uptake, two separate BAFs are used to predict the biological transfer of contaminants from soil to vegetative (foliage) or reproductive and storage (berries and roots) plant parts (Baes et al., 1984; Travis and Arms, 1988). Additional transfer factors include soil to animal (assumed earthworm), and animal to animal (earthworm to shrew). All factors were

taken from sources listed in the RVAAP facility-wide eco-risk guidance (USACE, 2003d). Contaminants that do not have BAFs or BSAFs are assigned a default value of 1. Appendix Y presents the ecological risk assessment tables with the transfer factors for soil to plant, soil to invertebrate and diet to animal.

7.2.3 Exposure Routes

The potential pathways by which ecological receptors may be exposed to COPCs were identified, along with the species that could be adversely affected by these chemicals. Several potential exposure pathways may exist. For example, terrestrial animals may be exposed to soil contaminants through ingestion of contaminated food items. Animals can also incidentally ingest soil while grooming fur, preening feathers, digging, grazing close to the soil, or feeding on items to which soil has adhered (such as roots and tubers). Terrestrial vegetation may be exposed to contaminants via direct aerial deposition and root translocation. Terrestrial animal receptors may also come into contact with contaminants in surface water by drinking the water, although this exposure route typically represents a negligible portion of total exposure for most terrestrial receptors because of the relatively low contaminant concentrations in surface water as compared to other media. Aquatic and semi-aquatic organisms may be exposed to contaminants via direct contact with surface water and sediments, incidental ingestion of surface water and sediments, and consumption of contaminated food items. Aquatic and semi-aquatic organisms may also be exposed to constituents from contaminated groundwater that flows into surface water.

7.2.3.1 Surface Soil

Several groups of terrestrial ecological receptors can be exposed to contaminants in the surface or subsurface soil (0–4 ft bgs), although most of the exposure is expected to occur in the top 12 inches. Invertebrates, such as earthworms, are exposed to the contaminants as they move through the soil and ingest soil particles while searching for food. Plants are exposed via direct contact as contaminants are absorbed through the roots, which may then translocate to different parts of the plants (i.e., leaves, seeds).

Small mammals may be exposed to contaminants in the soil via several exposure routes. They may be exposed by direct contact as they search for food or burrow into the soil. However, exposure of terrestrial wildlife to contaminants in the soil via dermal contact is unlikely to represent a major exposure pathway because fur, feathers, and chitinous exoskeletons are expected to minimize transfer of contaminants across dermal tissue. The exposure of animals to constituents in soil by dermal contact is likely to be a small fraction of the direct exposure to constituents in soil by incidental ingestion and the indirect exposure by ingestion of contaminated biota. It is true that for amphibians and reptiles, the dermal pathway may be more important. However, there currently are no standard methods for evaluating risks to amphibians and reptiles from dermal exposure to chemicals in soil. Therefore, the dermal pathway is not

evaluated in this SERA. Small mammals also may be exposed to contaminants in the soil via incidental ingestion of soil and ingestion of plants and/or invertebrates that have accumulated contaminants from the soil. The soil and food ingestion pathways are evaluated in this SERA.

Larger predatory species, such as the red fox (*Vulpes vulpes*), barn owl (*Tyto alba*) and red-tailed hawk (*Buteo jamaicensis*), can be exposed (indirectly) to site contaminants in the soil by ingesting small mammals that have accumulated contaminants from the soil. The small mammal ingestion pathway is evaluated in this SERA.

7.2.3.2 Groundwater

Ecological receptors are not directly exposed to contaminants in the groundwater, so this exposure pathway is not complete. According to USACE (2003d), because groundwater at the site is greater than 2 ft deep, it does not have to be evaluated as surface water.

7.2.3.3 Surface Water/Sediment

Contaminants in the soil may enter the intermittent drainage ditches via overland flow. Most of the water bodies immediately adjacent to the load line buildings are small drainage ditches that do not support fish, and probably only support a small benthic invertebrate population during certain times of the year.

A small pond once used for underwater explosive testing is located on site; however, fish were not observed in the pond during site visits and the field investigation. The pond may support benthic organism populations that could be exposed to contaminants in the water by direct contact and incidental ingestion of water.

7.2.3.4 Air

Although inhalation of particulates may be a complete pathway, it is expected to be insignificant compared to other pathways, such as ingestion of food items that have accumulated contaminants from soil. Also, inhalation pathways typically are not evaluated in SERAs because of the uncertainty in exposures and effects concentrations. The exposure of animals to constituents in soil by inhalation is likely to be a small fraction of the direct exposure to constituents in soil by incidental ingestion and the indirect exposure by ingestion of contaminated biota. It is true that for amphibians and reptiles, the inhalation pathway may be more important. However, there currently are no standard methods for evaluating risks to amphibians and reptiles from inhalation exposure to chemicals in soil. Therefore, this pathway was not evaluated.

7.2.4 Preliminary Assessment and Measurement Endpoints

One of the major tasks in the screening-level problem formulation is the selection of assessment and measurement endpoints. Both are discussed in the following subsections.

7.2.4.1 Assessment Endpoints

Assessment endpoints are explicit expressions of the environmental value that is to be protected (USEPA, 1997b). The selection of these endpoints is based on the habitats present, the migration pathways of probable contaminants, and the routes that contaminants may take to enter receptors.

The habitat at and adjacent to the site consists primarily of open field with grasses and surrounding forested areas. For this SERA, the assessment endpoints are the protection of the following groups of receptors from adverse effects of contaminants on their growth, survival, and reproduction (note that although toxicity data may not be available for all of the potential effects for each receptor group, it is assumed that the toxicity data from one endpoint will be sufficiently protective of the other endpoints):

- Soil invertebrates;
- Terrestrial vegetation;
- Herbivorous mammals;
- Invertivorous mammals and birds;
- Carnivorous mammals and birds; and
- Aquatic organisms and benthic invertebrates.

The following paragraphs discuss why the above receptors are selected for this SERA.

Soil Invertebrates – Soil invertebrates are expected to be present in the soil at the site. They aid in the formation of soil and redistribution and decomposition of organic matter in the soil and serve as a food source for higher trophic level organisms. They also can accumulate some contaminants that can then be transferred to the higher trophic level organisms that consume invertebrates.

Terrestrial Vegetation – Terrestrial vegetation at the site consists of grasses, shrubs, and trees. They serve as a food source and provide shade and cover for many organisms and help prevent soil erosion, among other important functions. They also can accumulate some contaminants that can then be transferred to higher trophic level organisms that consume them.

Herbivorous Mammals – Herbivorous mammals (animals that consume only plant tissue) may be present at the site because of the vegetative habitats. Their role in the community is essential because, without them, higher trophic levels could not exist. They may be exposed to and accumulate contaminants that are present in the plants they consume.

Invertivorous Mammals and Birds – Birds and mammals that eat soil invertebrates (invertivores) are present throughout RVAAP in different terrestrial habitats (i.e., forested and open field). These are considered first–level carnivores, and they serve as a food source for higher trophic level carnivores. The invertivores may be exposed to and accumulate contaminants that are present in the food items they consume.

Carnivorous Mammals and Birds – Carnivorous mammals and birds consume invertebrates and other mammals and birds. Carnivorous mammals and birds that feed on other birds and mammals are at the top of the food chain. The top carnivores typically are less densely distributed than the herbivores and first-level carnivores because they require a larger area to hunt for their food. Carnivores may accumulate contaminants that are present in the food items they consume.

Aquatic Organisms and Benthic Invertebrates – Aquatic organisms and benthic invertebrates are similar to soil invertebrates in that they serve as a food source for higher trophic level organisms (i.e., amphibians, reptiles, birds and mammals). They may also accumulate contaminants that can then be transferred to the higher trophic level organisms that consume them.

All the potential assessment endpoints are not evaluated in the SERA. As indicated in USEPA guidance (1997), “It is not practical or possible to directly evaluate risks to all of the individual components of the ecosystem at a site. Instead, assessment endpoints focus the risk assessment on particular components of the ecosystem that could be adversely affected by contaminants from the site.” Therefore, the SERA focuses on the receptors that will tend to yield the highest risks, which should then account for receptors that will have lower risks. Although piscivorous receptors are potentially present at LL–6, they were not included as assessment endpoints because the food items they consume (i.e., fish) were not observed at LL–6. Therefore, piscivorous receptors would not be exposed to contaminants at LL–6. The assessment endpoints that are selected for each site are presented in the site-specific sections of this report.

To be conservative, large carnivorous mammals (i.e., red fox) and birds (i.e., barn owl and red-tailed hawk) are evaluated in this SERA, although the area of LL–6 is small (51 acres) and well below the typical home and feeding ranges of large carnivorous animals. The greatest exposure to site contaminants is expected to occur to the small mammals and birds that ingest earthworms or plants.

7.2.4.2 Measurement Endpoints

Measurement endpoints are estimates of biological impacts (i.e., mortality and reduction in growth or reproduction) that are used to evaluate the assessment endpoints. The following measures of effects are used to evaluate the assessment endpoints in this SERA, where applicable:

- Soil screening values – Mortality, growth, and reproduction of plants and soil invertebrates are evaluated by comparing the measured concentrations of chemicals in the surface soil to screening values designed to be protective of ecological receptors.

- No-observed-adverse effects levels (NOAELs) for surrogate wildlife species – Mortality, reproductive, and/or developmental effects of birds and mammals are evaluated by comparing the estimated ingested dose from contaminants in the surface water, surface soil, plants, and/or invertebrates to these levels.

- Sediment screening values – Mortality and other adverse effects (i.e., growth, feeding rates, and behavioral changes) of benthic macroinvertebrates are evaluated by comparing the measured concentrations of chemicals in the sediment to screening values designed to be protective of ecological receptors.

- Surface water screening values – Mortality and other adverse effects (i.e., growth, feeding rates, and behavioral changes) of aquatic organisms are evaluated by comparing the measured concentrations of chemicals in the surface water to screening values designed to be protective of ecological receptors.

7.2.5 Selection of Receptor Species for Food Chain Model

To address potential effects on wildlife via food chain modeling, several species of vertebrates were selected to be evaluated in this SERA. The dietary exposure (dose of contaminants from ingesting and drinking) of these receptors was estimated and then compared to effect levels (threshold values that, if exceeded, may elicit an effect).

For most receptor species, ingestion is the primary route of exposure. Representative species are selected for their preferred habitat, body size, sensitivity, home range, abundance, commercial or sport value, legal status, and functional role (i.e., predators). For conservativeness, representative species may be small and have small home ranges. The availability of exposure parameters such as body mass, feeding rate, and drinking rate may also be a factor in selecting representative species. The following representative species are used for the food chain modeling:

- Herbivorous mammal: meadow vole (*Microtus pennsylvanicus*);

- Invertivorous mammal: short-tail shrew (*Blarina brevicauda*);
- Invertivorous bird: American robin (*Turdis migratorius*);
- Carnivorous bird: barn owl and red-tailed hawk, and
- Carnivorous mammal: red fox.

7.3 Preliminary Ecological Effects Evaluation

The preliminary ecological effects evaluation is an investigation of the relationship between the magnitude of exposure to a chemical and the nature and magnitude of adverse effects resulting from exposure. As the first step in the ecological effects evaluation, COPCs are selected by comparing the contaminant concentrations in the surface water, sediment, and surface soil samples from the site to ecological screening values (ESVs). A hierarchy of ESVs was specified by Ohio EPA and RVAAP guidance documents (Ohio EPA, 2003; USACE, 2003d). The first available screening value is used in the hierarchy regardless of whether it may be greater or lesser than other screening values.

Surface water chemical concentrations are compared to chemical criteria using a surface water screening hierarchy of: (1) outside mixing zone maximum (OMZM) criteria for the protection of aquatic life in the Lake Erie Basin from Ohio Administrative Codes (OAC 3745–1) and (2) USEPA Ambient Water Quality Criteria (AWQC).

Sediment concentrations are screened using the site-specific background concentrations and Ohio-specific sediment reference values (SRVs) (Appendix H in Ohio EPA, 2003), then using a sediment screening hierarchy of: (1) consensus-based threshold effect concentrations (TECs) (MacDonald et al., 2000) and (2) Region 5 ecological data quality levels (EDQLs) (USEPA Region 5, 1999).

Soil concentrations are screened using the site-specific background concentrations, then using a soil screening value hierarchy in the order given in the guidance, as follows: (1) preliminary remediation goals (PRGs) (Efroymson et al., 1997a); (2) toxicological benchmarks for soil and litter invertebrates (Efroymson et al., 1997b); (3) toxicological benchmarks for terrestrial plants (Efroymson et al., 1997c); and (4) Region 5 EDQLs (USEPA, 1999).

Although the EDQLs have since been updated by the ecological screening levels (ESLs) (USEPA Region 5, 2003), they were not used as soil or sediment screening levels, according to e-mail correspondence from Laurie Moore of Ohio EPA on December 17, 2004.

Also, risks to reptiles and amphibians are not quantitatively evaluated in this SERA because exposure factors are not established for most species and toxicity data are very limited.

7.4 Preliminary Risk Calculation and Selection of COPCS

This initial selection of COPCs uses conservative assumptions to eliminate chemicals detected during the RI at concentrations below those levels reported in the literature to cause adverse effects on growth, survival, or reproduction. The process involves the combination of a preliminary exposure estimate with a preliminary risk calculation.

The first step in selecting initial COPCs is to select a conservative exposure point concentrations (EPCs) for comparison with background and ESVs. The maximum concentration is used as the initial EPC for screening. Screening-level risk calculations compare the conservative exposure estimate to ecological effect values estimated by ESVs.

The ratio of the initial EPC to the ESV is called a hazard quotient (HQ) and is defined as follows:

$$HQ_I = EPC_I / ESV_I$$

Where: HQ_I = hazard quotient for analyte "I" (unitless)

EPC_I = exposure point concentration for analyte "I" (mg/L or mg/kg)

ESV_I = ecological screening value for analyte "I" (mg/L or mg/kg)

When the ratio of the EPC to its respective screening value or benchmark exceeds 1.0, adverse impacts are possible, and the chemical is considered for selection as a COPC. The HQ is not probabilistic, but a numerical indicator of the extent to which an EPC exceeds an ESV.

7.4.1 Selection of Soil COPCs

The following subsections summarize the procedures that were used in the SERA for LL–6 to select COPCs. Note that calcium, magnesium, potassium, and sodium are not retained as COPCs in any medium because of their relatively low toxicity to ecological receptors and their high natural variability in concentrations. Contaminants without ESVs are retained as COPCs for further evaluation.

- Inorganic contaminants whose maximum concentrations do not exceed the site-specific background concentrations are not selected as COPCs.
- Inorganic and organic contaminants whose maximum concentrations do not exceed soil screening levels are not retained as COPCs, unless the chemicals are bioaccumulative. Inorganic and organic contaminants that are bioaccumulative are selected as COPCs even if their maximum concentration does not exceed a screening level. A chemical was considered to be bioaccumulative if it is included in the list of important bioaccumulative chemicals in USEPA (2000a) guidance.
- Inorganic and organic contaminants without screening values are selected as COPCs.

Table 7–1 summarizes the screening of soil COPCs. Four analytes are retained as COPCs because no screening values are available: two SVOCs (carbazole and dibenzofuran), one explosive (HMX), and one propellant (nitrocellulose). The following analytes were selected as COPCs because their maximum concentrations exceeded their respective ESVs: aluminum, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, vanadium, and zinc. Several of these chemicals were also retained as COPCs for inclusion in the food chain model because they are important bioaccumulative chemicals. Additionally, the detected PAHs (excluding 2–methylnaphthalene and naphthalene) and aroclor 1254 were retained as COPCs for inclusion in the food chain model, although maximums did not exceed soil screening levels, because they are important bioaccumulative chemicals.

7.4.2 Selection of Sediment COPCs

The following summarizes the procedures that were used in the SERA for LL–6 to select sediment COPCs:

- Inorganic contaminants whose maximum concentrations do not exceed Ohio-specific SRVs or site-specific background are not selected as COPCs.
- Inorganic and organic contaminants without screening values are selected as COPCs.

Table 7–2 summarizes the initial selection of sediment COPCs. Two analytes − beryllium and nitrocellulose − are retained as sediment COPCs because no screening values are available. The following contaminants had concentrations that exceed their ESVs and are retained as COPCs: arsenic, cadmium, copper, lead, and mercury.

7.4.3 Selection of Surface Water COPCs

The following summarizes the procedures that were used in the SERA for LL–6 to select surface water COPCs:

- Inorganic contaminants whose maximum concentrations do not exceed background are not selected as COPCs.
- Inorganic and organic contaminants whose maximum concentrations do not exceed water quality criteria in OAC 3745–1 (or the AWQC, as discussed in Section 7.3) are not retained as COPCs.
- Inorganic and organic contaminants without screening values are retained as COPCs.

Table 7–3 summarizes the screening of surface water COPCs. Acetone, manganese, and nitrocellulose are selected as COPCs because no surface water screening level is available. The following contaminants had concentrations that exceed their ESVs and are retained as COPCs: aluminum, copper, iron, lead, selenium, and zinc.

Table 7–1
Ecological COPC Selection Table for Deep Surface Soil (0–4 ft)

Parameter	Frequency of Detection	Minimum Concentration	Maximum Concentration	Mean Concentration	Average of Positive Detects	Sample of Maximum Detect	Site Background Criteria[1]	Detects > Site Background Criteria[2]	Max Conc > Bkg Conc	Surface Soil Screening Level		HQ	Bio Chemical	PBT Chemical	Selected as a COPC?	Rationale[3]
										Value	Source					
Volatile Organics (µg/kg)																
ACETONE	1/11	12	12	3.06	7.38	LL6SB-044-0001-SO-D	NA	NA	NA	2500	d	0.005	NO	NO	NO	BSL
METHYLENE CHLORIDE	1/11	4.8 Ja	4.8 Ja	1.59	3.28	LL6SB-044-0001-SO-D	NA	NA	NA	4050	d	0.001	NO	NO	NO	BSL
Semivolatile Organics (µg/kg)																
2-METHYLNAPHTHALENE	1/11	22 Ja	22 Ja	2.81	22	LL6SB-024-0001-SO	NA	NA	NA	3240	d	0.01	NO	NO	NO	BSL
ACENAPHTHENE	2/11	4.6 Ja	69	7.37	36.8	LL6SB-024-0001-SO	NA	NA	NA	20000	a	0.003	YES	NO	YES	BIO
ANTHRACENE	3/11	1.7 Ja	130	13.1	46.8	LL6SB-024-0001-SO	NA	NA	NA	1480000	d	0.0001	YES	NO	YES	BIO
BENZO(A)ANTHRACENE	6/11	4.9 J	290	33.3	60.4	LL6SB-024-0001-SO	NA	NA	NA	5210	d	0.06	YES	NO	YES	BIO
BENZO(A)PYRENE	6/11	3.7 J	200	25	44.8	LL6SB-024-0001-SO	NA	NA	NA	1520	d	0.13	YES	NO	YES	BIO
BENZO(B)FLUORANTHENE	6/11	4 J	230 H	28.5	51.2	LL6SB-024-0001-SO	NA	NA	NA	59800	d	0.004	YES	NO	YES	BIO
BENZO(G,H,I)PERYLENE	5/11	5.5 Ja	83	12.1	25.2	LL6SB-024-0001-SO	NA	NA	NA	119000	d	0.001	YES	NO	YES	BIO
BENZO(K)FLUORANTHENE	5/11	4.2 Ja	160	20.1	42.3	LL6SB-024-0001-SO	NA	NA	NA	148000	d	0.001	YES	NO	YES	BIO
BIS(2-ETHYLHEXYL)PHTHALATE	7/11	16 Ja	160 Ja	35.4	52.3	LL6SB-044-0001-SO	NA	NA	NA	926	d	0.17	NO	NO	NO	BSL
CARBAZOLE	1/11	140 Ja	140 Ja	31.6	140	LL6SB-024-0001-SO	NA	NA	NA	NA	NA	NA	NO	NO	YES	NTX
CHRYSENE	6/11	4.7 J	300	34.8	62.9	LL6SB-024-0001-SO	NA	NA	NA	4730	d	0.06	YES	NO	YES	BIO
DIBENZO(A,H)ANTHRACENE	4/11	4.8 Ja	52	9.56	24	LL6SB-024-0001-SO	NA	NA	NA	18400	d	0.003	YES	NO	YES	BIO
DIBENZOFURAN	1/11	45 Ja	45 Ja	5.55	45	LL6SB-024-0001-SO	NA	NA	NA	NA	NA	NA	NO	NO	YES	NTX
FLUORANTHENE	6/11	6.8 Ja	760	84.2	154	LL6SB-024-0001-SO	NA	NA	NA	122000	d	0.01	YES	NO	YES	BIO
FLUORENE	1/11	57	57	6.05	57	LL6SB-024-0001-SO	NA	NA	NA	30000	b	0.002	YES	NO	YES	BIO
INDENO(1,2,3-CD)PYRENE	4/11	7.8 Ja	88	13.1	33.9	LL6SB-024-0001-SO	NA	NA	NA	109000	d	0.001	YES	NO	YES	BIO
NAPHTHALENE	1/11	78	78	8.0	78	LL6SB-024-0001-SO	NA	NA	NA	99.4	d	0.78	NO	NO	NO	BSL
PHENANTHRENE	5/11	6.2 Ja	510	52.2	114	LL6SB-024-0001-SO	NA	NA	NA	45700	d	0.01	YES	NO	YES	BIO
PYRENE	6/11	5 Ja	510	57.3	104	LL6SB-024-0001-SO	NA	NA	NA	78500	d	0.01	YES	NO	YES	BIO
Pesticides PCBs (µg/kg)																
AROCLOR-1254	1/10	33	33	4.36	33.0	LL6SS-010-0001-SO	NA	NA	NA	371	a[4]	0.09	YES	YES	YES	BIO,PBT
Energetics (µg/kg)																
HMX	1/17	170 Ja	190 Ja	70.6	180	LL6SS-003-0001-SO	NA	NA	NA	NA	NA	NA	NO	NO	YES	NTX
Total Metals (mg/kg)																
ALUMINUM	75/75	1990	21000	12536	12536	LL6SB-012-0001-SO-D	17700	5/75	YES	50	c	420	NO	NO	YES	ASL
ANTIMONY	13/75	0.074 B	0.62 B	0.25	0.271	LL6SS-025-0001-SO	0.96	0/75	NO	5	a	0.12	NO	NO	NO	BSL
ARSENIC	75/75	2.2	41	12	12	LL6SS-007-0001-SO	15.4	11/75	YES	9.9	a	4.1	YES	NO	YES	ASL,BIO
BARIUM	75/75	34	180	74.5	74.5	LL6SS-032-0001-SO	88.4	17/75	YES	283	a	0.64	NO	NO	NO	BSL
BERYLLIUM	75/75	0.2 B	2.1	0.62	0.62	LL6SS-032-0001-SO and Dup	0.88	11/75	YES	10	a	0.21	NO	NO	NO	BSL
CADMIUM	13/75	0.11 B	6.8	0.199	0.932	LL6SS-002-0001-SO	NA	NA	NA	4	a	1.7	YES	NO	YES	ASL,BIO
CALCIUM	75/75	120	184000 H	12173	12173	LL6SS-002-0001-SO	15800	13/75	YES	NA	NA	NA	NO	NO	NO	NUT
CHROMIUM	75/75	5.7	29	16.7	16.7	LL6SB-015-0001-SO	17.4	31/75	YES	0.4	a	73	YES	NO	YES	ASL,BIO
COBALT	75/75	2.3	33	9.09	9.09	LL6SB-016-0001-SO, LL6SB-018-0001-SO-D	10.4	17/75	YES	20	a	1.7	NO	NO	YES	ASL
COPPER	75/75	5	627	23.8	23.8	LL6SS-002-0001-SO	17.7	41/75	YES	60	a	10.5	YES	NO	YES	ASL,BIO
IRON	75/75	9940 H	45000 H	23460	23460	LL6SB-030-0001-SO	23100	36/75	YES	200	b[5]	225	NO	NO	YES	ASL
LEAD	75/75	7.5	250	29.2	29.2	LL6SB-015-0001-SO-D	19.1	30/75	YES	40.5	a	6.2	YES	NO	YES	ASL,BIO
MAGNESIUM	75/75	910	8800	3303	3303	LL6SS-032-0001-SO	3030	36/75	YES	NA	NA	NA	NO	NO	NO	NUT
MANGANESE	75/75	45	1800	445	445	LL6SS-032-0001-SO	1450	0/75[6]	YES	100	b[5]	18	NO	NO	YES	ASL
MERCURY	74/75	0.0081 B	0.6	0.0414	0.0420	LL6SS-017-0001-SO	0.04	10/75	YES	0.00051	a	1176	YES	YES	YES	ASL,BIO,PBT
NICKEL	75/75	7.8	36	19.3	19.3	LL6SB-015-0001-SO	21.1	24/75	YES	30	a	1.2	YES	NO	YES	ASL,BIO
POTASSIUM	75/75	531	2800	1287	1287	LL6SS-033-0001-SO	927	59/75	YES	NA	NA	NA	NO	NO	NO	NUT
SELENIUM	29/75	0.45 B	2.5	0.516	0.951	LL6SB-030-0001-SO	1.4	8/75	YES	0.21	a	12	YES	NO	YES	ASL,BIO
SODIUM	31/75	93 B	1800	426	960	LL6SB-004-0001-SO	123	29/75	YES	NA	NA	NA	NO	NO	NO	NUT
THALLIUM	4/75	0.22 B	0.33	0.233	0.285	LL6SD-011-0001-SD	0.91	0/75	NO	1	a	0.33	NO	NO	NO	BKG,BSL
VANADIUM	75/75	5.6	32	21.3	21.3	LL6SB-018-0001-SO	31.1	0/75[6]	YES	2	a	16	NO	NO	YES	ASL
ZINC	75/75	28	280	66.4	66.4	LL6SB-015-0001-SO-D	61.8	28/75	YES	8.5	a	33	YES	NO	YES	ASL,BIO
Miscellaneous Parameters																
NITROCELLULOSE (µg/kg)	10/10	720 B	10100	2454	2454	LL6SS-010-0001-SO	NA	NA	NA	NA	NA	NA	NO	NO	YES	NTX

Table 7–1
Ecological COPC Selection Table for Deep Surface Soil (0–4 ft)

Notes:
Shaded cells are chemicals that are retained as COPCs.
1 - Background criteria as described in Section 4.
2 - For duplicate pairs, the average chemical concentrations of the original and duplicate samples were compared to the site background criteria.
3 - Rationale Codes:
Above Screening Levels (ASL)
Toxicity information not available (NTX)
Maximum detected concentration is below background screening criteria (BKG)
Below Screening Levels (BSL)
Essential Nutrient (NUT)
Bioaccumulative chemical (BIO)
Persistent, Bioaccumulative, and Toxic chemical (PBT)
4 - Value is based on Total PCBs.
5 - Value is based on estimated effects on microorganisms.
6 - The maximum concentration is greater than the site background criteria although the average concentration is less than the criteria.

Sources of Screening Levels and Hierarchy for Selection:
a - Preliminary Remediation Goals from Efroymson et al. (1997a)
b - Efroymson et al. (1997b) Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Processes
c - Efroymson et al. (1997c) Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants
d - Ecological Data Quality Level (USEPA Region 5, 1999)

Table 7–2
Ecological COPC Selection Table for Sediment

Parameter	Frequency of Detection	Minimum Concentration	Maximum Concentration	Mean Concentration	Average of Positive Detects	Sample of Maximum Detect	Site Background Criteria[1]	Detects > Site Background Criteria[2]	Ohio Sediment Reference Value (SRV)	Max Conc > Bkg Conc and Ohio SRV	Sediment Screening Level		HQ	Selected as a COPC?	Rationale[3]
											Value	Source			
Semivolatile Organics (µg/kg)															
2-METHYLNAPHTHALENE	1/2	9.9 J	15 J	6.7	12.5	LL6SD-010-0001-SD-D	NA	NA	NA	NA	20.2	b	0.74	NO	BSL
BENZO(A)ANTHRACENE	2/2	5.2 J	30 J	17.1	17.1	LL6SD-010-0001-SD-D	NA	NA	NA	NA	108	a	0.28	NO	BSL
BENZO(A)PYRENE	2/2	6.2 J	38 J	20.1	20.1	LL6SD-010-0001-SD-D	NA	NA	NA	NA	150	a	0.25	NO	BSL
BENZO(B)FLUORANTHENE	2/2	5.8 J	44 J	22.4	22.4	LL6SD-010-0001-SD-D	NA	NA	NA	NA	10,400	b	0.004	NO	BSL
BENZO(G,H,I)PERYLENE	1/2	26 J	30 J	14.6	28	LL6SD-010-0001-SD-D	NA	NA	NA	NA	170	b	0.18	NO	BSL
BENZO(K)FLUORANTHENE	1/2	33 J	45 J	20.4	39	LL6SD-010-0001-SD-D	NA	NA	NA	NA	240	b	0.19	NO	BSL
BIS(2-ETHYLHEXYL)PHTHALATE	1/2	36 J	36 J	13.6	21.3	LL6SD-010-0001-SD-D	NA	NA	NA	NA	182	b	0.20	NO	BSL
CHRYSENE	2/2	8.1 J	48	24.8	24.8	LL6SD-010-0001-SD-D	NA	NA	NA	NA	166	a	0.29	NO	BSL
DIBENZO(A,H)ANTHRACENE	1/2	9.4 J	9.4 J	3.4	5.45	LL6SD-010-0001-SD-D	NA	NA	NA	NA	33	a	0.28	NO	BSL
FLUORANTHENE	2/2	14 J	74	38.8	38.8	LL6SD-010-0001-SD-D	NA	NA	NA	NA	423	a	0.17	NO	BSL
INDENO(1,2,3-CD)PYRENE	2/2	4.3 J	28 J	14.7	14.7	LL6SD-010-0001-SD-D	NA	NA	NA	NA	200	b	0.14	NO	BSL
NAPHTHALENE	1/2	13 J	13 J	4.06	7.08	LL6SD-010-0001-SD-D	NA	NA	NA	NA	176	a	0.07	NO	BSL
PHENANTHRENE	1/2	25 J	33 J	14.8	29	LL6SD-010-0001-SD-D	NA	NA	NA	NA	204	a	0.16	NO	BSL
PYRENE	2/2	11 J	58	29.8	29.8	LL6SD-010-0001-SD-D	NA	NA	NA	NA	195	a	0.30	NO	BSL
Pesticides PCBs (µg/kg)															
4,4'-DDE	1/2	1.5 J	2.4	1.18	1.95	LL6SD-010-0001-SD	NA	NA	NA	NA	3.16	a [4]	0.76	NO	BSL
AROCLOR-1260	1/2	6.5 J	9.6 J	4.45	8.05	LL6SD-010-0001-SD	NA	NA	NA	NA	59.8	a [5]	0.16	NO	BSL
Inorganics (mg/kg)															
ALUMINUM	9/9	4500	16200	10617	10617	LL6SD-001-0001-SD	13900	1/9	29000	NO	NA	NA	NA	NO	BKG
ANTIMONY	1/9	0.6	0.6	0.347	0.6	LL6SD-001-0001-SD	NA	NA	1.3	NO	NA	NA	NA	NO	BKG
ARSENIC	9/9	6.8	37	14.1	14.1	LL6SD-004-0001-SD	19.5	1/9	25	YES	9.79	a	3.78	YES	ASL
BARIUM	9/9	30	95	72.4	72.4	LL6SD-004-0001-SD	123	0/9	190	NO	NA	NA	NA	NO	BKG
BERYLLIUM	9/9	0.41 B	0.82	0.595	0.595	LL6SD-014-0001-SD	0.38	9/9	0.8	YES	NA	NA	NA	YES	NTX
CADMIUM	5/9	0.1 B	1.1	0.349	0.559	LL6SD-004-0001-SD	NA	NA	0.79	YES	0.99	a	1.11	YES	ASL
CALCIUM	9/9	620	22000	4698	4698	LL6SD-010-0001-SD-D	5510	1/9	21000	YES	NA	NA	NA	NO	NUT
CHROMIUM	9/9	9.1	23.2	16	16	LL6SD-001-0001-SD	18.1	2/9	29	NO	43.4	a	0.53	NO	BKG,BSL
COBALT	9/9	6.3	15	9.40	9.40	LL6SD-003-0001-SD	9.1	5/9	12	YES	50	b	0.30	NO	BSL
COPPER	9/9	13	97	38.3	38.3	LL6SD-014-0001-SD	27.6	3/9	32	YES	31.6	a	3.07	YES	ASL
IRON	9/9	16000 H	27500 H	22111	22111	LL6SD-001-0001-SD	28200	0/9	41000	NO	NA	NA	NA	NO	BKG
LEAD	9/9	11	156	51.3	51.3	LL6SD-001-0001-SD	27.4	6/9	47	YES	35.8	a	4.36	YES	ASL
MAGNESIUM	9/9	670	3880	2611	2611	LL6SD-001-0001-SD	2760	4/9	7100	NO	NA	NA	NA	NO	NUT
MANGANESE	9/9	240	770	409	409	LL6SD-003-0001-SD	1950	0/9	1500	NO	NA	NA	NA	NO	BKG
MERCURY	9/9	0.014 B	0.25	0.0757	0.0757	LL6SD-015-0001-SD	0.06	3/9	0.12	YES	0.18	a	1.39	YES	ASL
NICKEL	9/9	12	31	19.8	19.8	LL6SD-010-0001-SD and Dup	17.7	5/9	33	NO	22.7	a	1.37	NO	BKG
POTASSIUM	9/9	400	1820	1116	1116	LL6SD-001-0001-SD	1950	0/9	6800	NO	NA	NA	NA	NO	NUT
SELENIUM	4/9	0.66 B	1.3 B	0.594	0.823	LL6SD-004-0001-SD	1.7	0/9	1.7	NO	NA	NA	NA	NO	BKG
SODIUM	1/9	243	243	82.4	243	LL6SD-001-0001-SD	112	1/9	NA	YES	NA	NA	NA	NO	NUT
VANADIUM	9/9	13	27.2	19.3	19.3	LL6SD-001-0001-SD	26.1	1/9	40	NO	NA	NA	NA	NO	BKG
ZINC	9/9	49	450	142	142	LL6SD-004-0001-SD	532	0/9	160	NO	121	a	3.72	NO	BKG
Miscellaneous Parameters															
NITROCELLULOSE (µg/kg)	2/2	1500	2200	1900	1900	LL6SD-003-0001-SD	NA	NA	NA	NA	NA	NA	NA	YES	NTX
TOTAL ORGANIC CARBON (mg/kg)	8/8	3900	27000	11300	11300	LL6SD-004-0001-SD	NA	NA	NA	NA	NA	NA	NA	NO	NA

Notes:
Shaded cells are chemicals that are retained as COPCs.
1 - Background criteria as described in Section 4.
2 - For duplicate pairs, the average chemical concentrations of the original and duplicate samples were compared to the site background criteria.
3 - Rationale Codes:
Above Screening Level (ASL)
Toxicity information not available (NTX)
Maximum detected concentration is less than the site background criteria or Ohio Sediment Reference Value (BKG)
Below Screening Level (BSL)
Essential Nutrient (NUT)
4 - Value is based on sum DDE.
5 - Value is based on total PCBs.
Sources of Screening Levels and Hierarchy for Selection:
a - Threshold Effects Concentration from MacDonald et al. (2000)
b - Ecological Data Quality Level (USEPA Region 5, 1999)

Table 7–3
Ecological COPC Selection Table for Surface Water

Parameter	Frequency of Detection	Minimum Concentration	Maximum Concentration	Mean Concentration	Average of Positive Detects	Sample of Maximum Detect	Site Background Criteria[1]	Detects > Site Background Criteria[2]	Max Conc > Bkg Conc	Surface Water Screening Level		HQ	Selected as a COPC?	Rationale[3]
										Value	Source			
Volatile Organics (µg/L)														
ACETONE	1/1	2.2	8.2	5.2	5.2	LL6SW-002-0001-SW-D	NA	NA	NA	NA	NA	NA	YES	NTX
Semivolatile Organics (µg/L)														
4-METHYLPHENOL	1/1	0.26 J	0.36 J	0.31	0.31	LL6SW-002-0001-SW-D	NA	NA	NA	480[4]	a	0.001	NO	BSL
Inorganics (µg/L)														
ALUMINUM	5/5	97.2 B	16000	5091	5091	LL6SW-004-0001-SW	3370	2/5	YES	87	b	184	YES	ASL
ARSENIC	3/5	1.6 B	26	7.83	11.9	LL6SW-004-0001-SW	3.2	2/5	YES	340[5]	a	0.08	NO	BSL
BARIUM	5/5	15.2	230	78.3	78.3	LL6SW-004-0001-SW	47.5	3/5	YES	2000[4]	a	0.12	NO	BSL
BERYLLIUM	2/5	0.31 B	0.8 B	0.656	0.555	LL6SW-004-0001-SW	NA	NA	NA	18[4,6]	a	0.044	NO	BSL
CADMIUM	1/5	1.1 B	1.1 B	0.552	1.1	LL6SW-004-0001-SW	NA	NA	NA	1.35[4,5,6]	a	0.81	NO	BSL
CALCIUM	5/5	11000 H	72000	42390	42390	LL6SW-002-0001-SW	41400	3/5	YES	NA	NA	NA	NO	NUT
CHROMIUM	3/5	1.6 B	23	8.1	11.6	LL6SW-004-0001-SW	NA	NA	NA	247[4,5,6]	a	0.09	NO	BSL
COBALT	3/5	1.1 B	22	5.94	8.9	LL6SW-004-0001-SW	NA	NA	NA	220[4]	a	0.10	NO	BSL
COPPER	4/5	3.6 B	31	11.8	13.6	LL6SW-004-0001-SW	7.9	2/5	YES	5.15[4,5,6]	a	6.02	YES	ASL
IRON	5/5	1000	38000	10725	10725	LL6SW-004-0001-SW	2560	2/5	YES	1000	b	38	YES	ASL
LEAD	4/5	0.96 B	83	23.1	28.6	LL6SW-004-0001-SW	NA	NA	NA	26[4,5,6]	a	3.19	YES	ASL
MAGNESIUM	5/5	2100	8800	6224	6224	LL6SW-004-0001-SW	10800	0/5	NO	NA	NA	NA	NO	NUT
MANGANESE	5/5	62	11000	2746	2746	LL6SW-004-0001-SW	391	2/5	YES	NA	NA	NA	YES	NTX
MERCURY	2/5	0.072 B	0.12 B	0.0682	0.096	LL6SW-004-0001-SW	NA	NA	NA	1.4[5]	a	0.09	NO	BSL
NICKEL	2/5	12	25	8.78	18.5	LL6SW-004-0001-SW	NA	NA	NA	198[4,5,6]	a	0.13	NO	BSL
POTASSIUM	5/5	2100	5500	3505	3505	LL6SW-005-0001-SW	3170	2/5	YES	NA	NA	NA	NO	NUT
SELENIUM	1/5	7.2	7.2	3.94	7.2	LL6SW-004-0001-SW	NA	NA	NA	5[7]	a	1.44	YES	ASL
SODIUM	5/5	530 B	3200	1627	1627	LL6SW-004-0001-SW	21300	0/5	NO	NA	NA	NA	NO	NUT
VANADIUM	2/5	14	28	9.32	21	LL6SW-004-0001-SW	NA	NA	NA	150[4]	a	0.19	NO	BSL
ZINC	5/5	4.7 B	430	106	106	LL6SW-004-0001-SW	42	2/5	YES	49[4,5,6]	a	8.78	YES	ASL
Miscellaneous Parameters (mg/L)														
NITROCELLULOSE	1/1	0.1	0.1	0.05	0.05	LL6SW-002-0001-SW-D	NA	NA	NA	NA	NA	NA	YES	NTX

Notes:
Shaded cells are chemicals that are retained as COPCs.
1 - Background criteria as described in Section 4.
2 - For duplicate pairs, the average chemical concentrations of the original and duplicate samples were compared to the site background criteria.
3 - Rationale Codes:
Above Screening Level (ASL)
Below Screening Level (BSL)
Essential Nutrient (NUT)
Toxicity information not available (NTX)
Persistent, Bioaccumulative, and Toxic chemical (PBT)
4 - Outside Mixing Zone Maximum value.
5 - Dissolved criteria.
6 - Based on a calculated water hardness of 36.1 mg/L (in order to be most conservative, the minimum hardness at location LL6SW-003 was used).
7 - Outside Mixing Zone Average value. An Outside Mixing Zone Maximum value is not available.

Sources of Screening Levels and Hierarchy for Selection:
a - Ohio Water Quality Criteria
b - USEPA Recommended Water Quality Criteria

7.5 Methodology for Refining Conservative Exposure Assumptions

As discussed in Section 7.1, Step 3a is technically the first step of a BERA (although it is included in this SERA) and consists of refining the conservative exposure assumptions/concentrations when evaluating potential risks to ecological receptors (i.e., plants, invertebrates, and wildlife receptors) and re-evaluating the analytical data using benchmarks that may be more appropriate for the assessment endpoints. The objective of the Step 3a evaluation is to reduce the number of chemicals retained as COPCs, if possible, so the SERA can focus on the remaining COPCs that pose the greatest risks to ecological receptors. The Step 3a evaluation is designed to eliminate chemicals from further evaluation for certain groups of receptors.

7.5.1 Surface Soil

Chemicals that were initially selected as COPCs in surface soil were further evaluated to determine potential risks to: (1) plants, (2) invertebrates, and (3) wildlife (i.e., mammals and birds). This evaluation was conducted to determine whether there are potential risks to the three receptor groups (i.e., plants, invertebrates, and wildlife) or to only one or two of the receptor groups. This is important because if the site proceeds further in a BERA, the studies in the BERA should focus only on the receptors that are potentially at risk. The first step in the Step 3a evaluation was to compare the maximum and average chemical concentrations in the soil to toxicity benchmarks that are based on effects to earthworms and plants. Tables 7–4 and 7–5 present this comparison for earthworms and plants, respectively.

The following hierarchy was used to select the earthworm benchmark in Table 7–4:

- USEPA ecological soil screening levels (Eco-SSLs) for earthworms (USEPA, 2005e and USEPA, 2005n) and individual documents for each chemical). These values were selected first because they are USEPA values and the most recent.
- The greater of the values from the following two sources. :
    - Canadian Soil Quality Guidelines (individual documents for each chemical): or
    - Oak Ridge National Laboratory (ORNL), *Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision* (Efroymson et al., 1997b).

Because both of these sources are typically used as screening levels in ERAs, the values from either source should be protective of earthworms. For that reason, the greater value was selected to refine the list of chemicals retained as COPCs.

Table 7–4
Direct Toxicity to Earthworms

Parameter	Frequency of Detection	Maximum Concentration	Average Concentration	Earthworm Toxicity Benchmark		Maximum > TRV	Average > TRV
				Value	Source		
Semivolatile Organics (µg/kg)							
CARBAZOLE	1/11	140 J	31.6	No TRV	NA	No TRV	No TRV
DIBENZOFURAN	1/11	45 J	5.55	No TRV	NA	No TRV	No TRV
Energetics (µg/kg)							
HMX	1/17	190 J	70.6	No TRV	NA	No TRV	No TRV
Total Metals (mg/kg)							
ALUMINUM	75/75	21000	12536	pH[(1)]	a	NA	NA
ARSENIC	75/75	41	12	60	b	NO	NO
CADMIUM	13/75	6.8	0.199	140	a	NO	NO
CHROMIUM	75/75	29	16.7	64	c	NO	NO
COBALT	75/75	33	9.09	No TRV	NA	No TRV	No TRV
COPPER	75/75	627	23.8	60	c	YES	NO
IRON	75/75	45000	23460	No TRV	NA	No TRV	No TRV
LEAD	75/75	250	29.2	1700	a	NO	NO
MANGANESE	75/75	1800	445	No TRV	NA	No TRV	No TRV
MERCURY	74/75	0.6	0.0414	12	c	NO	NO
NICKEL	75/75	36	19.3	200	b	NO	NO
SELENIUM	29/75	2.5	0.516	70	b	NO	NO
VANADIUM	75/75	32	21.3	130	c	NO	NO
ZINC	75/75	280	66.4	200	c	YES	NO
Miscellaneous Parameters							
NITROCELLULOSE (µg/kg)	10/10	10100	2454	No TRV	NA	No TRV	No TRV

Notes:
- Average concentration includes positive detections and non-detected results. Detection limits are divided by two for non-detected values.
- Frequency of detection refers to number of times compound was detected among all samples versus total number of samples analyzed for that parameter.
- Number of samples may vary based on the number of usable results.
- Shaded cells are chemicals that are retained for further evaluation in Step 3a.

1 - Benchmark for aluminum is based on the pH of the soil.

Sources of Earthworm Toxicity Benchmarks:

a - Ecological Soil Screening Level (Eco-SSL) from U.S. EPA (2005).
b - Earthworm toxicity benchmark from Efroymson et al. (1997b).
c - Canadian Soil Quality Guideline (SQG) from Environment Canada (EC, 1999).

Table 7–5
Direct Toxicity to Plants

Parameter	Frequency of Detection	Maximum Concentration	Average Concentration	Plant Toxicity Benchmark		Maximum > TRV	Average > TRV
				Value	Source		
Energetics (µg/kg)							
HMX	1/17	190 J	70.6	No TRV	NA	No TRV	No TRV
Total Metals (mg/kg)							
ALUMINUM	75/75	21000	12536	pH[(1)]	a	NA	NA
ARSENIC	75/75	41	12	18	a	YES	NO
CADMIUM	13/75	6.8	0.199	32	a	NO	NO
CHROMIUM	75/75	29	16.7	64	c	NO	NO
COBALT	75/75	33	9.09	13	a	YES	NO
COPPER	75/75	627	23.8	100	b	YES	NO
IRON	75/75	45000	23460	pH[(1)]	a	NA	NA
LEAD	75/75	250	29.2	120	a	YES	NO
MANGANESE	75/75	1800	445	500	b	YES	NO
MERCURY	74/75	0.6	0.0414	12	c	NO	NO
NICKEL	75/75	36	19.3	50	c	NO	NO
SELENIUM	29/75	2.5	0.516	1	b	YES	NO
VANADIUM	75/75	32	21.3	130	c	NO	NO
ZINC	75/75	280	66.4	200	c	YES	NO
Miscellaneous Parameters							
NITROCELLULOSE (µg/kg)	10/10	10100	2454	No TRV	NA	No TRV	No TRV

Notes:
- Average concentration includes positive detections and non-detected results. Detection limits are divided by two for non-detected values.
- Frequency of detection refers to number of times compound was detected among all samples versus total number of samples analyzed for that parameter.
- Number of samples may vary based on the number of usable results.
- Shaded cells are chemicals that are retained for further evaluation in Step 3a.

1 - Benchmarks for aluminum and iron are based on the pH of the soil.

Sources of Earthworm Toxicity Benchmarks:

a - Ecological Soil Screening Level (Eco-SSL) from U.S. EPA (2005).
b - Plant toxicity benchmark from Efroymson et al. (1997c).
c - Canadian Soil Quality Guideline (SQG) from Environment Canada (EC, 1999).

The following hierarchy was used to select the plant benchmark in Table 7–5:

- USEPA eco-SSLs for plants (USEPA, 2005 and individual documents for each chemical). These values were selected first because they are USEPA values and are the most recent values.
- The greater of the values from the following two sources:
    - Canadian Soil Quality Guidelines (individual documents for each chemical).
    - ORNL *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision* (Efroymson et al., 1997c).

Because both of these sources are typically used as screening levels in ERAs, the values from either source should be protective of plants. For that reason, the greater value was selected to refine the list of chemicals retained as COPCs.

If the chemical concentration is less than the benchmarks for earthworms and/or plants, it was concluded that risks from the chemical to that receptor group are unlikely and the chemical was not evaluated further in Step 3a for that receptor group.

If the chemical concentration was greater than the benchmarks for earthworms and/or plants (or the chemical does not have a benchmark), the chemical was further evaluated in Step 3a to determine whether the risks are great enough to warrant additional evaluations (i.e., proceed to a BERA and develop cleanup levels).

In addition, bioaccumulative chemicals that were retained as COPCs were further evaluated to determine whether there are likely risks to wildlife. If the chemical is not bioaccumulative, it was not carried through the food chain model (see Section 7.5.5), and it was concluded that the chemical is not likely causing a risk to wildlife. If the chemical is bioaccumulative, it was carried through the food chain model. The following bullets outline decisions that were made based on the results of the food chain model:

- If the HQ is less than 1.0 using average contaminant concentrations and the NOAEL as the toxicity reference value (TRV), it was concluded that risks from the chemical to wildlife are unlikely and the chemical was not evaluated further in Step 3a.
- If the HQ is greater than 1.0 using average contaminant concentrations and the NOAEL as the TRV, the chemical was further evaluated in Step 3a to determine whether the risks are great enough to warrant additional evaluations (i.e., proceed to a BERA and develop cleanup levels).

For chemicals evaluated further in Step 3a, the other Step 3a factors described below in Section 7.5.4 were used to determine whether the risks are great enough to warrant additional evaluations such as proceeding to a BERA and developing cleanup levels.

7.5.2 Sediment

Chemicals selected as COPCs in sediment were evaluated to assess risks to benthic invertebrates. The first step in the Step 3a evaluation was to compare the average chemical concentrations in the sediment to the screening level, and then to compare the maximum and average chemical concentrations in the sediment to higher effects levels (as described below). Table 7–6 presents this comparison.

As discussed in Section 7.3, the TEC from MacDonald el al., (2000) was used as the primary source of the sediment screening, followed by the USEPA Region 5 EDQL (USEPA Region 5, 1999). TECs are considered "lower effects levels" because they are intended to identify contaminant concentrations below which harmful effects on benthic invertebrates are not expected. Probable effects concentrations (PECs) are considered "higher effects levels" because they are intended to identify concentrations above which harmful effects are expected to occur. Therefore, the PECs were selected first as the higher effects level in Table 7–6. The severe effects level (SEL) from the Ontario sediment quality guidelines (OMOE, 1993) and the apparent effects threshold (AET) from Buchman (1999) were reviewed for beryllium and nitrocellulose because a PEC is not available for these chemicals; however, neither SELs nor AETs are available for these chemicals.

All of the chemicals that were selected as COPCs were evaluated further in Step 3a using the benchmarks described above, along with the other Step 3a factors described below, to determine whether the risks are great enough to warrant additional evaluations such as proceeding to a BERA and developing cleanup levels.

7.5.3 Surface Water

Chemicals selected as COPCs in surface water were further evaluated for risks to aquatic organisms using the other Step 3a factors described below to determine whether the risks are great enough to warrant additional evaluations (i.e., proceed to a BERA and develop cleanup levels).

7.5.4 Other Step 3a Factors

For chemicals that are evaluated further in Step 3a, the following factors were evaluated, as appropriate, to determine whether the risks are great enough to warrant additional evaluations (i.e., proceed to a BERA and develop cleanup levels).

Table 7–6
Step 3a Table for Evaluating Risks to Sediment Invertebrates

Parameter[1]	Frequency of Detection	Maximum Concentration	Average Concentration	Sediment Screening Level Comparison		Higher Effects-Level Comparison			
				Screening Level[2]	Average > Screening Level	Higher Effects Level	Source	Maximum > Higher Effects Level	Average > Higher Effects Level
Inorganics (mg/kg)									
ARSENIC	9/9	37	14.1	9.79	YES	33	a	YES	NO
BERYLLIUM	9/9	0.82	0.595	NO TRV	NA	No TRV	NA	NA	NA
CADMIUM	5/9	1.1	0.349	0.99	NO	5	a	NO	NO
COPPER	9/9	97	38.3	31.6	YES	149	a	NO	NO
LEAD	9/9	156	51.3	35.8	YES	128	a	YES	NO
MERCURY	9/9	0.25	0.0757	0.18	NO	1.06	a	NO	NO
Miscellaneous Parameters									
NITROCELLULOSE (µg/kg)	2/2	2200	1900	NO TRV	NA	No TRV	NA	NA	NA

Notes:
- Shaded cells are chemicals that are retained for further evaluation in Step 3a.

1 - This table only presents the chemicals that were retained as COPCs because the maximum detected concentration exceeded the screening level or the chemical did not have a screening level.
2 - Table 7-2 presents the source of the screening levels.

Sources of Higher Effects Levels:
a - Probable Effects Concentration from MacDonald et al. (2000).

- Magnitude of criterion exceedance: Although the magnitude of the risks may not relate directly to the magnitude of a criterion exceedance, the magnitude of the criterion exceedance may be one item used in a lines-of-evidence approach to determine the need for further site evaluation. The greater the criterion exceedance, the greater the probability and concern that risk is likely to exist.

- Frequency of chemical detection and spatial distribution: A chemical detected at a low frequency typically is of less concern than a chemical detected at higher frequency if toxicity, concentrations, and spatial areas represented by the data are similar. All else being equal, chemicals detected frequently were given greater consideration than those detected infrequently.

- Contaminant bioavailability: Many contaminants (especially metals) are present in the environment in forms that are typically not bioavailable, and the limited bioavailability was considered when evaluating the exposures of receptors to site contaminants. Contaminants with generally less bioavailability are considered to be less toxic than the more bioavailable contaminants, all other factors being equal.

- Habitat: Although exceedances of criteria may occur, potential risks to ecological receptors may be minimal if there is little habitat for those receptors. Therefore, the extent of habitat was used qualitatively when considering additional evaluation. Areas with little habitat were less of a concern than areas with suitable habitat to support the receptors of interest.

- Alternate benchmarks: Use of alternate benchmarks ensures that more realistic exposure assumptions are evaluated. However, some of the alternate benchmarks are overly protective for some receptors and may not have been used in some cases. For example, the EDQLs and PRGs for soil may be based on risks to small mammals. Therefore, an exceedance of that EDQL does not necessarily indicate that potential risks to plants or invertebrates exist, so other more appropriate benchmarks were used to evaluate potential risks to those receptors (as is reported in Tables 7–4 and 7–5). Use of these alternate benchmarks was case-specific, and the justification for their use is explained in Section 7.6. Additionally, screening values may not have been available for some chemicals in some media. For example, chemicals retained as COPCs in Tables 7–1, 7–2, and 7–3 are evaluated in Step 3a using alternate benchmarks when available.

7.5.5 Terrestrial Food Chain Modeling

Terrestrial intake modeling was used to estimate the exposure of the COPCs to terrestrial wildlife receptors to evaluate potential risks to terrestrial wildlife ingesting soil, surface water, plants, invertebrates, and small mammals. Note that the food chain model incorporates chemical concentrations that are estimated into various food items (i.e., plants, invertebrates), but it does not model the amount of chemical transferred from one trophic level to the next.

Chemicals evaluated in the terrestrial food chain model were limited to those identified by the USEPA as bioaccumulative (USEPA, 2000). Although wildlife may be exposed to non-bioaccumulative chemicals via direct ingestion of the media (i.e., soil), the exposure to the chemical will be low compared to the exposure to bioaccumulative chemicals through the food. It is common practice to only include bioaccumulative chemicals in food chain models and this approach results in more chemicals being included in the food chain model than what is required by Ohio EPA (2003) in their risk assessment guidance. In Attachment A, Section 2, of Ohio EPA (2003), it states that "Food-web and direct contact evaluations are required for a Level III ERA and are dependent upon the type of contamination and the affected media. … Persistent, bioaccumulative and toxic (PBT, see Level II ERA guidance) compounds are also to be evaluated using direct contact and food-web models…" The Ohio PBT list is only a subset of the list of bioaccumulative chemicals. Therefore, only bioaccumulative chemicals were included in the food chain model.

Risk to terrestrial receptors from COPCs in the soil, surface water, and prey is determined by estimating the chronic daily intake (CDI) and comparing the CDI to TRVs representing acceptable daily doses in mg/kg/day. The TRVs are developed from NOAELs and lowest-observed-adverse-effect-levels (LOAELs) obtained from wildlife studies, if available. The majority of the TRVs are obtained from the ORNL *Toxicological Benchmarks for Wildlife: 1996 Revision* (Sample et al., 1996). Other sources for NOAELs and LOAELs were used as necessary. Appendix Y presents the TRVs that are used in this report and the derivation of the TRVs using the body-weight scaling equation presented below.

For avian species, the NOAEL (or LOAEL) for the test species is used as the NOAEL (or LOAEL) for the surrogate species in accordance with Sample et al. (1996). For mammalian species, the NOAEL (or LOAEL) from one species is adjusted to a NOAEL (or LOAEL) for the surrogate species using the following body-weight scaling equation from Sample et al. (1996):

$$NOAEL_W = NOAEL_t * (bwt/bww)^{0.25}$$

Where: $NOAEL_w$ = no-observed-adverse-effect-level for the surrogate wildlife species
$NOAEL_t$ = no-observed-adverse-effect-level for the test species
bwt = body weight of the test species
bww = body weight of the surrogate test species

The body-weight scaling is done because studies have shown that, for mammals, numerous physiological functions such as metabolic rate, as well as responses to toxic chemicals, are a function of body size (Sample et al., 1996). However, Sample et al. (1996) indicated that physiological scaling factors may not be appropriate for birds. Therefore, no body-weight scaling was conducted for the bird TRVs. The TRV for PAHs of 2 mg/kg/day is based on a chronic study using 7,12–dimethylbenz(a,h)anthracene (Trust et al., 1994). Appendix Y presents the body weights that are used for the surrogate and potential test species.

The Ravenna ERA guidance provided one set of TRVs that were based either on NOAELs, or based on LOAELs that were divided by 10. Therefore, LOAEL TRVs were estimated by multiplying the TRVs from the Ravenna ERA guidance by 10.

7.5.5.1 Characterization of Exposure

This section describes the potential or actual contact or co-occurrence of the contaminants with the receptors to determine their exposure dose.

Terrestrial soil invertebrates and plants are exposed to contaminants in the surface soil through direct contact, ingestion, or both. Aquatic organisms and benthic invertebrates are exposed to contaminants in the surface water and sediment through direct contact, ingestion, or both. The maximum or selected upper confidence level (UCL), whichever is lower, and average soil, and/or surface water concentrations are used in the food chain model to obtain a range of exposure from ingestion of soil, surface water, or both.

Exposure of the terrestrial receptors to the COPCs in the surface soil and surface water is determined by estimating the daily doses in mg/kg/day using exposure equations. The contaminant concentrations in the surface soil and surface water are used to calculate the CDI doses. The following equation presents the food chain model that is used for the surrogate species selected for modeling:

$$CDI\ Dose\,(mg/kg/day) = \frac{(FI * FC) + (WI * C_{sw}) = (SI * C_{ss})}{BW}$$

Where: CDI = chronic daily intake (mg/kg/day)
FI = food ingestion rate (kg/day)
FC = food concentration (mg/kg)
WI = surface water ingestion rate (L/day)
C_{Sw} = contaminant concentration in surface water (mg/L)
BW = body weight (kg)
SI = incidental soil ingestion rate (kg/day)
C_{Ss} = contaminant concentration in surface soil (mg/kg)

For inorganic and organic constituents in surface soil, the contaminant concentration of the prey items (i.e., earthworms) is calculated using the following equation:

$$FC = C_{ss} * BAF$$

Where: FC = contaminant concentration in food (mg/kg)
C_{ss} = contaminant concentration in soil (mg/kg)
BAF = bioaccumulation factor (chemical-specific)

For inorganic and organic constituents in small mammal tissue, the contaminant concentration of the prey items (i.e., small mammal) is calculated using the following equation:

$$FC = C_{ss} * BAF_{si} * BAF_{dm}$$

Where:
- FC = contaminant concentration in food (mg/kg)
- C_{ss} = contaminant concentration in soil (mg/kg)
- BAF_{si} = bioaccumulation factor for soil to invertebrate (chemical-specific)
- BAF_{dm} = bioaccumulation factor for diet to mammal (chemical-specific)

The exposure assumptions (i.e., ingestion rate, body weight) are obtained from the RVAAP ecological risk guidance (USACE, 1999). Appendix Y presents the exposure parameters that are used in the SERA. The receptors home ranges were not quantitatively used in the food chain model because the home ranges for most of the receptors were less than the size of LL6 (51 acres). Although the home ranges for the owl, fox, and hawk are greater than 51 acres (see Table W-5), the home ranges were not used in the initial food chain to be conservative. If the HQs from the conservative food chain model for the owl, fox, and hawk are greater than 1.0, the home ranges would be quantitatively used for the refinement.

7.5.5.2 Ecological Risk Characterization

The risk characterization is the final phase of a risk assessment that compares the exposure to the ecological effects. It is at this phase that the likelihood of adverse effects occurring as a result of exposure to a stressor will be evaluated. The HQ approach (as described in Section 7.4) is used to characterize the risk to terrestrial receptors. This approach characterizes the potential effects by comparing exposure concentrations with the effects data. An HQ greater than 1.0 is considered to indicate a potential risk. The HQ is not an expression of probability. The HQ for the terrestrial wildlife model is calculated as follows:

$$\mathrm{HQ} = \frac{Dose}{TRV}$$

Where: HQ = ecological effects quotient (unitless)
Dose = daily intake dose (mg/kg/day)
TRV = toxicity reference value (NOAEL or LOAEL) (mg/kg/day)

7.6 Step 3a Refinement

Subsequent to the initial screening, other factors were considered to further refine COPCs, as discussed in Section 7.5. The following sections present the results of the Step 3a refinement.

7.6.1 Risks to Terrestrial Plants and Invertebrates

Potential risks to terrestrial plants and terrestrial invertebrates from exposure to COPCs were evaluated using the methodologies described in Section 7.5.1. The following subsections

discuss whether the chemicals initially selected as COPCs should be retained for further evaluation of risks to soil invertebrates and terrestrial vegetation. Note that bioaccumulative chemicals that were detected at concentrations less than their respective screening levels are not discussed in the following sections because the chemicals are not COPCs for risks to plants and invertebrates (see Table 7–1).

Tables 7–4 and 7–5 summarize the results of potential direct toxicity of chemicals in soil to earthworms and plants, respectively. The tables list only the chemicals that were retained as COPCs because they were detected at concentrations that exceeded screening levels or they did not have screening levels. Chemicals that were retained as COPCs because they were bioaccumulative are not listed on the table. Both maximum and average concentrations are compared to the toxicity benchmarks for earthworms. Copper and zinc were the only chemicals with maximum detected concentrations that were greater than the earthworm toxicity benchmarks; however, the average chemical concentrations for these chemicals were not greater than the benchmarks. Arsenic, cobalt, copper, lead, manganese, selenium, and zinc were the only chemicals with maximum concentrations that were greater than the plant toxicity benchmarks; the average chemical concentrations for these chemicals were not greater than the plant benchmarks. Earthworm and/or plant benchmarks were not available for several of the chemicals. The following text presents the Step 3a evaluation for the chemicals listed above that were detected at concentrations greater than the earthworm or plant toxicity benchmarks and chemicals that do not have earthworm or plant toxicity benchmarks.

Carbazole and Dibenzofuran

Carbazole and dibenzofuran were initially selected as COPCs because screening levels are not available. Toxicity information for these SVOCs is not available; therefore, these chemicals are further evaluated using the other Step 3a factors discussed in Section 7.5.4. Both carbazole and dibenzofuran were detected infrequently in only one of 11 surface soil samples. Additionally, these chemicals were detected at concentrations similar to those of other detected SVOCs, which had HQs that were less than 1.0. For these reasons, carbazole and dibenzofuran are not retained as COPCs.

HMX

HMX was initially selected as a COPC because a screening level is not available. The only available alternate toxicity information for HMX is the lowest-observed-effect concentration (LOEC) (280 mg/kg) for earthworm reproduction, reported by Robidoux et al. (2001).

The LOEC was based on the number of juveniles hatching per cocoon being significantly reduced by HMX at 280 mg/kg in soil; a no-observed-effect concentration (NOEC) was not generated from the study (Robidoux et al., 2001). Also, productivity of cocoons and juveniles as well as total biomass of juveniles were significantly reduced by HMX at >280 mg/kg in soil

(Robidoux et al., 2001). The maximum concentration of HMX (0.19 mg/kg) is significantly lower than the LOEC for earthworm reproduction from Robidoux et al. (2001) and less than the estimated NOEC of 28 mg/kg (i.e., if the LOEC is divided by an uncertainty factor of 10). Therefore, risks to earthworms at LL–6 are unlikely.

Toxicity information for plants could not be located; however, HMX was detected only once in 17 samples. Additionally, the majority of LL–6 is vegetated and plants do not appear to be affected overall. Therefore, the low frequency of detection combined with the relatively low concentration (with respect to the earthworm LOEC) does not warrant retaining HMX for further evaluation in a BERA. In summary, risks to plants and invertebrates from HMX are unlikely, and HMX is not retained as a COPC for risks to plants or invertebrates.

Aluminum

Aluminum was initially selected as a COPC because the maximum concentration (21,000 mg/kg) exceeded the ORNL plant benchmark (50 mg/kg) (Efroymson et al., 1997c). However, the screening value is the toxicological benchmark to protect plants, based on laboratory toxicity testing using soluble aluminum added to soils. The standard analytical measurement of aluminum in soils is total recoverable aluminum (soluble + fixed). Comparison of total aluminum concentration in soils to soluble aluminum-based benchmarks and screening values is probably not appropriate. The USEPA Eco-SSL document indicates that aluminum should be identified as a COPC only at sites where the soil pH is less than 5.5 (USEPA, 2003a). No soil pH was collected at LL–6, but the average soil pH levels at LL–2, LL–3, and LL–4 were greater than 5.5 (USACE, 2003a, 2003b, and 2003c); therefore, it is likely that soil pH at LL–6 is also greater than 5.5. Additionally, only 5 of 75 samples were greater than the site background concentration (17,700 mg/kg), and the maximum concentration is only slightly greater than the background concentration. With these considerations, potential impacts from aluminum are unlikely. Consequently, the risks to plants and invertebrates from aluminum are unlikely and aluminum is not retained as a COPC for risks to plants or invertebrates.

Arsenic

This inorganic chemical was initially selected as a COPC because the maximum detected concentration (41 mg/kg) exceeded the ORNL PRG (9.9 mg/kg) (Efroymson et al., 1997a). The PRG is based on risks to wildlife (short-tail shrew) and plants. No direct toxicity to earthworms is expected based on the ORNL earthworm benchmark of 60 mg/kg (see Table 7–4). Although potential risks to plants are possible because the maximum concentration is greater than the USEPA Eco-SSL for plants (18 mg/kg), arsenic is not retained as a COPC for further evaluation in the ERA for several reasons. Samples at only three locations exceeded the Eco-SSL for plants: LL6SS–013–0001–SO/LL6SB–013–0001–SO (20 mg/kg), LL6SS–020–0001–SO/LL6SB–020–0001–SO (19 mg/kg), and LL6SS–007–0001–SO/LL6SB–007–0001–SO (41 mg/kg). However, two of the three samples that exceeded the Eco-SSL had concentrations

only slightly greater than the plant Eco-SSL. Additionally, the maximum detected arsenic concentration of 41 mg/kg is only two times greater than the background concentration. The average arsenic concentration of 12 mg/kg was compared to the Eco-SSL plant value to determine whether potential risks are widespread. The average arsenic concentration was less than the Eco-SSL for plants and the background concentration (15.4 mg/kg). Additionally, the majority of LL–6 is heavily vegetated, so further evaluation of risk to plants in the BERA is not necessary. In summary, risks to plants and invertebrates from arsenic are unlikely and arsenic is not retained as a COPC for risks to plants or invertebrates. However, because arsenic is a bioaccumulative chemical, risks to wildlife from arsenic are evaluated in Section 7.7 of this ERA.

Cobalt

Cobalt was initially selected as a COPC because the maximum concentration (33 mg/kg) exceeded the ORNL PRG (20 mg/kg) (Efroymson et al., 1997a). The PRG is based on risks to plants. The maximum concentration also exceeded the Eco-SSL for plants (13 mg/kg; see Table 7–5). No toxicity information is available for risks to earthworms. Cobalt exceeded the ORNL PRG in only two of 75 samples. In fact, all other sample concentrations were less than the PRG and similar to the background concentration of 10.4 mg/kg. Therefore, the average cobalt concentration was compared to the PRG, Eco-SSL, and background concentration. The average cobalt concentration (9.09 mg/kg) is less than the plant benchmarks. Although no toxicity information is available for soil invertebrates, the average cobalt concentration is less than the background concentration, indicating potential site-related impacts on soil invertebrates are not likely. The potentially affected areas are small, and widespread risks are not expected; therefore, cobalt is not retained as a COPC.

Copper

Copper was initially selected as a COPC because the maximum concentration (627 mg/kg) exceeded the ORNL PRG (60 mg/kg), which is based on earthworm toxicity. The maximum concentration also exceeded the Eco-SSL for earthworms (60 mg/kg; see Table 7–4) and the ORNL plant benchmark (100 mg/kg, see Table 7–5). However, the duplicate sample concentration at the location of the maximum concentration (145 mg/kg) was significantly lower than the maximum concentration. Copper concentrations exceeded the earthworm and plant benchmarks in only four samples at two locations (i.e., exceeded benchmarks in both the original and duplicate samples collected at two separate locations) not directly adjacent to each other. Concentrations at all other locations were less than the earthworm and plant benchmarks and were similar to the background concentration (17.7 mg/kg). Therefore, the potentially affected areas are small and widespread risks are not expected. For this reason, risks from copper are unlikely, and copper is not retained as a COPC.

Iron

Iron was initially retained as a COPC because both the maximum (45,000 mg/kg) and average (23,460 mg/kg) soil concentration greatly exceeded the screening level based on toxicity to microorganisms (200 mg/kg). According to the Eco-SSL for iron (USEPA, 2003b), iron is essential for plant growth and is generally considered to be a micronutrient. Because plants regulate its uptake, iron is not expected to be toxic to plants in well-aerated soils with pH levels between 5 and 8 (S.U.) (USEPA, 2003b). Although soil pH data has not been collected at LL–6, the average soil pH levels at Load Lines 2, 3, and 4 were within the pH range of 5 to 8 S.U. (SAIC, 2003a, 2003b, and 2003c)); therefore, it is likely that soil pH at LL–6 is also greater than 5.5. Therefore, iron is not expected to be toxic to plants at the site. No toxicity data was located to evaluate risks to invertebrates from iron. However, because iron is generally considered a non-toxic metal, it is highly unlikely that soil invertebrates are being affected by iron at the site. For these reasons, iron is not retained as a COPC for risks to these receptors.

Lead

Lead was initially selected as a COPC because the maximum concentration (250 mg/kg) exceeded the ORNL PRG (40.5 mg/kg). The PRG is based on dietary toxicity to the woodcock; therefore, lead concentrations were further compared to toxicity benchmarks for earthworms and plants. The maximum lead concentration is less than the Eco-SSL for earthworms (1,700 mg/kg); therefore, lead is not retained as a COPC for these receptors.

The Eco-SSL for plants is 120 mg/kg (see Table 7–5). Only four samples (at three locations) exceeded the plant Eco-SSL. The area represented by these three locations (LL6SS–007–0001–SO/LL6SB–007–0001–SO, LL6SS–015–0001–SO/LL6SB–015–0001–SO, and LL6SS–034–0001–SO/LL6SB–034–0001–SO) is small when compared to the overall load line. These three locations are not immediately adjacent to each other and are bounded by other samples. Although the maximum concentration is twice that of the Eco-SSL for plants, the maximum concentration was detected in the duplicate sample collected at LL6SS–015–0001–SO/LL6SB–015–0001–SO. The lead concentration in the original sample collected at this location (130 mg/kg) only slightly exceeded the plant Eco-SSL. Concentrations at the other two locations were also not exceedingly high in comparison to the Eco-SSL: LL6SS–007–0001–SO/LL6SB–007–0001–SO (150 mg/kg) and LL6SS–034–0001–SO/LL6SB–034–0001–SO (180 mg/kg). Additionally, LL–6 is heavily vegetated. For these reasons, risks to plants from lead are not expected so lead is not retained as a COPC for risks to plants. However, because lead is a bioaccumulative chemical, risks to wildlife from lead are evaluated in Section 7.7 of this ERA.

Manganese

Manganese (like iron) was initially selected as a soil COPC because the maximum soil concentration (1,800 mg/kg) exceeded the screening level based on toxicity to microorganisms

(100 mg/kg). No benchmark for earthworms was available, but the maximum soil concentration exceeds the plant toxicity benchmark (500 mg/kg). The maximum detected manganese concentration of 1,800 mg/kg at location LL6SS–032–0001–SO/LL6SB–032–0001–SO is only slightly greater than the background concentration of 1,420 mg/kg. Additionally, the duplicate concentration at LL6SS–032–0001–SO/LL6SB–032–0001–SO was much lower at 810 mg/kg, and the average of the original and duplicate sample at this location is less than the background value. No other detection at LL–6 exceeds the background value. Therefore, site-related risks to plants and invertebrates from manganese are not likely, and manganese is not retained as a COPC for risks to plants or invertebrates.

Selenium

Selenium was initially selected as a COPC because the maximum soil concentration (2.5 mg/kg) exceeded the ORNL PRG (0.21 mg/kg). The PRG is based on dietary toxicity to the mouse; therefore, selenium concentrations were further compared to toxicity benchmarks for earthworms and plants.

The maximum concentration is less than the ORNL benchmark for earthworms (70 mg/kg); therefore, selenium is not retained as a COPC for risks to earthworms. The maximum concentration exceeds the ORNL benchmark for plants (1 mg/kg); however, the ORNL plant benchmark is less than the background concentration of 1.4 mg/kg. The maximum concentration only slightly exceeds the background concentration. All other detected concentrations were less than or only slightly greater than the background concentration, indicating selenium concentrations are typical of background variation and not site activities. Therefore, site-related risks to selenium are not likely, and selenium is not retained as a COPC for risks to plants or invertebrates. However, because selenium is a bioaccumulative chemical, risks to wildlife from selenium are also evaluated in Section 7.7 of this ERA.

Zinc

Zinc was initially selected as a COPC because the maximum soil concentration (280 mg/kg) exceeded the soil screening level of 8.5 mg/kg and was greater than the RVAAP installation background criteria concentration (61.8 mg/kg). The soil screening level is based on dietary toxicity to wildlife (woodcock). The selected alternate benchmark for risks to plants and invertebrates was the Canadian soil quality guideline (SQG) (EC, 1999). The maximum detected concentration, exceeded the Canadian SQG (200 mg/kg); however, the maximum concentration was detected in the duplicate sample at location LL6SS–015–0001–SO/LL6SB–015–0001–SO, and the concentration in the original sample at this location (160 mg/kg) was less than the SQG. In fact, every other sample concentration at LL–6 was less than the SQG. The Canadian SQG for zinc of 200 mg/kg is the lowest LOEC of the plants and invertebrate data set and is based on an effect on seedling emergence for radish (EC, 1999). As presented in Appendix VI of the Canadian SQG document (EC, 1999), all of the earthworm effects and no-

effects data (with the exception of one test in one study) were equal to or greater than 200 mg/kg, indicating that earthworms appear to be less sensitive to zinc than plants. Additionally, the average zinc concentration of 66.4 mg/kg is similar to the background concentration of 61.8 mg/kg. Based on the single detected concentration just slightly greater than the Canadian SQG, the potential risks to plants and invertebrates are not great enough to warrant proceeding further in the ERA process for zinc.

Therefore, zinc is not retained as a COPC for risks to plants or invertebrates. However, because zinc is a bioaccumulative chemical, risks to wildlife from zinc are also evaluated in Section 7.7 of this ERA.

Nitrocellulose

Nitrocellulose was initially selected as a COPC because a screening level is not available. Although it is probable that nitrocellulose is related to site activities, nitrocellulose is typically considered to be a relatively inert compound, so it is unlikely to affect plants or invertebrates. As such, nitrocellulose is not retained as a COPC for plants or invertebrates.

7.6.2 Risks to Benthic Invertebrates

Potential risks to benthic invertebrates from exposure to COPCs were evaluated using the method described in Section 7.5.2. The following subsections discuss whether the chemicals initially selected as COPCs should be retained for further evaluation of risks to benthic invertebrates.

As previously discussed in Sections 7.2.1 and 7.2.3.3, the drainage ditches at LL–6 are not perennial and are wet only seasonally depending on precipitation and temperature. Consequently, the drainage ditches provide poor ecological habitat and do not support benthic invertebrates year-round. One sample (LL6SD–001–0001–SD) was collected from the testing pond during the azide screening in March 2002. All other sediment samples were collected from the drainage ditches at LL–6 during the RI sampling investigation in December 2003.

Table 7–6 summarizes the results of potential direct toxicity of chemicals in sediment to benthic invertebrates. The table lists only the chemicals that were retained as COPCs because they were detected at concentrations that exceeded screening levels or they did not have screening levels. Table 7–6 presents the average chemical concentrations compared to the same screening levels that were used to select chemicals as COPCs because the COPC screening table (Table 7–2) only presented the comparison of the maximum concentrations to the screening levels. Table 7–6 also presents the maximum and average concentrations compared to the higher effects levels (i.e., the PEC as discussed in Section 7.5.2) for benthic invertebrates to display the range of probability of effects. Arsenic, copper, and lead were the only chemicals with average concentrations that were greater than the sediment screening level. Maximum

chemical concentrations for arsenic and lead also exceeded the higher effects level; average concentrations for the chemicals were less than the higher effects levels. Sediment benchmarks were not available for beryllium and nitrocellulose. The following text presents the Step 3a evaluation for the chemicals listed above that were detected at average concentrations greater than the sediment benchmarks and chemicals that do not have sediment benchmarks.

Arsenic

Arsenic was initially selected as a COPC because the maximum concentration (37 mg/kg) exceeded the site background criterion (19.5 mg/kg), the Ohio SRV (25 mg/kg), and the TEC (9.79 mg/kg). The maximum concentration also slightly exceeded the PEC (33 mg/kg) (see Table 7–6). The maximum concentration was detected at LL6SD–004–0001–SD, which is located in the top central portion of LL–6. Although the northern end of the load line (i.e., near the gate house and change houses) drains to this ditch, it is also located in close proximity to a building that was formerly used as a fire station. Therefore, it is unclear whether the arsenic concentration at this location is attributable to LL–6, particularly because the nearest surface soil sample (LL6SS–031–0001–SO) had an arsenic concentration of 2.2 mg/kg.

No other sample concentration exceeded the site background criteria. The maximum detected arsenic concentration of 37 mg/kg is less than two times the Ohio SRV. Therefore, the average arsenic concentration was used to determine if potential risks are widespread. The average concentration (14.1 mg/kg) is less than the background criteria and the PEC; therefore, widespread risks are not expected. For these reasons, arsenic is not retained as a COPC for further evaluation in a BERA.

Beryllium

Beryllium was initially selected as a COPC because the maximum concentration (0.82 mg/kg) exceeded the site background criterion (0.38 mg/kg), but only slightly exceeded the Ohio SRV (0.8 mg/kg). No toxicity benchmarks for benthic invertebrates were available (including higher effects levels), so risks to these receptors could not be determined. However, the slight exceedance of the SRV in only one sample indicates that beryllium concentrations are unlikely to be related to site activities. For these reasons, beryllium is not retained as a COPC for further evaluation in a BERA.

Copper

Copper was initially selected as a COPC because the maximum detected concentration in the sediment (97 mg/kg) exceeded the site background criterion (27.6 mg/kg), the Ohio SRV (32 mg/kg), and the TEC (31.6 mg/kg). Although the average concentration (38.3 mg/kg) exceeds the TEC (see Table 7–6), both the maximum and average copper concentrations are less than the higher effects level of 149 mg/kg (the PEC from MacDonald et al., 2000).

Copper concentrations exceeded the Ohio SRV at three of the nine sample locations (LL6SD–001–0001–SD [68.4 mg/kg], LL6SD–004–0001–SD [57 mg/kg], and LL6SD–014–0001–SD [97 mg/kg]). LL6SD–001–0001–SD is located in the explosives testing pond. LL6SD–004–0001–SD and LL6SD–014–0001–SD are located in small drainage ditches at LL–6, which provide poor ecological habitat. Although LL6SD–004–0001–SD drains the northern portion of the AOC, it is unclear whether inorganic concentrations at this location are attributable to the LL–6 operations because LL6SD–004–0001–SD is close to a former fire station. It is also unclear whether copper concentrations at these three locations are related to LL–6 activities because surface soil concentrations are similar to the site background criteria (17.7 mg/kg) overall. Additionally, widespread risks are not expected because the average copper concentration (38.3 mg/kg) in the sediment sample is only slightly greater than the Ohio SRV (32 mg/kg). For these reasons, copper is not retained as a COPC for further evaluation in a BERA.

Lead

Lead was initially selected as a COPC because the maximum sediment concentration (156 mg/kg) exceeded the TEC (35.8 mg/kg). As indicated in Table 7–6, the average lead concentration (51.3 mg/kg) exceeds the screening level and the maximum concentration is greater than the higher effects level (128 mg/kg) (the PEC from MacDonald et al., 2000).

Lead concentrations were particularly elevated at two locations (LL6SD–001–0001–SD [156 mg/kg] and LL6SD–004–0001–SD [85 mg/kg]). As mentioned previously, LL6SD–001–0001–SD is located in the former explosives testing pond and LL6SD–004–0001–SD is located in the north-central portion of the site and is also potentially affected by non-LL–6 activities. Concentrations at all other locations were 51 mg/kg and less, which is similar to the Ohio SRV (47 mg/kg). Although the maximum concentration was detected in the former explosives testing pond, the slightly elevated concentration does not appear to be significant because of the poor habitat it provides. For example, the testing pond is approximately as deep (12 ft) as it is wide (15 to 18 ft in diameter). Although it is possible that the pond supports benthic organisms, it is not expected that the benthic community is abundant, diverse, or indicative of a healthy water body. The pond is likely stagnant; and conditions at the bottom of the pond are likely anaerobic throughout the year because the large depth and relatively small width of the pond are not conducive to significant aeration at the bottom of the pond.

Similar to copper, it is unclear whether the lead concentration at LL6SD–004–0001–SD is related to LL–6 activities because surface soil concentrations are similar to the site background criteria (19.1 mg/kg) overall. For example, the average lead concentration (29.2 mg/kg) in the surface soil is only slightly greater than the site background criteria (19.1 mg/kg). Additionally, widespread risks are not expected because the average sediment concentration (51.3 mg/kg) is not significantly greater than the Ohio SRV (47 mg/kg). For these reasons, lead is not retained as a COPC for further evaluation in a BERA.

Nitrocellulose

Nitrocellulose was initially selected as a COPC because a screening level was not available. Two samples were analyzed and nitrocellulose was detected at similar concentrations [LL6SD–003–0001–SD (2.2 mg/kg) and LL6SD–010–0001–SD (1.7 mg/kg)]. Although it is probable that nitrocellulose is related to the site, nitrocellulose is typically considered to be a relative inert compound, so it is unlikely to affect sediment invertebrates. For this reason, and because of the general lack of habitat for benthic invertebrates in the ditches (as discussed above), risks from nitrocellulose to benthic receptors at LL–6 are unlikely; it was not retained as a COPC for risks to sediment invertebrates.

7.6.3 Risks to Aquatic Organisms

As mentioned for the sediment, the drainage ditches at LL–6 are not perennial and are wet only seasonally, depending on precipitation and temperature. Therefore, the drainage ditches provide poor ecological habitat and do not support aquatic organisms and benthic invertebrates year-round, although the testing pond likely does support aquatic and benthic organisms. One sample (LL6SW–001–0001–SW) was collected from the testing pond during the azide screening in March 2002. All other surface water samples were collected from the drainage ditches at LL–6 during the RI sampling investigation in December 2003. For the most part, the lowest concentrations of metals were detected in the sample collected from the testing pond. This is probably because the samples collected from the drainage ditches had higher turbidity levels (i.e., more suspended solids) as noted by the moderate to high turbidity on the field sheets than that collected from the testing pond. In fact, the drainage ditches are relatively shallow and, in many cases, little water was available to collect a sample. It is likely that some sediment was mobilized when trying to fill the sample jars directly. Dissolved metals are the bioavailable fraction that causes toxicity in aquatic organisms. However, because filtered surface water samples were not collected at the site, the actual impact of the metals concentrations on aquatic organisms at LL–6 is not completely known.

One VOC, eight metals, and one miscellaneous parameter were selected as COPCs after the initial screening. Acetone, manganese, and nitrocellulose were retained as COPCs because screening levels were not available for comparison.

Acetone

Acetone was analyzed and detected in one surface water sample. A duplicate sample was also collected at the location. Acetone was retained as a COPC because no water quality criteria were available from the Ohio EPA or USEPA. An alternative benchmark is the secondary chronic value (SCV) available from the Tier II method described in USEPA's *Proposed Water Quality Guidance for the Great Lakes System* (USEPA, 1993b) and reported in ORNL's *Toxicological Benchmarks for Screening Potential COCs for Effects on Aquatic Biota* (Suter and

Tsao, 1996). The maximum detected concentration of acetone in surface water (8.2 µg/L) did not exceed the SCV of 1,500 µg/L. Because the maximum detected concentration of acetone in surface water was less than the alternative benchmark, potential risks of acetone to aquatic organisms is unlikely, and acetone is not retained as a COPC for further evaluation.

Aluminum

Aluminum was initially selected as a COPC in surface water because the maximum concentration (16,000 µg/L) at LL6SW–004–0001–SW exceeded the USEPA AWQC of 87 µg/L. The site background criterion is 3,370 µg/L. The maximum concentration and the sample concentration at LL6SW–005–0001–SW (8,300 µg/L) both exceed the site background criteria. Samples from these locations are described as having high and medium-high turbidity, respectively, and the water was approximately 0.5 ft deep when the samples were collected. The actual impact on aquatic receptors at these locations is not known because of the high level of suspended solids (i.e., relatively low bioavailability) and the poor aquatic habitat present in these ditches. Risks at the other locations are expected to be similar to background because concentrations at all other locations are less than the site background criteria. Additionally, aluminum concentrations are lowest at LL6SW–001–0001–SW (107 µg/L and 97.2 µg/L, in the original and duplicate samples, respectively) where aquatic habitat is sufficient to sustain benthic populations year-round and are similar to the conservative AWQC (87 µg/L). However, the elevated concentrations with respect to background and the AWQC at two of the five locations indicate potential risks are possible to aquatic organisms if present in the ditches. For this reason, aluminum is retained as a COPC for risks to aquatic organisms in surface water.

Copper

Copper was initially selected as a COPC because the maximum surface water concentration (31 µg/L) at LL6SW–004–0001–SW exceeded the site background criterion (7.9 µg/L) and the Ohio WQC (5.15 µg/L). The Ohio water WQC was calculated using the minimum hardness at LL6SW–003. However, the maximum concentration was detected at LL6SW–004–0001–SW where the hardness was greater. The Ohio WQC for LL6SW–004–0001–SW, (using the hardness from that location) is 22.6 µg/L. Similarly, if the Ohio WQC is recalculated using the hardness from LL6SW–005–0001–SW, the WQC is 19.2 µg/L; the copper concentration at this location is 15 µg/L. Therefore, it does not appear that copper concentrations at LL6SW–005–0001–SW are presenting potential risks to aquatic receptors when considering water hardness at that particular location. Concentrations at all other locations are less than the copper WQC calculated using the minimum hardness at LL6SW–003–0001–SW, including LL6SW–001–0001–SW where copper was not detected. Although uncertainties exist with the bioavailability of metals at LL6SW–004–0001–SW and the lack of abundant ecological habitat for aquatic organisms, the elevated copper concentration at LL6SW–004–0001–SW indicates potential risks are possible to aquatic organisms if they are present in the ditch at this location. Risks at

other locations are unlikely. For this reason, copper is retained as a COPC for risks to aquatic organisms in surface water.

Iron

Iron was initially selected as a COPC because the maximum concentration (38,000 µg/L) exceeded the site background criterion (2,560 µg/L) and the USEPA AWQC of 1,000 µg/L. Although all samples collected exceeded the AWQC, only the maximum concentration and the iron concentration at LL6SW–005–0001–SW (12,000 µg/L) exceeded the site background criterion. As mentioned previously, it is uncertain whether metals concentrations at these locations are related to high levels of suspended solids. Additionally, the drainage ditches are expected to consist of poor ecological habitat for aquatic organisms. However, the elevated concentrations with respect to background at two of the five locations indicate potential risks are possible there while risks at other locations are unlikely. For this reason, iron is retained as a COPC for risks to aquatic organisms in surface water.

Lead

Lead was initially selected as a COPC because the maximum concentration (83 µg/L) exceeded the Ohio WQC (26 µg/L). A site background criterion for lead was not available. Similar to the previously discussed metals, the maximum concentration and the lead concentration at LL6SW–005–0001–SW (26 µg/L) exceed the WQC while concentrations at all other locations are less than the lead WQC. Although uncertainties exist with the bioavailability of metals at these locations and the actual exposure owing to the lack of abundant ecological habitat for aquatic organisms, the elevated metals concentrations at these two locations indicate potential risks are possible. However, the elevated concentrations with respect to background at two of the five locations indicate potential risks are possible at these locations while risks at other locations are unlikely. For this reason, lead is retained as a COPC for risks to aquatic organisms in surface water.

Manganese

The maximum surface water concentration (11,000 µg/L) for manganese was greater than the RVAAP installation background criteria (391 µg/L), but no water quality criteria were available. The maximum manganese detection at LL–6 occurred at LL6SW–004–0001–SW. Maximum concentrations of most other metals were detected at this location. Manganese concentrations also exceeded the site background criteria at location LL6SW–002–0001–SW, although concentrations at the three other surface water locations were less than the background criteria.

As described above, the ORNL SCV (120 µg/L) was developed using the Tier II method described in the USEPA's *Proposed Water Quality Guidance for the Great Lakes System* (1993b) and Suter and Tsao, (1996). Tier II values were developed so that aquatic benchmarks

could be established with fewer data than are required for the USEPA water quality criteria. Tier II values are concentrations expected to be higher than WQC in no more than 20% of cases (Suter and Tsao, 1996). In the USEPA publication, *Quality Criteria for Water* – 1986 (the *Gold Book*), it states that ions of manganese are found rarely at concentrations above 1 mg/L and, because the tolerance values reported range from 1.5 mg/L to over 1,000 mg/L, manganese is not typically considered to typically be a problem in fresh waters (USEPA, 1986). The ORNL benchmark is likely lower than the tolerance values cited in the *Gold Book* (USEPA, 1986) because of the numerous uncertainty factors used to calculate the benchmark (Suter and Tsao, 1996).

Only the maximum manganese concentration is greater than the minimum tolerance value (1,500 µg/L) cited in the *Gold Book* (USEPA, 1986), so impacts on aquatic organisms at most locations are not expected. Risks to aquatic organisms at the location of the maximum concentration are also somewhat questionable because the maximum concentration (11,000 µg/L) falls within the range of tolerance values (1,500 µg/L – 1,000,000 µg/L) reported in the *Gold Book* (USEPA, 1986). As mentioned previously, metals concentrations at LL6SW–004–0001–SW are questionable. Additionally, as discussed previously, there is very little aquatic habitat in the ditches, so there is unlikely to be a significant population of aquatic receptors. The exceedance of the minimum tolerance value at one location does not warrant retaining manganese for further evaluation. For these reasons, manganese is not retained as a COPC for further evaluation in a BERA.

Selenium

Selenium was initially selected as a COPC because the maximum concentration (7.2 µg/L) slightly exceeded the Ohio WQC (5 µg/L). A site background criterion for selenium was not available. However, selenium was detected in only one of the five samples collected at LLSW–004–0001–SW at a concentration slightly exceeding the WQC. The slight exceedance of the conservative WQC at one location, combined with the uncertainties associated with bioavailability of metals and aquatic habitat at this location, do not warrant retaining selenium as a COPC for further evaluation. Selenium is not retained as a COPC.

Zinc

Zinc was initially selected as a COPC because the maximum concentration (430 µg/L) exceeded the site background criterion (42 µg/L) and the Ohio WQC (49 µg/L). The Ohio WQC was calculated using the minimum hardness at LL6SW–003–0001–SW. However, the maximum concentration was detected at LL6SW–004–0001–SW, where the hardness was greater. The Ohio WQC for LL6SW–004–0001–SW (using the hardness from that location) is 187 µg/L. Similarly, if when the Ohio WQC is recalculated using the hardness from LL6SW–005–0001–SW, the WQC is 161 µg/L; the zinc concentration at this location is 59 µg/L. Therefore, aquatic receptors at location LL6SW–005–0001–SW are not adversely affected by

zinc at this location. Concentrations at all other locations are less than the zinc WQC calculated using the minimum hardness at LL6SW–003–0001–SW. Although uncertainties exist with the bioavailability of metals at LL6SW–004–0001–SW and the actual exposure owing to the lack of abundant ecological habitat for aquatic organisms, the elevated metals concentrations at LL6SW–004–0001–SW indicate potential risks are possible to aquatic organisms if present in the ditch at this location. Risks at other locations are unlikely. For this reason, zinc is retained as a COPC for risks to aquatic organisms in surface water.

Nitrocellulose

Nitrocellulose was initially selected as a COPC because a screening value was not available for comparison. Nitrocellulose was detected and analyzed in one of five samples (LL6SW–002–0001–SW). Nitrocellulose was detected in the duplicate sample (0.1 mg/L) at this location, but was not detected in the original sample. Although it is possible that nitrocellulose is related to the site, nitrocellulose is typically considered to be a relatively inert compound, so it is unlikely to affect aquatic organisms. For this reason, and because of the general lack of habitat for aquatic organisms in the ditches (as discussed above), risks from nitrocellulose to aquatic organism at LL–6 are unlikely. Nitrocellulose was not retained as a COPC for risks to sediment invertebrates.

7.7 Risks to Terrestrial Wildlife

The discussions in previous sections were not designed to evaluate dietary risks to wildlife through ingestion of food items, drinking water, and incidental ingestion of soil. Instead, a food chain model was used to evaluate potential risks posed by COPCs to upper-level terrestrial wildlife receptors. Section 7.5.5 describes the food chain model. Chemicals evaluated in the terrestrial food chain model were limited to those identified by the USEPA as bioaccumulative (USEPA, 2000). Separate discussions are provided below for evaluations of potential risk to insectivorous/herbivorous and carnivorous receptors. The maximum (or 95% UCL, whichever is lower) concentration detected in the surface soil and surface water is used as the EPC for the conservative food chain model. The average chemical concentrations detected in the surface soil and surface water samples are used as the EPCs for the average food chain model. Appendix Y presents the spreadsheets used to calculate the doses and HQs.

7.7.1 Risks to Insectivorous/Herbivorous Species

Table 7–7 presents the terrestrial wildlife model HQs based on conservative input parameters for terrestrial surrogate species (meadow vole, short-tailed shrew, and American robin). As discussed in Section 7.2.4.1, the assessment endpoints included the protection of herbivorous and invertivorous mammals and birds from adverse effects of contaminants on their growth, reproduction, and survival, among other endpoint. To evaluate these endpoints, potential risks to voles (herbivorous mammal), shrews (invertivorous mammals), and robins (invertivorous

birds) were determined. This section of the risk assessment presents this evaluation. For all PAHs, the NOAEL HQs in the conservative models are less than 1.0. However, the HQs in the conservative scenario exceed 1.0 for the following analytes and receptors:

- Arsenic NOAEL for the vole and shrew,
- Chromium NOAEL for the robin,
- Lead NOAEL for the robin and shrew,
- Lead LOAEL for the robin, and
- Zinc NOAEL for the robin.

LL–6 is relatively small (51 acres). The home ranges of the vole, robin, and shrew are less than 1 acre, but they are greater than 100 acres for the barn owl, hawk, and fox. Because the home range for the vole, robin, and shrew is much smaller than the site, these receptors may obtain all of their food from the site. The remainder of this section discusses the likelihood that the chemicals are causing a significant impact to these species. Average COPC concentrations are more realistic EPCs for some wildlife receptors than maximum concentrations because they are exposed to COPC concentrations throughout the load line, rather than at a single location. Seventy-five surface soil samples were collected from locations scattered throughout the 51 acre site, so there is adequate spatial coverage within the exposure area making it appropriate to calculate an average concentration as the EPC.

Table 7–8 presents the HQs based on average exposure input parameters for the insectivorous and herbivorous species. Note that Table 7–8 list only the chemicals that had NOAEL HQs greater than 1.0 using the maximum (or 95% UCL) concentrations. HQs in the average scenario are greater than 1 for the following analytes and receptors:

- Arsenic NOAEL for the shrew,
- Chromium NOAEL for the robin,
- Lead NOAEL for the robin and shrew,
- Lead LOAEL for the robin, and
- Zinc NOAEL for the robin.

Arsenic was detected in all 75 samples collected, with a 95% UCL of 13.3 mg/kg and an average concentration of 11.97 mg/kg.

Although arsenic concentrations in approximately 15% of the samples (11 of 75) were greater than the RVAAP installation background criteria concentration (15.4 mg/kg), most of those detected concentrations exceeded the background concentration only slightly and the greatest concentration was only twice the background concentration.

Table 7–7
Terrestrial Food Chain Model - Conservative Scenario
(Insectivorous, Herbivorous, and Carnivorous Receptors)

Chemical	Herbivorous Receptor EEQs		Insectivorous Receptors EEQs				Carnovorous Receptors EEQs					
	Meadow Vole		American Robin		Short-tailed Shrew		Barn Owl		Red Fox		Red-Tailed Hawk	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Semivolatile Organic Compounds												
Acenaphthene	8.4E-03	8.4E-04	2.1E-03	2.1E-04	1.9E-03	1.9E-04	NC	NC	NC	NC	NC	NC
Anthracene	1.7E-02	1.7E-03	6.0E-03	6.0E-04	7.5E-03	7.5E-04	NC	NC	NC	NC	NC	NC
Benzo(a)anthracene	2.1E-02	2.1E-03	1.5E-02	1.5E-03	2.5E-02	2.5E-03	NC	NC	NC	NC	NC	NC
Benzo(a)pyrene	2.1E-03	2.1E-04	9.7E-03	9.7E-04	1.7E-02	1.7E-03	NC	NC	NC	NC	NC	NC
Benzo(b)fluoranthene	1.3E-02	1.3E-03	1.1E-02	1.1E-03	2.0E-02	2.0E-03	NC	NC	NC	NC	NC	NC
Benzo(g,h,i)perylene	3.6E-03	3.6E-04	3.5E-03	3.5E-04	6.4E-03	6.4E-04	NC	NC	NC	NC	NC	NC
Benzo(k)fluoranthene	6.5E-03	6.5E-04	5.4E-03	5.4E-04	9.5E-03	9.5E-04	NC	NC	NC	NC	NC	NC
Carbazole	3.4E-02	3.4E-03	8.1E-03	8.1E-04	6.6E-03	6.6E-04	NC	NC	NC	NC	NC	NC
Chrysene	2.2E-02	2.2E-03	1.5E-02	1.5E-03	2.6E-02	2.6E-03	NC	NC	NC	NC	NC	NC
Dibenzo(a,h)anthracene	2.4E-03	2.4E-04	2.3E-03	2.3E-04	4.2E-03	4.2E-04	NC	NC	NC	NC	NC	NC
Dibenzofuran	1.1E-02	1.1E-03	3.1E-03	3.1E-04	3.1E-03	3.1E-04	NC	NC	NC	NC	NC	NC
Fluoranthene	8.8E-02	8.8E-03	4.4E-02	4.4E-03	6.6E-02	6.6E-03	NC	NC	NC	NC	NC	NC
Fluorene	3.5E-03	3.5E-04	1.0E-03	1.0E-04	1.1E-03	1.1E-04	NC	NC	NC	NC	NC	NC
Indeno(1,2,3-CD)pyrene	4.1E-03	4.1E-04	4.1E-03	4.1E-04	7.4E-03	7.4E-04	NC	NC	NC	NC	NC	NC
Phenanthrene	1.1E-01	1.1E-02	3.7E-02	3.7E-03	4.6E-02	4.6E-03	NC	NC	NC	NC	NC	NC
Pyrene	5.9E-02	5.9E-03	2.9E-02	2.9E-03	4.4E-02	4.4E-03	NC	NC	NC	NC	NC	NC
PCBs												
Aroclor-1254	1.4E-03	1.4E-04	1.8E-01	1.8E-02	4.0E-01	4.0E-02	6.8E-03	6.8E-04	4.2E-02	4.2E-03	6.0E-03	6.0E-04
Total Metals												
Arsenic	1.0E+00	1.0E-01	1.7E-01	1.7E-02	7.1E+00	7.1E-01	NC	NC	NC	NC	NC	NC
Cadmium	3.5E-03	3.5E-04	6.4E-01	6.4E-02	3.7E-01	3.7E-02	NC	NC	NC	NC	NC	NC
Chromium	2.6E-05	2.6E-06	2.8E+00	2.8E-01	4.5E-04	4.5E-05	NC	NC	NC	NC	NC	NC
Copper	2.9E-02	2.9E-03	9.4E-02	9.4E-03	1.1E-01	1.1E-02	NC	NC	NC	NC	NC	NC
Lead	2.2E-02	2.2E-03	3.5E+01	3.5E+00	1.9E+00	1.9E-01	NC	NC	NC	NC	NC	NC
Mercury	1.2E-03	1.2E-04	2.7E-02	2.7E-03	3.8E-03	3.8E-04	5.2E-02	5.2E-03	1.8E-02	1.8E-03	4.6E-02	4.6E-03
Nickel	3.1E-03	3.1E-04	5.6E-02	5.6E-03	4.6E-02	4.6E-03	NC	NC	NC	NC	NC	NC
Selenium	1.8E-02	1.8E-03	6.7E-01	6.7E-02	6.7E-01	6.7E-02	NC	NC	NC	NC	NC	NC
Zinc	2.6E-02	2.6E-03	6.1E+00	6.1E-01	2.0E-01	2.0E-02	NC	NC	NC	NC	NC	NC

Cells are blackened if the value is greater than 1.0
NC - Not calculated because the food chain model for carnivorous receptors is only done for persistent, bioaccumulative, and toxic chemicals.
EEQ - Ecological Effects Quotient
NOAEL - No Observed Adverse Effects Level
LOAEL - Lowest Observed Adverse Effects Level

Table 7–8
Terrestrial Food Chain Model - Average Scenario
(Insectivorous, Herbivorous, and Carnivorous Receptors)

Chemical	Herbivorous Receptor EEQs		Insectivorous Receptors EEQs				Carnovorous Receptors EEQs					
	Meadow Vole		American Robin		Short-tailed Shrew		Barn Owl		Red Fox		Red-Tailed Hawk	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Total Metals												
Arsenic	9.1E-01	9.1E-02	1.5E-01	1.5E-02	6.3E+00	6.3E-01	NC	NC	NC	NC	NC	NC
Chromium	2.4E-05	2.4E-06	2.6E+00	2.6E-01	4.3E-04	4.3E-05	NC	NC	NC	NC	NC	NC
Lead	2.0E-02	2.0E-03	3.3E+01	3.3E+00	1.8E+00	1.8E-01	NC	NC	NC	NC	NC	NC
Zinc	2.4E-02	2.4E-03	5.7E+00	5.7E-01	1.9E-01	1.9E-02	NC	NC	NC	NC	NC	NC

This table only lists the chemicals that had EEQs greater than 1.0 using the conservative exposure assumptions
Cells are blackened if the value is greater than 1.0
NC - Not calculated because the food chain model for carnivorous receptors is only done for persistent, bioaccumulative, and toxic chemicals.
EEQ - Ecological Effects Quotient
NOAEL - No Observed Adverse Effects Level
LOAEL - Lowest Observed Adverse Effects Level

Therefore, arsenic may or may not be related to site activities. Also, because the average arsenic concentration used in the food chain model is less than the background concentration, the risks from arsenic are similar to background criteria risks. For these reasons, it is not likely that potential site-related risks to small mammals are great enough to warrant further evaluation of arsenic in the BERA. Therefore, arsenic is eliminated as a COPC for risks to small mammals.

Chromium was detected in all 75 samples collected, with a 95% UCL of 17.5 mg/kg and an average concentration of 16.7 mg/kg. Although chromium concentrations in approximately 40% of the samples were greater than the RVAAP installation background criteria concentration (17.4 mg/kg), most of those detected concentrations exceeded the background concentration only slightly and the greatest concentration was less than two times greater than the background concentration. Therefore, chromium may or may not be related to site activities. Also, because the average chromium concentration that was used in the food chain model is less than the background concentration, the risks from chromium are similar to background criteria risks. For these reasons, it is not likely that potential site-related risks to small mammals are great enough to warrant further evaluation of chromium in the BERA. Therefore, chromium is eliminated as a COPC for risks to small mammals.

Lead was detected in all 75 samples collected, with a 95% UCL of 31.6 mg/kg and an average concentration of 29.2 mg/kg. Lead NOAEL and LOAEL-based estogenic equivalent (EEQs) exceeded 1.0 in the average exposure scenario robin food chain model and the NOAEL-based EEQ exceeded 1.0 in the shrew food chain model; however, the average concentration only slightly exceeds the RVAAP installation background criteria concentration for lead of 19.1 mg/kg. In fact, EEQs are greater than 1.0 when the background concentration is used in the robin and shrew average food chain models.

As can be seen in the food chain model calculation spreadsheets in Appendix Y, the dose from soil invertebrates accounts for a large portion of the total calculated dose. The estimated earthworm concentration (58.4 mg/kg) was caused by the BAF of 2.0 that was used in the food chain model. USEPA (2005) presents a soil-to-earthworm uptake equation for estimating lead concentrations in earthworms from soil. Using the equation from USEPA (2005), the estimated earthworm concentration in the robin and shrew food chain models is 1.96 mg/kg. Using the earthworm concentration as estimated from the equation in USEPA (2005), the NOAEL-based EEQ under the average exposure scenario in the robin food chain model is 2.6 and the LOAEL-based EEQ is less than 1.0. Similarly, if the earthworm concentration is calculated using the equation from USEPA (2005) in the shrew food chain model, both NOAEL and LOAEL-based EEQs are less than 1.0. Even though the NOAEL-based EEQ exceeds 1.0 in the robin food chain model using the estimated earthworm concentration as calculated in USEPA (2005), the risks to the robin overall are expected to be low. Therefore, lead is eliminated as a COPC for risks to birds.

Zinc was detected in all 75 samples collected with a 95% UCL of 70.7 mg/kg and an average concentration of 66.4 mg/kg. Although zinc concentrations in approximately 40% of the samples were greater than the RVAAP installation background criteria concentration (61.8 mg/kg), the average finding is only slightly greater than the background concentration. The estimated earthworm concentration (119 mg/kg) was caused by the BAF of 1.8 used in the food chain model. USEPA (2005) also presents a soil-to-earthworm uptake equation for estimating zinc concentrations in earthworms from soil. Using the equation from USEPA (2005), the estimated earthworm concentration in the robin food chain models is 54.2 mg/kg. Using the earthworm concentration as estimated from the equation in USEPA (2005), the NOAEL-based EEQ under the average exposure scenario in the robin food chain model is 3.0 and the LOAEL-based EEQ is less than 1.0. Most zinc concentrations were similar to the background concentration. Less than 10% of the soil samples had concentrations that were 1.5 to 3 times greater than the background concentration, and these sample locations were spread across the load line indicating no clear pattern of contamination. Additionally, the area represented by these few samples is small. Even though the NOAEL-based EEQ exceeds 1.0 in the robin food chain model using the estimated earthworm concentration as calculated in USEPA (2005), the risks to the robin overall are expected to be low, as discussed above for lead. For these reasons, it is not likely that potential site-related risks to small mammals are great enough to warrant further evaluation of zinc in the BERA. Therefore, zinc is eliminated as a COPC for risks to small mammals.

In summary, using average exposure concentrations and BAFs based on recent USEPA guidance (USEPA, 1993), the HQs based on the NOAEL exceeded 1.0 for several chemicals and receptors, but the HQs based on the LOAEL were less than 1.0. Therefore, it is possible that there may be some limited risks to small mammals and birds at the site based only on the HQs. When the additional following factors are considered, it is unlikely that receptors will be affected:

- The chemicals in soil will likely be less bioavailable than the form of the chemicals used to conduct the toxicity test to establish the NOAELs and LOAELs, so the risks are overestimated.
- In most cases, the average concentrations are high because of concentrations at only a few locations. The potentially contaminated area represented by these samples is small.

Also, as discussed above, the average concentrations for most metals used in the food chain model were similar to background concentrations, so potential risks would be similar to background risks. For these reasons, and the reasons discussed above for each chemical, no chemicals were retained as COPCs for further evaluation of risk to small mammals or birds.

7.7.2 Risks to Carnivorous Species

Table 7–7 presents the carnivorous wildlife model HQs based on conservative input parameters for surrogate species (barn owl, red fox, and red-tailed hawk). Note that only persistent, bioaccumulative, and toxic (PBT) COPCs were included in the carnivorous wildlife food chain model in accordance with the Ohio EPA ERA guidance (Ohio EPA, 2003). No chemicals had HQs in the conservative scenario exceeding 1.0. Consequently, risks to carnivorous wildlife from PBT COPCs are unlikely, and no chemicals are retained as COPCs for further evaluation regarding risks to carnivorous wildlife.

7.8 Ecological Risk Uncertainty Analysis

A significant uncertainty is that the nature and extent of the contamination in soil, sediment, surface water, and groundwater at LL-6 have not been determined. Therefore, the results of the ecological risk assessment presented in Section 7 (and the associated uncertainties) are preliminary and subject to change based on the data collected in the Phase II RI. This section presents the uncertainties associated with this SERA for LL–6.

7.8.1 Measurement and Assessment Endpoints

Measurement endpoints are used to evaluate the assessment endpoints selected for the SERA. Measures of effects are not the same as the assessment endpoints. The measures are used to predict effects to assessment endpoints by selecting surrogate species that will be evaluated. For example, the shrew was chosen as a surrogate species to predict effects on the small mammal population. A decrease in reproduction of shrews is used to assess a decrease in reproduction of the small mammal population. However, because of differences in ingestion rates, toxicity, food preferences among different species, predicting a decrease in reproduction of shrews may either under- or over-protect the small mammal population as a whole.

Risks to reptiles and amphibians are not quantitatively evaluated because exposure factors are not established for most species and toxicity data are very limited. Using aquatic organisms as a surrogate species, risks to amphibians exposed to the surface water and sediment are possible, but expected to be low, based on the Step 3a evaluations. However, potential risks to reptiles cannot be further evaluated in this SERA because of a lack of toxicity and exposure data.

7.8.2 Exposure Characterization

The contaminant dose to terrestrial wildlife is calculated using an equation that incorporates ingestion rates, body weights, bioaccumulation factors, and other exposure factors. These exposure factors are obtained from literature or are predicted using various equations.

Ingestion rates and body weights vary among species, especially among species inhabiting different areas.

Bioaccumulation of contaminants into various biological media (i.e., plants, invertebrates, small mammals) depends on characteristics of the media (soil, sediment, and surface water) such as pH and organic carbon. Therefore, actual bioaccumulation factors at the site may differ from those used in the SERA that were obtained from the guidance. For example, in the case of lead and zinc in the shrew and robin food chain models, the estimated earthworm concentrations were significantly greater when calculated using BAFs from the RVAAP guidance than when the earthworm concentrations were calculated using BAFs from USEPA (2005).

Also, the bioavailability of the chemicals is not taken into account in this SERA. All the chemicals are assumed to be 100% bioavailable at the detected concentrations, which is unlikely to occur for contaminants in the environment. For example, surface water samples with elevated concentrations (with respect to the AWQC and background criteria) were noted on the field forms as having “medium-high turbidity” and “high turbidity.” The elevated concentrations reported in these samples are potentially attributable to the suspended solids of these samples and not actual water concentrations. However, the suspended solids do not represent the bioavailable portion of the contaminant in the water column. Typically, uncertainties regarding the bioavailability of contaminants in surface water can be reduced by analyzing dissolved concentrations.

There is uncertainty in the chemical data that are collected at the site. Measured levels of chemicals are only estimates of the true site chemical concentrations. For samples that are deliberately biased toward known or suspected high concentrations, predicted doses probably will be higher than actual doses.

Finally, under the food chain model exposure scenario, terrestrial wildlife are assumed to live and feed only at the site. These assumptions will tend to over-predict risk because it is unlikely that most receptors will obtain all their food from within the site boundaries and from the most contaminated areas.

7.8.3 Ecological Effects Data

There is uncertainty in the ecological toxicity value comparison. The water quality criteria developed by USEPA in theory protects 95% of the exposed species. Therefore, some sensitive species may be present that are not protected by the use of these criteria. There also may be situations where the surface water screening level (SWSLs) are over-predictive of risk if the sensitive species used to develop the criteria do not inhabit the site. Finally, with the exception of hardness for a few metals, the SWSLs do not account for site-specific factors, such as TOC or pH, that may affect toxicity.

Potential adverse impacts on aquatic receptors from constituents in the sediment are evaluated by comparing the COPC concentration to sediment screening level (SDSLs). The SDSLs have more uncertainty associated with them than do the SWSLs. The procedures for developing the SDSLs are not as well established as the procedures for developing the SWSLs. As a result, the sediment screening levels have been developed using different methodologies. Additionally, there are fewer sediment toxicity data than surface water toxicity data. Sediment characteristics (i.e., pH, acid volatile sulfides, and TOC) also will have a large impact on the bioavailability and toxicity of constituents.

Potentially adverse impacts on terrestrial plants and invertebrates from constituents in the surface soil are evaluated by comparing the COPC concentration to shallow soil screening level (SSSLs). The SSSLs are similar to the sediment screening levels in that they are less established than the SWSLs. Fewer studies and fewer data are available for establishing SSSLs than SDSLs, and many of the SSSLs are based on the results of only a few studies. In addition, the SSSLs are based on different endpoints, depending on the preference of the agency that developed them. Therefore, they have more uncertainty than surface water and sediment screening values.

The NOAELs and LOAELs that were selected for the wildlife endpoint species were based on species other than the endpoint species (i.e., rats, mice, ducks). There is uncertainty in the application of toxicity data across species because the contaminant may be more or less toxic to the endpoint species than it was to the test study species.

The toxicity of chemical mixtures is not well understood. The toxicity information used in the SERA for evaluating risk to the ecological receptors is for individual chemicals. Chemical mixtures can affect the organisms very differently than the individual chemicals because of synergistic or antagonistic effects.

Toxicological data for a few of the COPCs are limited or do not exist. Therefore, there is uncertainty in any conclusions involving the potential impacts on ecological receptors from these constituents. Attempts were made to reduce the uncertainties associated with these COPCs, however, using the other Step 3a factors discussed in Section 7.5.4.

Several alternative benchmark values were used to gain a better understanding of the relationship between the maximum concentrations of the selected COPCs to the overall ecological risks of the site. There is some uncertainty involved when using these alternative benchmarks. The Canadian SQGs, which are used as alternative benchmarks for both plants and invertebrates, are based on effects to either plants or invertebrates. Thus, differentiation of risk to plants versus risk to invertebrates cannot be made using the Canadian guidelines. The ORNL values are separated into guidelines for plants and guidelines for invertebrates. However, the values are limited to only a few chemicals.

7.8.4 Risk Characterization

Risks are unlikely if an HQ is less than 1.0, but an HQ > 1 does not necessarily mean that the ecological receptor is being affected. An HQ greater than 1.0 simply indicates that the dose concentration was greater than the toxicity benchmark. Also, there is uncertainty in how the predicted risks to a species at the site translate into risk to the population in the area as a whole.

Several chemicals were retained as COPCs in surface water after the Step 3a evaluation. There are uncertainties in retaining these chemicals as COPCs for several reasons. The drainage ditches at LL–6 are not perennial and are seasonally wet, depending on precipitation and temperature; therefore, little aquatic habitat exists. Therefore, there is uncertainty regarding whether or not benthic invertebrates and aquatic organisms inhabit these small ditches.

Uncertainties exist regarding the source of chemical concentrations at LL6SW–004–0001–SW. This location is in the north-central portion of LL–6. Although, the northern end of the load line (i.e., near the gate house and change houses) drains to this ditch, it is also located in close proximity to a building that was formerly used as a fire station. Therefore, there is uncertainty whether or not concentrations of the chemicals retained as COPCs in surface water are attributable to site activities, particularly because most metals with elevated concentrations at this location had surface soil concentrations in site samples similar to the surface soil site background criteria.

One sediment and surface water sample was collected from the former explosives testing pond. There is uncertainty in whether or not the pond supports aquatic and benthic organism populations because of its depth relative to its small width. The pond is likely anoxic, which is stressful for most aquatic and benthic organisms.

7.9 Conclusions

Based on the SERA and the first step of the BERA (Step 3a), the following conclusions were drawn.

7.9.1 Terrestrial Plants and Soil Invertebrates

After the initial screening (Table 7–1), two SVOCs (carbazole and dibenzofuran), HMX, 14 metals (aluminum, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, vanadium, and zinc), and nitrocellulose were detected at concentrations that exceeded RVAAP installation background criteria, and exceeded soil screening levels or did not have soil screening levels. Other chemicals (i.e., PAHs and aroclor 1254) were retained as COPCs only because they were bioaccumulative. These chemicals were not included in the evaluation of risks to plants and invertebrates because they were not detected at concentrations that exceeded soil screening levels.

Tables 7–4 and 7–5 summarize the results of potential direct toxicity of chemicals in soil to earthworms and plants, respectively. Arsenic, cobalt, copper, lead, manganese, selenium, and zinc had maximum concentrations that were greater than the earthworm and plant toxicity benchmarks; the average chemical concentrations for these chemicals were less than the benchmarks. Based on the Step 3a factors discussed in Section 7.6.1, no chemicals initially selected as COPCs in the surface soil were retained for further evaluation for risks to plants and/or soil invertebrates.

7.9.2 Benthic Invertebrates

After the initial screening (Table 7–2), six metals (arsenic, beryllium, cadmium, copper, lead, and mercury) and nitrocellulose were detected at concentrations that exceeded the site background criteria, Ohio SRV, and sediment screening levels or did not have sediment screening levels.

Tables 7–6 summarizes the results of potential direct toxicity of chemicals in sediment to benthic invertebrates. The tables displays the average chemical concentrations compared to the same screening levels and the maximum and average concentrations compared to the higher effects levels. In summary, no chemicals initially selected as COPCs in the sediment were retained for further evaluation for risks to benthic invertebrates.

7.9.3 Aquatic Organisms

After the initial screening (Table 7–3), nitrocellulose, acetone, and seven metals (aluminum, copper, iron, lead, manganese, selenium, and zinc) were selected as COPCs because maximum concentrations exceeded the site background criteria and surface water screening levels or did not have surface water screening levels.

In summary, five metals (aluminum, copper, iron, lead, and zinc) were retained as COPCs for risks to aquatic organisms. These metals were retained as COPCs because concentrations at primarily two locations (LL6SW–004–0001–SW and LL6SW–005–0001–SW) greatly exceeded site background criteria and AWQC. However, there is uncertainty in retaining these metals as COPCs because, as discussed in Section 7.6.3, the drainage ditches and pond at LL–6 provide a poor ecological habitat. Additionally, it is suspected that concentrations at these two locations may be attributable to a high level of suspended solids during the sample collection and not actual surface water concentrations. Factors surrounding the uncertainties associated with retaining these chemicals as COPCs (see Section 7.8.4) should be taken into consideration when risk management decisions for LL–6 are made. Based on these factors, it does not appear that the site needs to proceed further in the BERA because of metals in surface water.

7.9.4 Terrestrial Wildlife

The potential risks to mammals and birds associated with all the COPCs in the surface soil, sediment, and/or surface water were further evaluated to determine whether site-related risks from the chemicals were possible or whether the risks were great enough to warrant retaining the chemicals as COPCs and proceeding further into the BERA.

Because of the conservative assumption of total bioavailability when only a few locations had elevated chemical concentrations, no HQs based on the LOAEL were greater than 1.0, and average concentrations for most metals used in the food chain model were similar to background concentrations, site-related risks to insectivorous and herbivorous receptors are unlikely. In summary, no chemicals were retained as COPCs for further evaluation of risk to small mammals or birds.

Based on the average scenario and the NOAEL, no chemicals had HQs greater than 1.0 for any carnivorous receptor. No chemicals were retained as COPCs for further evaluation of risks to upper-level carnivorous mammals and birds.

8.0 SUMMARY AND CONCLUSIONS

This section briefly summarizes the existing LL–6 conditions that were found during the RI, the possible fate and transport of contaminants found at the site, and the risk assessments tasks that were completed. The conclusions are based on the outcome of the BHHRA and SERA.

8.1 Summary

This section summarizes Sections 4.0 through 7.0 of the RI document.

8.1.1 Nature and Extent of Contamination

The nature and extent of contamination are examined in four media: soil, sediment, surface water, and groundwater. Contaminants were detected in all environmental media sampled. Most of the contaminants (except for metals) were detected in very few samples and there are insufficient occurrences to provide statistically valid analysis for contaminant distribution. No inferences can be made regarding contaminant distribution in any of the media because of the low frequency of detection the low number of samples collected. Therefore, the nature and extent of the contamination in soil, sediment, surface water and groundwater at LL–6 have not been determined.

Contaminants detected in soil above RVAAP installation background criteria and/or RBSC values included:

- Metals (aluminum, arsenic, manganese, vanadium);
- One propellant (nitrocellulose); and
- One SVOC (benzo(a)pyrene).

In sediment, metals and one propellant (nitrocellulose) were detected at concentrations above RVAAP installation background criteria and/or RBSC values.

In surface water, metals, one propellant (nitrocellulose), and two explosives (HMX and RDX) were detected above RVAAP installation background criteria and/or RBSC values.

In groundwater, metals, one propellant (nitrocellulose), and two SVOCs (bis(2–ethylhexyl)phthalate and 4–nitroaniline) were detected above RVAAP installation background criteria and/or RBSC values.

The nature and extent of the contamination in soil, sediment, surface water and groundwater at LL–6 have not been determined.

8.1.2 Contaminant Fate and Transport

The contaminant fate and transport analyses presented in this Phase I RI are preliminary and subject to change once the identified LL-6 data gaps are resolved. The physical paths or mechanisms by which LL–6 contaminants could migrate and the significance of those pathways are:

Leaching from soil to groundwater – Because the number of contaminants and associated concentrations found in soil are low, the mass that can be transported by this pathway is low. Also, sumps were removed during the thermal decontamination and demolition activities, conducted before the RI began.

Leaching from sediment to surface water – The reservoir of organic and inorganic contamination in drainage channels and creek sediments is low; therefore, this migration pathway is insignificant.

Leaching from Sewer Lines – The sewer lines are a potential migration pathway for contaminants and will be further investigated in the Phase II RI.

Transport in surface drainage channels – The topographical relief at LL–6 is moderate, so sediments do not move rapidly under normal conditions. The only exception is during rainstorm events when flow rates increase significantly. The total organic carbon content observed in LL–6 sediments is typical of environmental sediments, so adsorption would also be typical.

8.1.3 Baseline Human Health Risk Assessment

A BHHRA was performed to assess the potential current and future risks associated with human exposure to site-related contaminants found in LL–6. The BHHRA included:

- Data evaluation: Selecting COPCs;
- Exposure assessment: Identifying potential receptors, evaluating potential exposure pathways, and estimating the chemical intake resulting from exposure;
- Toxicity assessment: Evaluating the toxicity of each COPC and summarizing the toxicity criteria that were used;
- Risk characterization: Estimating the cancer and non-carcinogenic risk(s); and
- Uncertainty analysis: Identifying significant uncertainties that could affect the BHHRA results.

The COPCs selected for quantitative human health risk assessment are shown in Table 8–1.

Table 8–1

Summary of COPCs Selected for the Quantitative Human Health Risk Assessment

Soils	Groundwater	Surface Water	Sediment
aluminum arsenic manganese vanadium benzo(a)pyrene	arsenic antimony bis(2–ethyl hexyl)phthalate 4–Nitroaniline	aluminum arsenic chromium lead manganese vanadium	aluminum arsenic vanadium

The receptors evaluated included a security guard/maintenance worker, a National Guard trainee, a National Guard resident trainer, a National Guard fire/dust suppression worker, a hunter/trapper, and hypothetical future farmer residents (adult and child). The risk assessment calculations are shown in Table 8–2.

Table 8–2
Human Health Risk Assessment Calculation Summary

Receptor	Non Carcinogenic	Incremental Lifetime Cancer Risks
Security guard/maintenance worker	HI <1 (no adverse non-carcinogenic health effects)	Within USEPA target risk range of 1E-04 to 1E-06; does not exceed Ohio EPA's target of 1E-05.
Hunter/trapper	HI <1 (no adverse non-carcinogenic health effects)	<1E-06; does not exceed Ohio EPA's target risk value or USEPA target risk range.
National Guard resident trainer	HI >1 if it is assumed the receptor is using the shallow groundwater for domestic purposes and exposed to surface water. Arsenic in groundwater and manganese in surface water are the primary contributors to risk.	Exceeds USEPA target risk only if shallow groundwater is used for domestic purposes; exceeds Ohio EPA's target risk value. Arsenic is the contributor to risk exceedance.
National Guard trainee	Total HI >1 owing to inhalation of manganese in deep surface soil.	Within USEPA target risk range; exceeds Ohio EPA's target only if it is assumed the shallow groundwater and surface soil are evaluated as media of concern. Arsenic in groundwater is the only COC.

Table 8–2 (Continued)

Human Health Risk Assessment Calculation Summary

Receptor	Non Carcinogenic	Incremental Lifetime Cancer Risks
National Guard fire/dust suppression worker	HI <1 (no adverse non-carcinogenic health effects)	Within USEPA target risk range of 1E-04 to 1E-06; does not exceed Ohio EPA's target of 1E-05.
Adult resident farmer	HI >1 only if it is assumed the receptor is using the shallow groundwater for domestic purposes and if the ingestion-of -foodstuffs pathways are evaluated. Arsenic is the primary contributor to risk. See the uncertainty discussion.	Not applicable
Child resident farmer	HI >1. However, target-organ-specific HI > 1 for direct exposure if it is assumed that groundwater is used for domestic purposes and HI = 1 for arsenic's target organs when direct exposure to media other than groundwater are evaluated. For indirect exposure via the ingestion-of-foodstuffs pathways, HI > 1 for ingestion of vegetables. Arsenic is the primary contributor to risk. See the uncertainty discussion.	Not applicable
Lifelong resident farmer	Not applicable	Exceeds USEPA target risk range for direct exposure only if it is assumed that the shallow groundwater is used for domestic purposes and exposed to sediment; exceeds Ohio EPA's target risk value. Arsenic is primary contributor to risk.

Several significant uncertainties associated with the risk assessment were identified, as outlined in Section 6.7 and should be considered when making any risk management decisions. In many cases, conservative exposure and toxicity assumptions were applied, which may have resulted in conservative conclusions about potential risks.

8.1.4 Screening Ecological Risk Assessment

A SERA was performed to assess whether adverse ecological impacts are present as a result of site-related contaminants found in LL–6. The SERA included completing Steps 1 through 3a of the eight steps that comprise a Baseline Ecological Risk Assessment. The ecological risk assessment steps are stipulated in USEPA, Ohio EPA, and RVAAP FWERWP (USACE, 2003d). The steps that were completed as part of the LL–6 SERA are described below:

- Formulate the preliminary problem by identifying potential receptor groups and complete exposure pathways.

- Compare the contaminant concentrations for the chemicals found in LL–6 surface water, sediment, and surface soil to ecological screening values (ESVs) to initially select COPCs. The ESVs used in this risk assessment were stipulated by Ohio EPA and RVAAP guidance.

- Refine the list of COPCs by comparing exposure point concentrations to toxicity benchmarks established for specific receptor groups, by conducting food chain modeling for mammals and birds, and by evaluating other factors such as presence of suitable habitat, frequency of detection, and spatial distribution.

Ecological impact was evaluated for plants, soil, sediment invertebrates, aquatic organisms and terrestrial wildlife. Three types of mammals and birds were evaluated: insectivores, herbivores and carnivores.

The ecological risk calculations are shown in Table 8–3.

Table 8–3

Ecological Risk Calculations

Type of Species	Screening Results	Notes
Terrestrial plants and soil invertebrates	No COPCs retained.	Several bioaccumulative chemicals, though not retained as COPCs for terrestrial plants and invertebrates, were further evaluated for risks to wildlife.
Benthic Invertebrates	No COPCs retained.	No bioaccumulative chemicals were further evaluated for risks to piscivorous wildlife because no fish are reportedly present in the water bodies at the site.

Table 8–3 (Continued)

Ecological Risk Calculations

Type of Species	Screening Results	Notes
Aquatic Organisms	Aluminum, copper, iron, lead, and zinc were retained as COPCs.	Elevated concentrations are likely the result of high levels of suspended solids in the surface water samples. Also, the drainage ditches and pond at LL–6 provide poor ecological habitat. These factors should be taken into consideration when risk management decisions for LL–6 are made. Based on these factors, it does not appear that the site needs to proceed further in the BERA because of metals in surface water.
Terrestrial Wildlife−Insectivores/Herbivores	No COPCs retained.	Because of the conservative assumption of total bioavailability, only a few locations had elevated chemical concentrations. No HQs based on the LOAEL were greater than 1.0, and average concentrations for most metals used in the food chain model were similar to RVAAP installation background criteria concentrations. Therefore, risks are unlikely.
Terrestrial Wildlife−Carnivores	No COPCs retained.	Because no HQs based on the NOAEL were greater than 1.0 using average chemical concentrations, risks are unlikely.

8.2 Conclusions

Contaminants in surface soil, subsurface soil and sediments were detected at concentrations greater than the RVAAP installation background concentrations, Region 9 residential soil PRGs, or both. The lateral and vertical extent of contamination including explosives, propellants, metals, SVOCs in surface soils, subsurface soil, and sediments were not fully delineated during the Phase I RI. In addition, the presence of metals and SVOCs in groundwater and surface water at concentrations greater than RVAAP-specific background criteria (USACE, 2001b) indicate that contamination present in soils and sediment may be leaching into surface water and groundwater.

The total cancer risk estimate (summarized for each receptor and each media) for the primary receptor of concern (the National Guard trainee) equals 3E-05, and only the cancer risk

estimate developed for ingestion of arsenic in groundwater (assuming domestic use) exceeds 1E-05. The total non–cancer risk hazard index (HI) estimate (summarized for each receptor and each media) equals 1.0, but HIs calculated for other target organs and COPCs do not exceed unity. However, significant uncertainties were identified for the risk estimates for arsenic in groundwater and for the inhalation pathway and should be considered by the risk management team for RVAAP when making further remedial decisions for LL–6.

The total cancer risk estimate (summarized for each receptor and each media) for the National Guard resident trainer exceeds 1E-04 (Table 8-2) only when the future domestic use of the shallow groundwater resource is evaluated. The total HI (summarized for each receptor and each media) for the trainer exceeds 1.0 for the future domestic use of the shallow groundwater resource and for exposure to surface water. Cancer risk estimates and HIs for all other media do not exceed 1E-04 and 1.0, respectively (Table 8-2). As noted above, significant uncertainties were identified for the risk estimates for arsenic in groundwater and should be considered by the risk management team for RVAAP when making further remedial decisions for LL–6.

The total cancer risk estimate (summarized for each receptor and each media) for the hypothetical future resident farmer exposed by the direct contact exposure pathways exceeds 1E-04 only when future domestic use of the shallow groundwater resource is evaluated. Cancer risk estimates for soils and sediments evaluated for the direct contact exposure pathways exceed 1E-05 but do not exceed 1E-04 (Table 8-2). Total non-cancer risk estimates (HI) calculated on a target-organ-specific basis exceed 1.0 only when future domestic use of the shallow groundwater resource is evaluated for the adult farmer. For the child farmer, total HI calculated on a target-organ-specific basis exceed 1.0 when future domestic use of the shallow groundwater resource is evaluated and equal 1.0 for arsenic's target organs when direct exposure to media other than groundwater are evaluated. However, cancer and non-cancer risk estimates developed for the indirect-exposure pathways exceed both cancer and non-cancer risk benchmarks (i.e., 1E-04 and HI = 1, respectively) for consumption of homegrown foodstuffs (vegetables). Significant uncertainties were identified for the risk estimates for arsenic in groundwater and for the evaluation of the indirect exposure pathways and should be considered by the risk management team for RVAAP when making further remedial decisions for LL–6.

Ecological risks at LL–6 are unlikely. Based on the Step 3a refinement procedure, it was determined that site-related risks were not great enough to proceed with the ecological risk assessment process.

9.0 RECOMMENDATIONS

Concentrations of target analytes (primarily explosives, metals, SVOCs, and propellants) were detected in surface soil, subsurface soil, and sediment samples at concentrations exceeding RVAAP installation background (USACE, 2001b) concentrations, Region 9 residential soil PRGs, or both. Most of the contaminants (except for metals) were detected in very few samples and there are insufficient occurrences to provide statistically valid analysis for contaminant distribution. Therefore, the nature and extent of the contamination in soil, sediment, surface water and groundwater at LL–6 have not been fully determined. A Phase II RI should be conducted to fill data gaps identified in this Phase I RI. If data collected in the Phase II RI alters the conceptual site model presented in this Phase I RI, then the conclusions of the risk assessments presented in this report will require revision.

Although the BBHHRA indicated potential risk for a National Guard trainee (e.g., cancer risk estimate is less than 1E-04 but exceeds 1E-05) as a result of exposure to arsenic in groundwater and manganese in deep surface soil, conservative toxicity and exposure values were used to calculate the potential risks. Thus, the risk estimates presented for arsenic likely overestimate the potential for non-carcinogenic risk. Additionally, the arsenic concentrations detected in the environmental media may represent RVAAP installation background criteria conditions. It is recommended that the risk management team consider the need for any further remedial action based on the risk assessment results presented for this receptor. Further sampling analysis of subsurface soils will help to confirm and determine or reflect the risk associated with manganese in deep surface soils.

The conclusions of the risk assessments are based on available data. If data collected in the Phase II RI alters the conceptual site model presented in this Phase I RI, then the risk assessment findings presented in this report will require revision. The uncertainties presented in Section 6.7 of this report also should be considered. For example, the primary contributor to risk for LL–6 is arsenic (particularly in groundwater). However, arsenic is a naturally occurring metal. The RVAAP installation background criteria benchmarks reported for arsenic in groundwater range from 11 µg/L (filtered overburden) to 215 µg/L (unfiltered overburden). The maximum detected arsenic concentration for arsenic in groundwater at LL–6 was 13 µg/L.

Additional groundwater monitoring is warranted to determine whether the arsenic detections in the LL–6 groundwater are spurious, reflecting RVAAP installation background criteria conditions only. Additional groundwater monitoring should also be considered to address any potential data gaps owing to the small number of groundwater wells sampled (<10). The site sanitary sewers have not been inspected for integrity or fully sampled for contaminants of concern. Additional inspection and sampling should be conducted to evaluate the structures.

No additional action is recommended based on ecological risk because, based on the Step 3a refinement procedure, it was determined that site-related risks were not great enough to warrant proceeding further into the ecological risk assessment process.

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