Final

Phase II Remedial Investigation Report
for Soil, Sediment, and Surface Water at RVAAP-33 Load Line 6

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

Contract No. W912QR-15-C-0046

Prepared for:

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Louisville District

Prepared by:

leidos

Leidos
8866 Commons Boulevard, Suite 201
Twinsburg, Ohio 44087

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Sprinzl, Richard, E.
Adams, Heather, R.
Khan, Alauddin, PhD
Barta, Michael, L.
Robers, Sharon, K.

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Leidos
8866 Commons Boulevard
Suite 201
Twinsburg, Ohio 44087

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14. ABSTRACT

This Phase II Remedial Investigation Report for Load Line 6 presents physical characteristics, geology, and hydrogeology of Load Line 6; compiles historical and newly acquired environmental data; summarizes nature and extent of contamination in soil, sediment, and surface water; evaluates contaminant fate and transport; and provides human health and ecological risk assessments. These evaluations indicate there are no chemicals of concern (COCs) that pose unacceptable risk; and, therefore this report recommends No Further Action with respect to soil, sediment, and surface water at Load Line 6 to attain Unrestricted (Residential) Land Use.

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Risk assessment, weight of evidence, nature and extent, fate and transport, no further action

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CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Leidos has completed the Phase II Remedial Investigation Report for Soil, Sediment, and Surface Water at RVAAP-33 Load Line 6 at the Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of data quality objectives; technical assumptions; methods, procedures, and materials to be used; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing U.S. Army Corps of Engineers (USACE) policy. In addition, an independent verification was performed to ensure all applicable changes were made per regulatory and Army comments.

6/9/16

Jed Thomas, P.E.
Study/Design Team Leader, Main Author
Date

6/9/16

Mike Bolen
Independent Technical Review Team Leader
Date

Significant concerns and the explanation of the resolution are as follows:

Internal Leidos Independent Technical Review comments are recorded on a Document Review Record per Leidos standard operating procedure ESE A3.1 Document Review. This Document Review Record is maintained in the project file. Changes to the report addressing the comments have been verified by the Study/Design Team Leader. As noted above, all concerns resulting from independent technical review of the project have been considered.

6/9/16

Lisa Jones-Bateman
Senior Program Manager
Date

Ohio
Ohio Environmental Protection Agency

John R. Kasich, Governor
Mary Taylor, Lt. Governor
Craig W. Butler, Director

July 13, 2016

Mr. Mark Leeper
Army National Guard Directorate
ARNGD-ILE Clean Up
111 South George Mason Drive
Arlington, VA 22204
mark.s.leeper.civ@mail.mil

Re: **US Army Ammunition PLT RVAAP**
Remediation Response
Project Records
Remedial Response
Portage County
267000859091

Subject: **Ravenna Army Ammunition Plant, Portage/Trumbull Counties. "Final, Phase II Remedial Investigation Report for Soil, Sediment, and Surface Water at RVAAP-33, Load Line 6" Dated June 9, 2016**

Dear Mr. Leeper:

The Ohio Environmental Protection Agency (Ohio EPA) has received and reviewed the "Final, Phase II Remedial Investigation (RI) Report for Soil, Sediment, and Surface Water at RVAAP-33 Load Line 6" report for the Ravenna Army Ammunition Plant, Portage/Trumbull Counties. The report is dated June 9, 2016 and was received at Ohio EPA, Northeast District Office (NEDO) on June 10, 2016. The report was reviewed by various personnel in NEDO and Central Office (CO) in Columbus, Ohio.

The Final Phase II RI report is approved.

If you have any questions, please call me at (330) 963-1207.

Sincerely,

Vicki Deppisch

Vicki Deppisch
Hydrogeologist/Project Coordinator
Division of Environmental Response and Revitalization

VD/nvr

cc: Katie Tait/Kevin Sedlak OHARNG RTLS
Gregory F. Moore, USACE
Rebecca Shreffler/Gail Harris, VISTA Sciences Corp.
ec: Bob Princic, Ohio EPA, NEDO DERR
Rodney Beals, Ohio EPA NEDO DERR
Justin Burke, Ohio EPA, CO DERR
Kelly Kaletsky, Ohio EPA, CO DERR
Nat Peters, USACE
Carrie Rasik, Ohio EPA, CO DERR
Vanessa Steigerwald-Dick, Ohio EPA NEDO DERR

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Northeast District Office • 2110 East Aurora Road • Twinsburg, OH 44087-1924
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Final

Phase II Remedial Investigation Report for Soil, Sediment, and Surface Water at RVAAP-33 Load Line 6

Former Ravenna Army Ammunition Plant
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Contract No. W912QR-15-C-0046

Prepared for:
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8866 Commons Boulevard, Suite 201
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OHARNG = Ohio Army National Guard.
Ohio EPA = Ohio Environmental Protection Agency.
NEDO = Northeast Ohio District Office.
REIMS = Ravenna Environmental Information Management System.
USACE = U.S. Army Corps of Engineers.

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ACRONYMS AND ABBREVIATIONS

ACM	Asbestos-containing Material
amsl	Above Mean Sea Level
AOC	Area of Concern
AT123D	Analytical Transient 1-, 2-, 3-Dimensional
bgs	Below Ground Surface
BHC	Hexachlorocyclohexane
BHHRA	Baseline Human Health Risk Assessment
BUSTR	Bureau of Underground Storage Tank Regulations
Camp Ravenna	Camp Ravenna Joint Military Training Center
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMCOC	Contaminant Migration Chemical of Concern
CMCOPC	Contaminant Migration Chemical of Potential Concern
COC	Chemical of Concern
COPC	Chemical of Potential Concern
COPEC	Chemical of Potential Ecological Concern
CSM	Conceptual Site Model
CSEM	Conceptual Site Exposure Model
DAF	Dilution Attenuation Factor
DDE	Dichlorodiphenyldichloroethylene
DERR	Division of Environmental Response and Revitalization
DFFO	Director’s Final Findings and Orders
DNT	Dinitrotoluene
DQO	Data Quality Objective
DRO	Diesel Range Organics
EcoSSL	Ecological Soil Screening Level
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESL	Ecological Screening Level
ESV	Ecological Screening Value
EU	Exposure Unit
FA	Functional Area
FCR	Field Change Request
f_{oc}	mass fraction of the organic carbon soil content
FPA	Former Production Area
FS	Feasibility Study
FWCUG	Facility-wide Cleanup Goal
FWERWP	Facility-wide Ecological Risk Work Plan
FWGWMP	Facility-wide Groundwater Monitoring Program
FWHHRAM	Facility-wide Human Health Risk Assessors Manual
FWSAP	Facility-wide Sampling and Analysis Plan
gpm	gallons per minute
GRO	Gasoline Range Organics

GSSL	Generic Soil Screening Level
HELP	Hydrologic Evaluation of Landfill Performance
HHRA	Human Health Risk Assessment
HLC	Henry's Law Constant
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HQ	Hazard Quotient
ILCR	Incremental Lifetime Cancer Risk
INRMP	Integrated Natural Resources Management Plan
IRP	Installation Restoration Program
ISM	Incremental Sampling Methodology
K_d	soil/water partitioning coefficient
K_ds	distribution coefficients
K_{ow}	octanol-water partition coefficient
LES	Lakeshore Engineering Services, Inc.
MEC	Munitions and Explosives of Concern
MCL	Maximum Contaminant Level
MD	Munitions Debris
MDC	Maximum Detected Concentration
MDL	Method Detection Level
MMRP	Military Munitions Response Program
MRS	Munitions Response Site
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPA	Non-Production Area
NPDES	National Pollutant Discharge Elimination System
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
OMZA	Outside Mixing Zone Average
OMZM	Outside Mixing Zone Maximum
ORAM	Ohio Rapid Assessment Method
PAH	Polycyclic Aromatic Hydrocarbon
PBA08 RI	Performance-Based Acquisition 2008 Remedial Investigation
PBA08 SAP	Performance-Based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1
PBT	Persistent, Bioaccumulative, and Toxic
PCB	Polychlorinated Biphenyl
PP	Proposed Plan
ppm	parts per million
PRG	Preliminary Remediation Goal
QA	Quality Assurance
QC	Quality Control
R	Retardation Factor
RCRA	Resource Conservation and Recovery Act
RDA	Recommended Dietary Allowance
RDI	Recommended Daily Intake

RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
RfD	Reference Dose
RI	Remedial Investigation
ROD	Record of Decision
RRSE	Relative Risk Site Evaluation
RSL	Regional Screening Level
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SERA	Screening Ecological Risk Assessment
SESOIL	Seasonal Soil Compartment Model
SL	Screening Level
SI	Site Inspection
SOR	Sum-of-Ratios
SRC	Site-Related Contaminant
SRV	Sediment Reference Value
SSL	Soil Screening Level
SSSL	Site-Specific Soil Screening Level
STP	Sewage Treatment Plant
SVOC	Semi-volatile Organic Compound
TAL	Target Analyte List
TNT	2,4,6-Trinitrotoluene
TOW	Tube-launched, Optically-tracked, Wire-guided
TPH	Total Petroleum Hydrocarbons
TR	Target Risk
UCL	Upper Confidence Limit
USACE	U.S. Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USP&FO	U.S. Property and Fiscal Officer
USEPA	U.S. Environmental Protection Agency
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WOE	Weight-of-Evidence
WQC	Water Quality Criteria

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION AND SCOPE

This document has been revised by Leidos under U.S. Army Corps of Engineers Louisville District Contract Number W912QR-15-C-0046. This Remedial Investigation (RI) Report addresses soil, sediment, and surface water at Load Line 6 within the former Ravenna Army Ammunition Plant (RVAAP) [now known as Camp Ravenna Joint Military Training Center (Camp Ravenna)] in Portage and Trumbull counties, Ohio.

This report has been prepared in accordance with the requirements of Ohio EPA's *Director's Final Findings and Orders* (DFFO) for RVAAP, dated June 10, 2004 (Ohio EPA 2004). The DFFO requires conformance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan to implement an RI to characterize the area of concern (AOC); develop a Feasibility Study (FS) Report (if remediation is necessary); and evaluate remedial alternatives to address contamination presenting unacceptable risk to human health and the environment, present a preferred alternative in a proposed plan (PP), and document stakeholder selection and acceptance of the preferred final remedy in a record of decision (ROD). The following sections present the site history, scope of this report, and an explanation of the evaluation of future use.

ES.1.1 Site History

Load Line 6 is designated as AOC RVAAP-33 within the former RVAAP. Load Line 6, formerly known as Fuze Line #2, is a 43-acre, fenced AOC located immediately south of Fuze and Booster Road at the intersection of Fuze and Booster Spur Road. The AOC is located in the south-central portion of Camp Ravenna, west of Load Line 5 and east of Load Line 8.

All buildings, with the exception of four production buildings, were thermally decontaminated in 2002. Between 2005 and 2007, the remaining four production buildings were demolished by conventional methods, and all footers and floor slabs were removed to a minimum of 4 ft below ground surface (bgs). Remaining features at Load Line 6 include a one-lane asphalt perimeter road that enters the AOC from the north that surrounded the former production buildings. Remnants of the Firestone Test Facility (MRS RVAAP-033-R-01) include the Shaped Charge Test Chamber foundation, Former Test Pond, concrete blocks around the pond, and access road to the pond.

From 1941 through 1945, Load Line 6 operated at full capacity as a fuze assembly line. Load Line 6 was deactivated at the end of World War II, and the process equipment was removed. From 1950 to 1970, the Firestone Tire and Rubber Company's Defense Research Division used Load Line 6 intermittently for developing shaped charges for armor penetration. Firestone also performed weapons experimentation on the south portion of the AOC where three firing chambers and a small pond were installed and used as an underwater test chamber for their work. From 1981 through 1989, Physics International operated a pink water evaporation unit (historically designated as AOC RVAAP-14). This unit was closed under Resource Conservation and Recovery Act regulations. From

1987 to 1989, the Load Line 6 Treatment Plant (historically designated as AOC RVAAP-15) was operable. The pink water treatment plant was discharged under a National Pollutant Discharge Elimination System permit to the George Road Sewage Treatment Plant (RVAAP-22). Load Line 6 has not been used since 1989, and no historical information exists to indicate Load Line 6 was used for any other processes, other than what is presented above.

ES.1.2 Scope

The scope of this RI is to perform a CERCLA evaluation of soil, sediment, and surface water at Load Line 6. The media of concern associated with Load Line 6 are surface soil (0–1 ft bgs), subsurface soil (1–13 ft bgs), sediment, and surface water. This report does not include a full evaluation of groundwater or facility-wide sewers, as those will be evaluated as individual AOCs for the entire facility. However, the potential for soil contaminants to leach to and migrate in groundwater is evaluated in this RI Report to determine whether soil remedial actions to protect groundwater may be necessary.

ES.1.3 Evaluation of Future Use

In February 2014, the U.S. Department of the Army and Ohio EPA amended the risk assessment process to address changes in the RVAAP restoration program. The *Final Technical Memorandum: Land Uses and Revised Risk Assessment Process for the RVAAP Installation Restoration Program* (ARNG 2014) (herein referred to as the Technical Memorandum) identified three Categorical Land Uses and Representative Receptors to be considered during the RI phase of the CERCLA process. These three Land Uses and Representative Receptors are presented below:

1. Unrestricted (Residential) Land Use – Resident Receptor (Adult and Child) (formerly called Resident Farmer).
2. Military Training Land Use – National Guard Trainee.
3. Commercial/Industrial Land Use – Industrial Receptor [U.S. Environmental Protection Agency's (USEPA) Composite Worker].

Unrestricted (Residential) Land Use is considered protective for all three Land Uses at Camp Ravenna. Therefore, if an AOC meets the requirements for Unrestricted (Residential) Land Use, then the AOC is also considered to have met the requirements of the other Land Uses (i.e., Commercial/Industrial and Military Training), and those other Land Uses do not require evaluation.

ES.2 FINDINGS AND RECOMMENDATIONS OF THE REMEDIAL INVESTIGATION

This section presents the data used in the RI, contaminant nature and extent, fate and transport, human health risk assessment (HHRA), and environmental risk assessment (ERA), followed by the conclusions of the RI.

ES.2.1 DATA USE AND SAMPLE SELECTION PROCESS

Quality-assured sample data from the 2002 lead azide screening, 2003 Phase I RI, 2010 Performance-Based Acquisition 2008 Remedial Investigation (PBA08 RI), and 2011/2012 Former Test Pond investigations were used to evaluate nature and extent of contamination at Load Line 6. These investigations used discrete sampling methods.

All available sample data collected at the locations were evaluated to determine suitability for use in various key RI data screens and evaluations (i.e., nature and extent, fate and transport, and risk assessment). Evaluation of the data's suitability for use in the PBA08 RI involved two primary considerations: (1) whether the data represented current AOC conditions, and (2) sample collection methods (e.g., discrete versus incremental sampling methodology).

Samples from the 2002 lead azide screening and 2003 Phase I RI were evaluated to determine if conditions had changed substantively between earlier characterization efforts and the 2010 PBA08 RI. In May 2002, thermal decontamination and 5X certification of all buildings at Load Line 6 took place, with the exception of Buildings 2F-4, 2F-7, 2F-8, and 2F-9 (MKM 2007). These four buildings were demolished conventionally in July 2005 and the footers and floor slabs were removed in 2006 and 2007 after the Phase I RI field activities. Samples potentially affected by these demolition activities were surface and subsurface soil locations LL6ss-006, LL6ss-013, and LL6ss-016; surface soil sample LL6ss-018; and subsurface soil sample LL6ss-039. The surface and subsurface samples in proximity to the buildings that were later demolished were not omitted from the site-related contaminant (SRC) screen and were classified as part of the Former Production Area (FPA). Therefore, these data sets were considered representative of current conditions within and surrounding the footprints of the former buildings at Load Line 6.

Data collected in 2010 as part of the PBA08 RI focused on delineating the extent of contaminants identified in surface soil (0–1 ft bgs), subsurface soil (1–13 ft bgs), sediment, and surface water. The PBA08 RI sampled locations with the greatest likelihood of contamination (e.g., adjacent to production buildings or within sediment accumulation areas, such as ditches) and analyzed for chemicals identified in historical investigations.

ES.2.2 SUMMARY OF NATURE AND EXTENT OF CONTAMINATION

ES.2.2.1 Soil

Data from the 2002 lead azide screening, 2003 Phase I RI, and 2010 PBA08 RI were used to identify SRCs at Load Line 6, and data from samples collected in 2011 and 2012 were used to provide an additional assessment of the Former Test Pond. Collectively, this data set effectively characterizes the nature and extent of the contamination at the AOC. To support the evaluation of nature and extent of contamination, SRC concentrations were compared to SLs corresponding to the lowest facility-wide cleanup goal (FWCUG) for the Resident Receptor (Adult and Child) and National Guard Trainee at a target hazard quotient (HQ) of 0.1 or target risk (TR) of 1E-06, as presented in the *Facility-wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE

2010a) FWCUG Report. If there was no FWCUG for a chemical, the USEPA regional screening level (RSL) was used as the screening level (SL). Based on the information provided earlier in this section and the summary below, it can be concluded that the vertical and horizontal extent of contamination is defined, and no further sampling is needed to evaluate Load Line 6.

Locations where explosives were identified as potential contaminants from previous use were thoroughly evaluated, including around former process buildings and across each exposure unit (EU). The maximum concentrations of explosives and propellants were all below their respective SLs and were not considered chemicals of potential concern (COPCs). In addition, the 2002 lead azide screening had field tests conducted for 2,4,6-trinitrotoluene (TNT) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) using the Jenkins method. No explosives were detected above SLs in any of the surface soil, sediment, or surface water samples.

As identified in the Phase I RI Report, concentrations of contaminants are generally low. No apparent spatial trend in the distribution of inorganic chemicals throughout the AOC is evident. Inorganic chemicals, specifically arsenic and manganese concentrations, detected across the entire AOC were generally higher in samples taken from the FPA.

Seven inorganic chemicals (antimony, arsenic, barium, cadmium, chromium, lead, and mercury) were identified as potential inorganic SRCs and as potentially related to previous AOC operations. When evaluating these chemicals against their SLs (using the trivalent chromium FWCUG for chromium and the RSL of 400 mg/kg for lead), antimony, barium, chromium, lead, and mercury concentrations were all below their SLs; therefore, these chemicals were not considered COPCs for the FPA or Non-Production Area (NPA). Arsenic and cadmium are the only inorganic chemicals potentially related to previous AOC operations that are considered COPCs in surface soil at the FPA and NPA.

Arsenic is considered a COPC in surface soil at the FPA and NPA, with a maximum detected concentration (MDC) of 41 mg/kg at sample location LL6sb-007. However, subsurface soil was below the SL at this location. Arsenic was detected above its background concentration (19.8 mg/kg) in 2 of 38 subsurface samples, with an MDC of 26 mg/kg observed at 6–8 ft bgs at sample location LL6sb-033, which is adjacent to former Building 2F-11. This boring, installed in 2003, did not have a deeper sample; therefore, an additional boring (LL6sb-071) was installed in 2010 to fill this data gap. The arsenic concentration in the 4-7 ft bgs sample interval from sample location LL6sb-071 was 10.2 mg/kg, which is well below the subsurface background concentration.

Cadmium was not identified as a COPC in the NPA. Cadmium had one detection above the FWCUG at a TR of 1E-06, HQ of 0.1 (6.41 mg/kg) in 1 of 44 samples collected in the FPA, with an MDC of 6.8 mg/kg at sample location LL6sb-002. However, subsurface soil was below the SL at this location and throughout the FPA and NPA.

Manganese had a single detection above the background concentration of 1,450 mg/kg, with an MDC of 1,820 mg/kg at sample location LL96ss-078. This sample location is in the southern portion of the FPA along the road, which exceeded the National Guard Trainee FWCUG at a TR of 1E-05, HQ of 1 (351 mg/kg). Another isolated exceedance at a similar concentration was observed in the NPA at sample location LL6sb-032, the suspected test range. However, manganese was detected below the SL in subsurface soil at this location.

None of the detected concentrations of semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), pesticides, or polychlorinated biphenyls (PCBs) in surface or subsurface soil were above the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Building 2F-35 was the only building at Load Line 6 whose purpose was solvent storage. The sample associated with former Building 2F-35 (LL6sb-014) had no detectable concentrations of VOCs in soil. A Suspect VOC Disposal Pit to the east of this building was assessed during the Phase I RI. Of the 10 borings installed to assess this area, none of the borings had VOCs detected during the field screening. Also, of the four samples sent to the analytical laboratory, none had detections of total petroleum hydrocarbons (TPH) diesel range organics (DRO) and gasoline range organics (GRO) or VOCs. The only SVOC detected was at LL6sb-049 with an estimated concentration of 0.02J mg/kg of di-n-octylphthalate. Thus, no evidence of VOC contamination is present from the Suspect VOC Disposal Pit.

ES.2.2.2 Sediment and Surface Water

The Drainage Ditches EU was evaluated with two sediment and three surface water samples. No explosives or propellants were detected in the Drainage Ditches sediment samples. Nitrocellulose and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) were detected at low, estimated concentrations at sample location LL6sw-082 in the Drainage Ditches surface water. Both concentrations were below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. No sediment or surface water concentrations for metals in the Drainage Ditches samples exceeded the RSL at a TR of 1E-05, HQ of 1 except for the surface water concentration for cobalt at LL6sw-082. No SVOCs were identified as SRCs in the Drainage Ditches sediment samples, and only one SVOC (4-methylphenol) was identified as an SRC in surface water samples at the Drainage Ditches. 4-Methylphenol had a concentration below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1. No VOCs, pesticides, or PCBs were identified as SRCs in the Drainage Ditches sediment samples, and only one VOC (acetone) was identified as an SRC in surface water samples at the Drainage Ditches. The concentration of acetone was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1.

The Former Test Pond was assessed with one co-located sediment and surface water sample (LL6sd/sw-084) collected during the 2010 PBA08 RI, two sediment samples (FTFsd-002-SD and FTFsd-003-SD) and one surface water sample (FTFsw-001-0001-SW) collected in August 2011 during the Military Munitions Response Program (MMRP) RI, and one sediment sample (LL6sd-096-5870-SD) and surface water sample (LL6sw-096-5871-SW) collected in August 2012. One explosive (tetryl) was detected in sediment at sample location LLsd-084 at an estimated concentration of 0.031J mg/kg. This detection was below the RSL at a TR of 1E-06, HQ of 0.1, and is, therefore, not considered a COPC. One explosive (HMX) was detected in surface water at sample location LLsw-084 at an estimated concentration of 0.000062J mg/L collected from the Former Test Pond. This detection was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1, and is, therefore, not considered a COPC. None of the samples collected in 2011 or 2012 had detections of explosives or propellants. No sediment or surface water concentration for metals at the Former Test Pond exceeded the RSL at a TR of 1E-05, HQ of 1.

Surface water and wet sediment samples were collected at potential exit points from the Fuze and Booster Hill area (which includes Load Lines 5 through 11) and near the southern boundary of RVAAP/Camp Ravenna to determine nature and extent. Four surface water and co-located composite wet sediment samples were collected from these areas in order to characterize current conditions and assess potential exit pathways from the area. This report provides an evaluation of two of these samples (FWSsd/sw-101 and FWSsd/sw-103) that are south and southeast of Load Line 6. No explosives or propellants were detected in these sediment samples. HMX was detected in both surface water samples and RDX was detected at FWSsw-103 at concentrations well below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1. No sediment or surface water concentration for metals at FWSsd/sw-101 and FWSsd/sw-103 exceeded the RSL at a TR of 1E-05, HQ of 1. No PCBs were detected in sediment or surface water samples and only low, estimated concentrations of toluene (0.00041J mg/kg) at FWS-103 and gamma-chlordane (0.000048J mg/L) at FWS-101 in sediment were detected. All other SVOCs, VOCs and pesticides had non-detectable concentrations.

ES.3 SUMMARY OF CONTAMINANT FATE AND TRANSPORT

All SRCs identified in surface soil, subsurface soil, and sediment at Load Line 6 were evaluated through the stepwise contaminant fate and transport evaluation. The evaluation included analysis of leaching and migration from soil and sediment to groundwater, and determination of whether contaminations present in soil and sediment may potentially impact groundwater quality at the site.

Maximum concentrations of SRCs identified in surface and subsurface soil were evaluated using a series of generic screening steps to identify initial contaminant migration chemicals of potential concern (CMCOPCs). Initial CMCOPCs for soil were further evaluated using the Seasonal Soil Compartment Model to predict leaching concentrations and to identify final CMCOPCs based on RVAAP facility-wide background concentrations and the lowest risk-based screening criteria among USEPA maximum contaminant levels, USEPA tap water RSLs, or RVAAP groundwater FWCUGs for the Resident Receptor (Adult). A sediment screening analysis was performed for sediment samples at the AOC. Chemical-specific dilution attenuation factors (DAFs) were calculated using co-located surface water and sediment concentrations for identified sediment SRCs. These DAFs were used in the sediment screening analysis to identify the final CMCOPCs based on RVAAP facility-wide background concentrations and the lowest risk-based screening criteria. Final CMCOPCs were evaluated using the Analytical Transient 1-, 2-, 3-Dimensional model to predict groundwater concentrations beneath source areas and at the nearest downgradient groundwater receptor to the AOC (e.g., stream).

Evaluation of modeling results with respect to current AOC groundwater data and model limitations identified the following CMCOPCs:

- Selenium and naphthalene among the soil CMCOPCs were predicted to exceed the screening criteria in groundwater beneath the source area. Neither of these CMCOPCs was predicted to be above their criteria at the downgradient receptor location.
- No final sediment CMCOPCs were identified.

A qualitative assessment of the sample results and considerations of the limitations and assumptions of the models were performed to identify if any contaminant migration chemicals of concern (CMCOCs) are present in soil and sediment at Load Line 6 that may impact the groundwater beneath the source or at the downstream receptor location. This qualitative assessment concluded that there were no CMCOCs present in soil and sediment that may impact the groundwater beneath the source or at the downstream receptor location. No further action is required of soil and sediment at Load Line 6 for the protection of groundwater.

ES.4 SUMMARY OF HUMAN HEALTH RISK ASSESSMENT

The HHRA did not identify any chemicals of concern (COCs) that pose unacceptable risk to the Resident Receptor (Adult and Child). Because there is no unacceptable risk to the Resident Receptor, it can be concluded that there is no unacceptable risk to the National Guard Trainee and Industrial Receptor.

Media of concern at Load Line 6 are surface soil, subsurface soil, sediment, and surface water. Soil data associated with Load Line 6 were aggregated into surface and subsurface soil at the FPA and NPA. Sediment and surface water data were aggregated and evaluated separately at the Drainage Ditches and the Former Test Pond.

No COCs were identified for the Resident Receptor (Adult and Child) in any of the media of concern; therefore, no other receptors were evaluated, and no further action is recommended from a human health risk perspective.

ES.5 SUMMARY OF ECOLOGICAL RISK ASSESSMENT

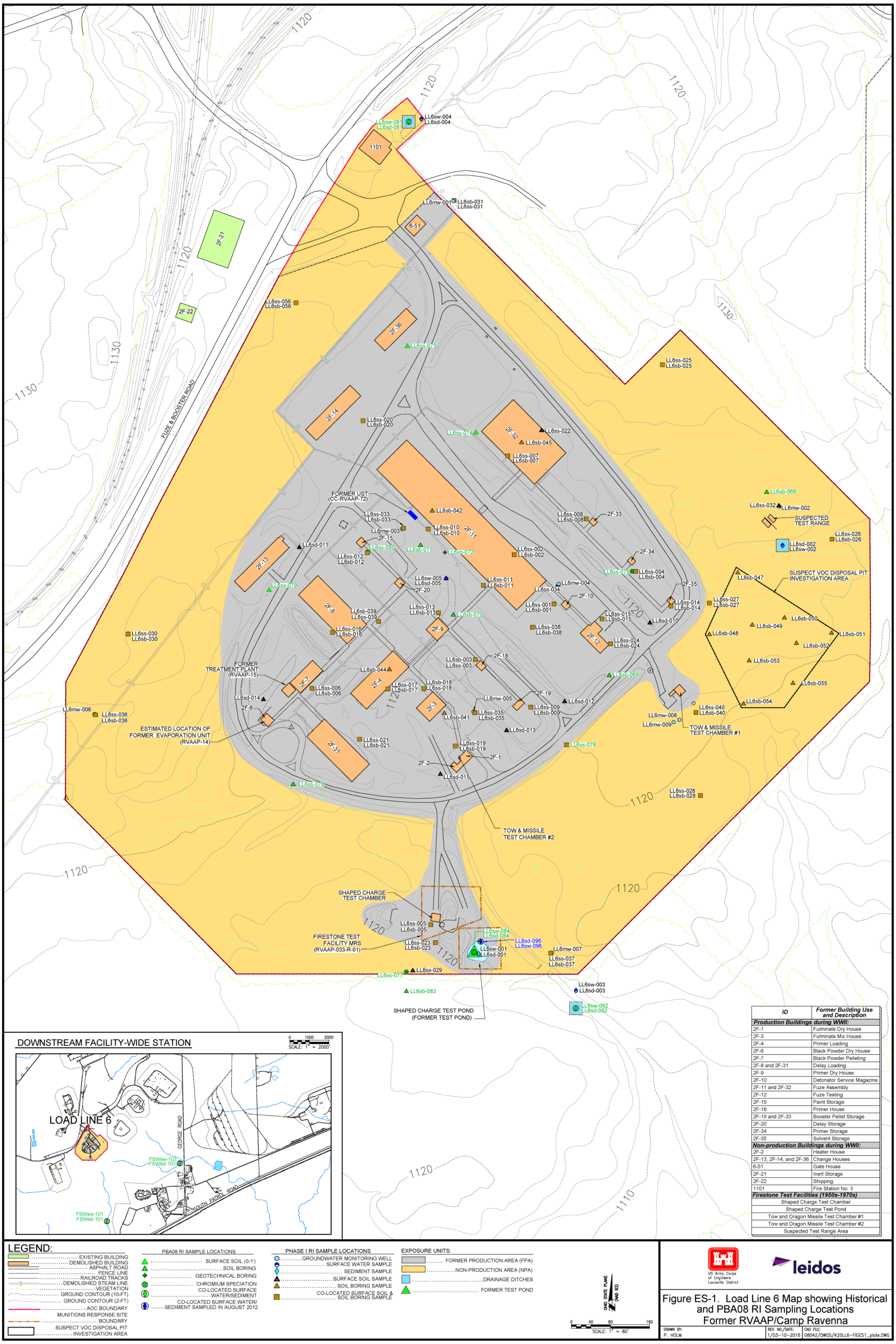
The ERA Level I presents important ecological resources on or near the AOC and evaluates the potential for current contamination to impact ecological resources. There is chemical contamination present in soil, sediment, and surface water at Load Line 6. This contamination was identified using historical and PBA08 RI data. Various forest and other ecological resources were observed on the 43 acres of the AOC. There are important and significant ecological resources in the AOC. Specifically, wetlands and surface water (e.g., a small test pond) are present and near contamination. These findings invoked a requirement of a Level II ERA.

The Level II ERA evaluated soil, sediment, and surface water chemicals of potential ecological concern (COPECs). Nineteen integrated COPECs were identified for soil. Five integrated COPECs were identified for sediment. Five integrated COPECs were identified for surface water. The integrated soil, sediment, and surface water COPECs were further evaluated with technical and refinement factors in Step 3A. The factors in Step 3A showed there are no integrated COPECs that are of ecological concern requiring remediation or further evaluation. Consequently, the Level II Screening ERA concluded that no further action is necessary to be protective of ecological resources.

ES.6 CONCLUSIONS OF THE REMEDIAL INVESTIGATION

Based on the investigation results, Load Line 6 has been adequately characterized and the recommended path forward is no further action for soil, sediment, and surface water at Load Line 6 to attain Unrestricted (Residential) Land Use. Further investigation is not warranted at this AOC for the following reasons: (1) the nature and extent of impacted media has been sufficiently characterized; (2) the fate and transport modeling did not identify soil CMCOCs requiring further evaluation or remediation to protect groundwater; (3) there are no CERCLA release-related human health COCs identified in soil, sediment, or surface water requiring further evaluation in an FS or remediation; and (4) remedial actions to protect ecological resources are not warranted.

The next step in the CERCLA process is to prepare a PP to solicit public input with respect to no further action for soil, sediment, and surface water. The PP will briefly summarize the history, characteristics, risks, and the basis for no further action. Comments on the PP received from state and federal agencies and the public will be considered in preparation of a ROD to document the final remedy. The ROD will also include a responsiveness summary addressing comments received on the PP.



ID	Former Building Use and Description
Production Buildings during WWII:	
2F-1	Fulminate Dry House
2F-3	Fulminate Mix House
2F-4	Primer Loading
2F-6	Black Powder Dry House
2F-7	Black Powder Pelleting
2F-8 and 2F-31	Delay Loading
2F-9	Primer Dry House
2F-10	Detonator Service Magazine
2F-11 and 2F-32	Fuze Assembly
2F-12	Fuze Testing
2F-15	Paint Storage
2F-18	Primer House
2F-19 and 2F-33	Booster Pellet Storage
2F-20	Delay Storage
2F-34	Primer Storage
2F-35	Solvent Storage
Non-production Buildings during WWII:	
2F-2	Heater House
2F-13, 2F-14, and 2F-36	Change Houses
6-51	Gate House
2F-21	Inert Storage
2F-22	Shipping
1101	Fire Station No. 3
Firestone Test Facilities (1950s-1970s)	
Shaped Charge Test Chamber	
Shaped Charge Test Pond	
Tow and Dragon Missile Test Chamber #1	
Tow and Dragon Missile Test Chamber #2	
Suspected Test Range Area	

Figure ES-1. Load Line 6 Map Showing Historical and PBA08 RI Sampling Locations - Former RVAAP/Camp Ravenna

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1.0 INTRODUCTION

This document was revised by Leidos under the U.S. Army Corps of Engineers (USACE), Louisville District Contract Number W912QR-15-C-0046. This Remedial Investigation (RI) Report addresses soil, sediment, and surface water at Load Line 6 within the former Ravenna Army Ammunition Plant (RVAAP) [now known as Camp Ravenna Joint Military Training Center (Camp Ravenna)] in Portage and Trumbull counties, Ohio (Figures 1-1 and 1-2). Load Line 6 is designated as area of concern (AOC) RVAAP-33.

This report has been prepared in accordance with the requirements of the Ohio Environmental Protection Agency (Ohio EPA) *Director's Final Findings and Orders* (DFFO) for RVAAP, dated June 10, 2004 (Ohio EPA 2004). The DFFO requires conformance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) to implement an RI to characterize the AOC, develop a Feasibility Study (FS) Report (if remediation is necessary), and evaluate remedial alternatives to address contamination presenting risk to human health and the environment, present a preferred remedial alternative in a proposed plan (PP), and document stakeholder selection and acceptance of the preferred final remedy in a record of decision (ROD). Figure 1-3 presents this process.

This RI Report includes the following components:

- A description of the operational history and environmental setting for the AOC.
- A summary of all historical assessments and investigations at Load Line 6.
- A description of the nature and extent of contamination, including the identification of site-related contaminants (SRCs) by screening applicable data against background concentrations, essential human nutrients, and frequency of detection/weight-of-evidence (WOE) screening.
- An evaluation of contaminant fate and transport by identifying contaminant migration chemicals of potential concern (CMCOPCs) and contaminant migration chemicals of concern (CMCOCs) that may pose a future threat to groundwater.
- A human health risk assessment (HHRA) to identify chemicals of potential concern (COPCs) and chemicals of concern (COCs).
- An ecological risk assessment (ERA) to identify chemicals of potential ecological concern (COPECs) and chemicals of ecological concern.
- Conclusions and recommendations of the RI Report.

Based on the outcome of the evaluation in this RI Report, a preferred alternative will be submitted for public review and comment in a PP. Public comments will be considered in the final selection of a remedy, which will be documented in a ROD.

1.1 PURPOSE

The purpose of the Performance-Based Acquisition 2008 Remedial Investigation (PBA08 RI) at Load Line 6 is to supplement the data from previous sampling events to delineate the nature and extent of contamination, evaluate contaminant fate and transport, and complete an HHRA and ERA to support remedial decisions. Depending on the results of the RI, a conclusion of no further action is provided or a recommendation to complete an FS to evaluate potential remedies and future actions will be made.

1.2 SCOPE

The scope of this RI Report is to present: (1) the nature and extent of contamination; fate and transport of contaminants in the environment; and risk assessments for surface soil, subsurface soil, sediment, and surface water at the AOC; (2) the results of the evaluation of remedial alternatives for meeting remedial action objectives for any CERCLA-related COCs identified in the media at the AOC; and (3) a conclusion of no further action or a preferred alternative to present to the public in a PP.

For the purposes of this RI Report, the term “surface soil” includes dry sediment. Dry sediment refers to unconsolidated inorganic and organic material within conveyances, ditches, or low-lying areas that occasionally may be covered with water, usually following a precipitation event or due to snowmelt. Dry sediment is not covered with water for extended periods, and typically is dry within seven days of a precipitation event. Dry sediment does not function as a permanent habitat for aquatic organisms, although it may serve as a natural medium for the growth of terrestrial organisms. Dry sediment is addressed the same as surface soil [0-1 ft below ground surface (bgs)] in terms of contaminant nature and extent, fate and transport, and risk exposure models. The term “sediment,” as used in this RI Report, refers to wet sediment within conveyances, ditches, wetlands, or water bodies that is inundated for extended periods. These definitions and terminology usage are consistent with the *Facility-wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 2010a) (herein referred to as the FWCUG Report).

Potential impacts to groundwater from soil, sediment, and surface water media (e.g., contaminant leaching) are evaluated in this report, as protectiveness to groundwater is included in the fate and transport analysis. However, groundwater will be evaluated as an individual AOC for the entire facility (designated as RVAAP-66) and addressed in a separate RI/FS Report. All buildings and structures at Load Line 6 have been demolished; therefore, they were not evaluated as continuing sources of contamination in this report.

As discussed in Section 2.4.1, only sanitary sewers are present at Load Line 6; no storm water sewer system exists within the AOC boundary. As part of the RVAAP-67 Facility-wide Sewers RI, sampling and evaluation of the sewer sediment, sewer water, and pipe bedding material media was performed and identified inorganic chemicals and polycyclic aromatic hydrocarbons (PAHs) as the predominant sewer SRCs. Fate and transport modeling was performed, and an HHRA and ERA were conducted for sewers at Load Line 6. These evaluations recommend no further action with respect to the Facility-wide Sewers within Load Line 6. The full evaluation and conclusion are presented in the *Draft Remedial Investigation/Feasibility Study Report for RVAAP-67 Facility-wide Sewers* (USACE 2012a).

1.3 REPORT ORGANIZATION

This report is organized in accordance with Ohio EPA and U.S. Environmental Protection Agency (USEPA) CERCLA RI guidance, as well as applicable USACE guidance. The following is a summary of the components of the report and a list of appendices:

- Section 2.0 provides a description and history of the former RVAAP and Load Line 6, presents potential sources of contamination, presents potential receptors, and summarizes co-located or proximate sites.
- Section 3.0 describes the environmental setting at Camp Ravenna and Load Line 6, including the geology, hydrogeology, climate, and population.
- Section 4.0 summarizes previous assessments and investigations at Load Line 6, as well as the data used to support this RI.
- Section 5.0 discusses the occurrence and distribution of contamination at the AOC.
- Section 6.0 provides an evaluation of contaminant fate and transport.
- Section 7.0 includes the methods and results of the HHRA and ERA.
- Section 8.0 provides the conclusions and recommendations of the RI.
- Section 9.0 summarizes the framework for conducting the necessary agency and public involvement activities.
- Section 10.0 provides a list of references used to develop this report.
- Appendices:
  Appendix A: Field Sampling Logs,
  Appendix B: Project Quality Assurance Summary,
  Appendix C: Data Quality Control Summary Report,
  Appendix D: Laboratory Analytical Results and Chains-of-Custody,
  Appendix E: Fate and Transport Modeling Results,
  Appendix F: Investigation-derived Waste Management Reports,
  Appendix G: Human Health Risk Assessment Tables,
  Appendix H: Ecological Risk Assessment Information and Data,
  Appendix I: PBA08 Remedial Investigation Summary,
  Appendix J: Ordnance and Explosives Avoidance Survey Report, and
  Appendix K: Ohio EPA Comments.

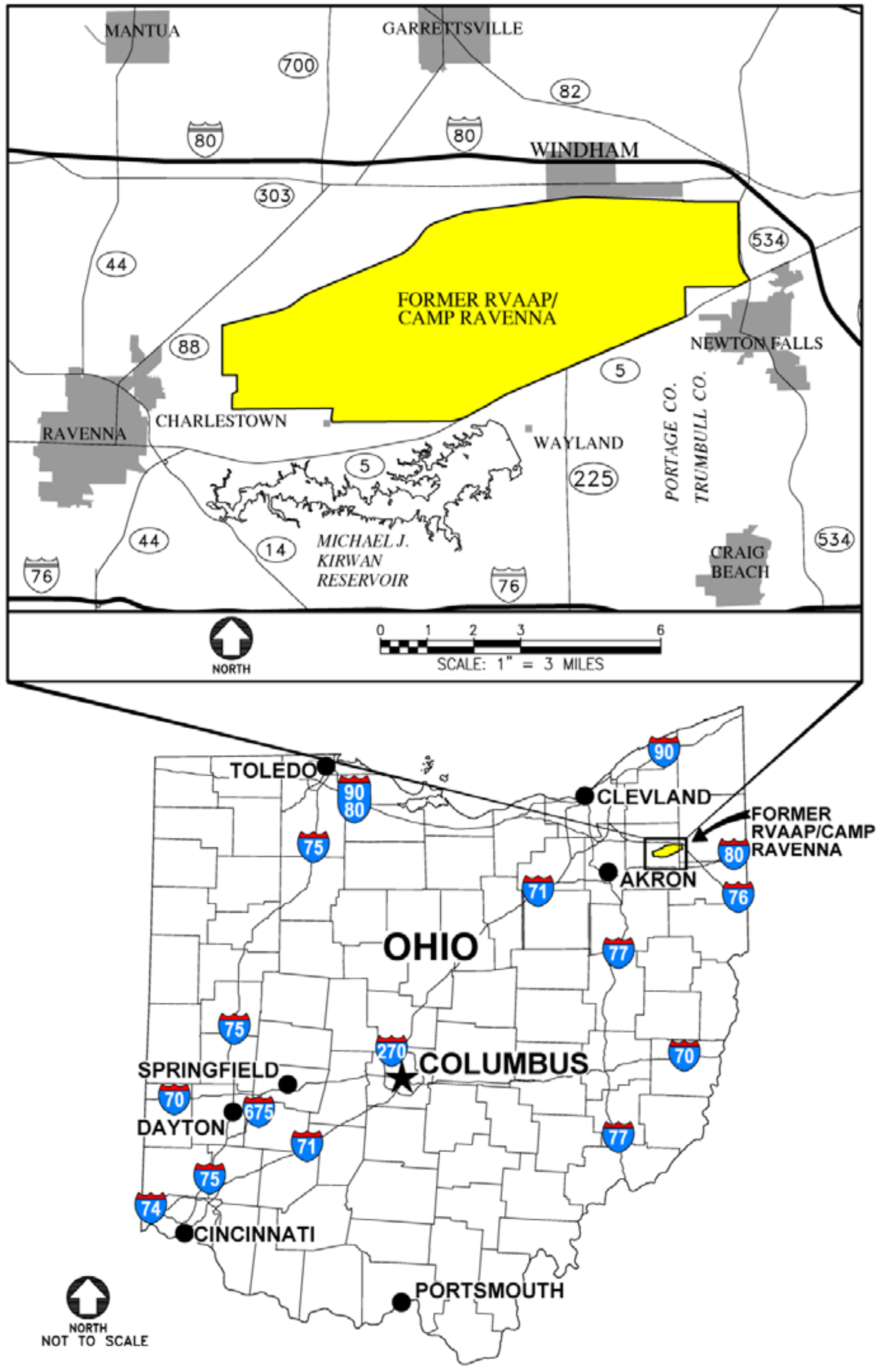

Figure 1-1. General Location and Orientation of Camp Ravenna

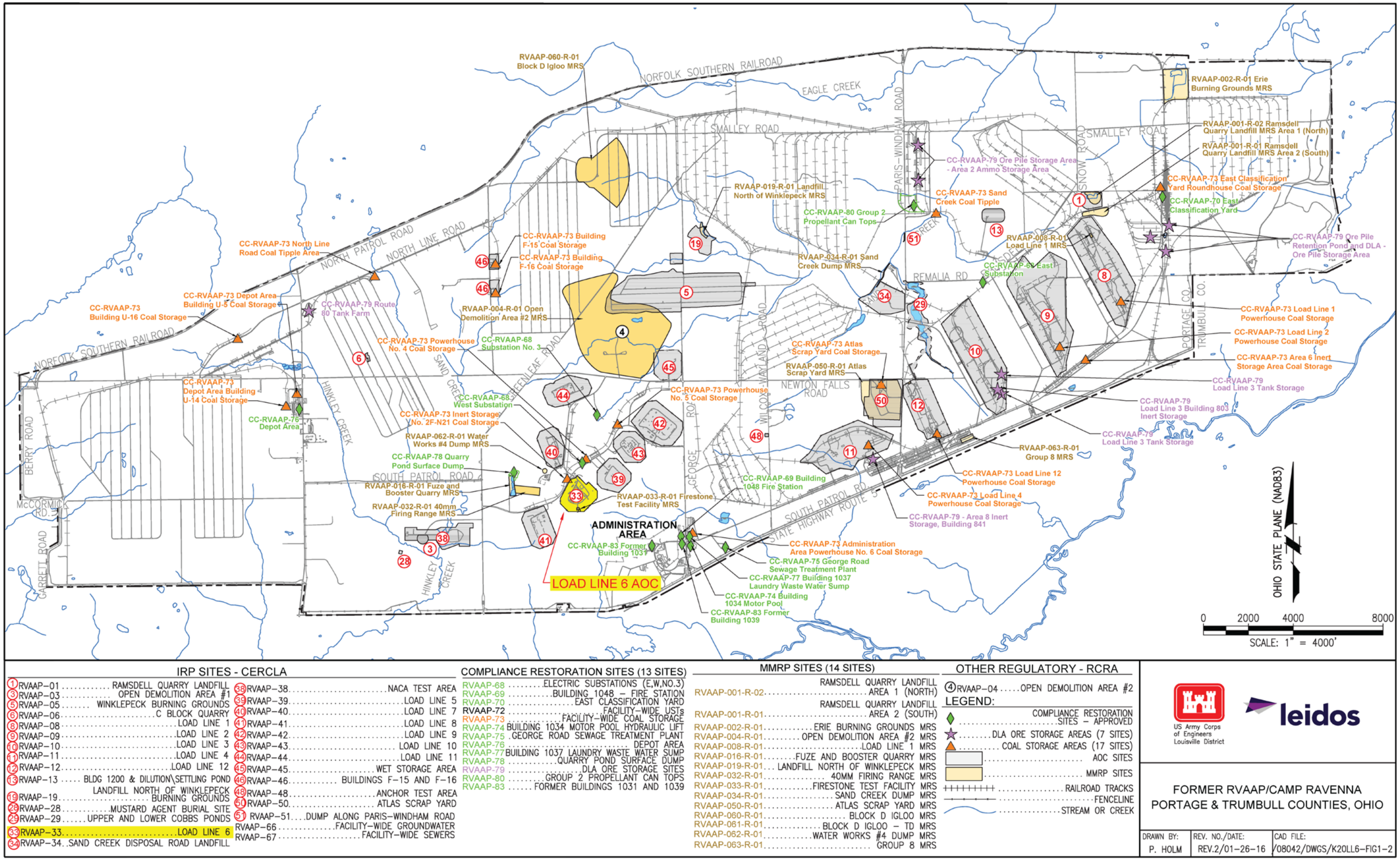

Figure 1-2. Location of AOCs and Munitions Response Sites at Camp Ravenna

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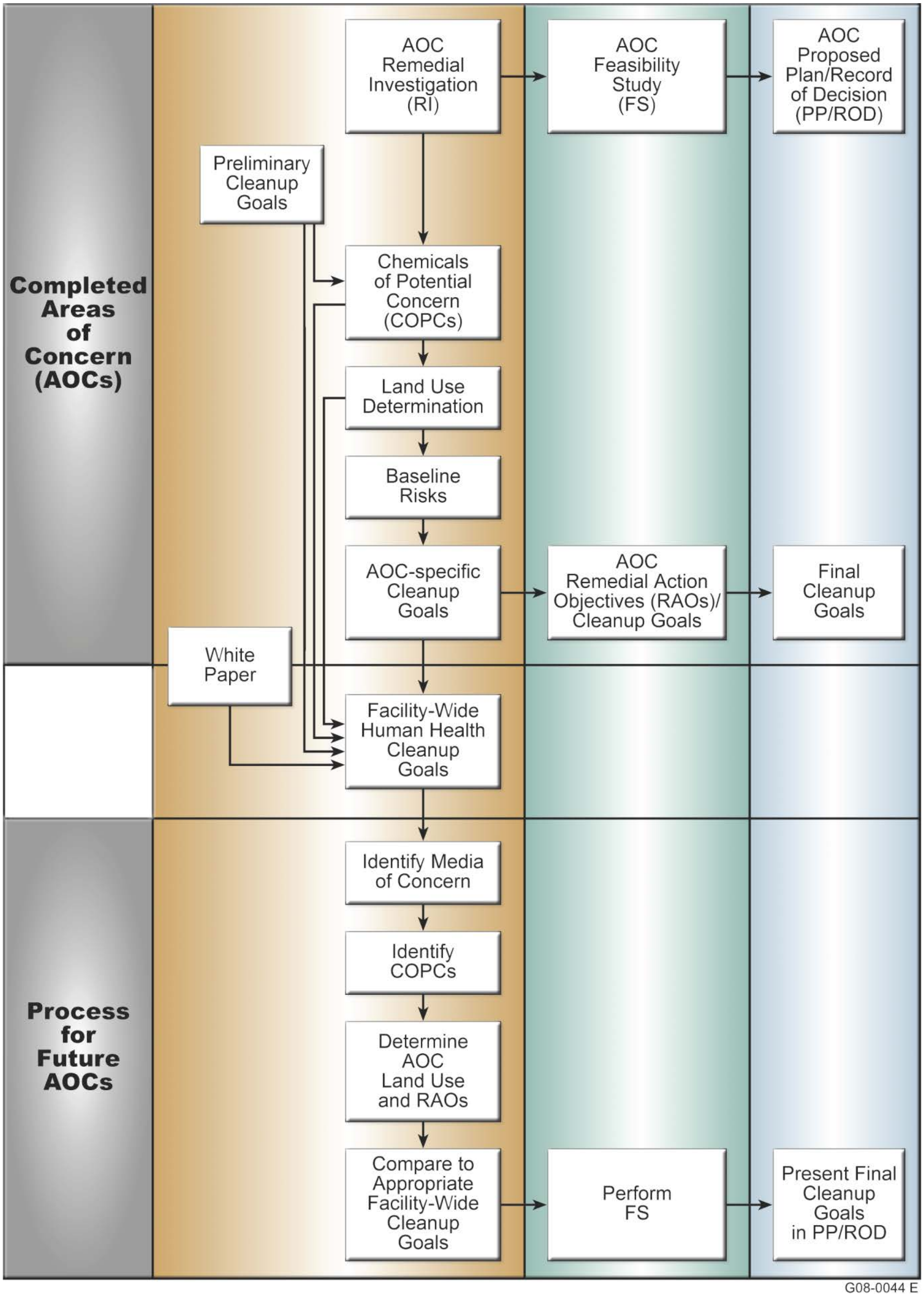

Figure 1-3. Process for Developing Remedial Decisions at Areas of Concern

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2.0 BACKGROUND

This section provides a description of the facility. In addition, it provides a summary of Load Line 6 operational history, potential sources, building demolition activities, potential human health and ecological receptors, co-located or proximate sites, and potential site-related releases.

2.1 FACILITY-WIDE BACKGROUND INFORMATION

2.1.1 General Facility Description

The facility, consisting of 21,683 acres, is located in northeastern Ohio within Portage and Trumbull counties, approximately 4.8 kilometers (3 miles) east/northeast of the city of Ravenna and approximately 1.6 kilometers (1 mile) northwest of the city of Newton Falls (Figure 1-1). The facility, previously known as RVAAP, was formerly used as a load, assemble, and pack facility for munitions production. As of September 2013, administrative accountability for the entire acreage of the facility has been transferred to the U.S. Property and Fiscal Officer (USP&FO) for Ohio and subsequently licensed to the Ohio Army National Guard (OHARNG) for use as a military training site (Camp Ravenna). References in this document to RVAAP relate to previous activities at the facility as related to former munitions production activities or to activities being conducted under the restoration/cleanup program.

In 1978, the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) conducted an Installation Assessment of RVAAP to review the potential for contaminant release at multiple former operations areas, as documented in *Installation Assessment of Ravenna Army Ammunition Plant* (USATHAMA 1978). The Installation Assessment indicated there is no evidence that bulk handling of the primary explosives lead azide or lead styphnate took place within the boundaries of this load line. According to this assessment, from 1941-1945, Load Lines 5 through 11 produced 19,257,297 miscellaneous fuzes, 44,297,485 miscellaneous boosters, 79,580,576 miscellaneous detonators, 226,387,306 percussion elements, and 50,660,725 primers. The 19,257,297 miscellaneous fuzes were produced at Load Line 6.

The former RVAAP received bulk 2,4,6-trinitrotoluene (TNT) product during operational activities and did not manufacture/produce dinitrotoluene (DNT) or TNT. A facility where DNT is manufactured will have the following isomers of DNT in the finished product: 2,4-DNT; 2,6-DNT; 2,5-DNT; 3,4-DNT; 2,3-DNT; and 3,5-DNT. This is not applicable to the former RVAAP. Degradation of TNT to 2,4-DNT occurs in soil; however, 2,4-DNT and 2,6-DNT do not degrade to the lesser isomers. It is the Army's position that testing DNT isomers other than 2,4- and 2,6-DNT is unnecessary and has no additional value of being protective to human health and the environment at the former RVAAP (RVAAP 2013).

2.1.2 Demography and Land Use

Camp Ravenna occupies east–central Portage County and southwestern Trumbull County. Census projections for 2010 indicated that the populations of Portage and Trumbull counties are 161,419 and

210,312, respectively. Population centers closest to Camp Ravenna are Ravenna, with a population of 11,724 and Newton Falls, with a population of 4,795.

The facility is located in a rural area and is not close to any major industrial or developed areas. Approximately 55% of Portage County, in which the majority of Camp Ravenna is located, consists of either woodland or farmland acreage. The closest major recreational area, the Michael J. Kirwan Reservoir (also known as West Branch Reservoir), is located adjacent to the western half of Camp Ravenna south of State Route 5.

Camp Ravenna (which is located on the remainder of the property) is federally owned and is licensed to the OHARNG for use as a military training site. Restoration activities at Camp Ravenna are managed by the Army National Guard and OHARNG. Training and related activities at Camp Ravenna include field operations and bivouac training, convoy training, maintaining equipment, C-130 aircraft drop zone operations, helicopter operations, and storing heavy equipment.

2.2 LOAD LINE 6 BACKGROUND INFORMATION

2.2.1 Operational History

Load Line 6, also known as Fuze Line #2, is a 43-acre fenced AOC located immediately south of Fuze and Booster Road at the intersection of Fuze and Booster Spur Road. The AOC is located in the south-central portion of Camp Ravenna, west of Load Line 5 and east of Load Line 8. The general location of Load Line 6 is illustrated in Figure 1-2, and AOC features are presented in Figure 2-1. A description of the operational use at Load Line 6 is as follows:

- 1941-1945 – The site predominantly operated at full capacity as a fuze assembly line. At the end of World War II, Load Line 6 was deactivated, and the process equipment was removed.
- 1950s–late 1970s – The Firestone Tire and Rubber Company’s Defense Research Division used Load Line 6 intermittently for developing shaped charges for armor penetration on the south portion of the AOC. Two buildings were used as test chambers for tube-launched, optically-tracked, wire-guided (TOW) missiles and Dragon missiles. These buildings are referred to as TOW and Dragon Missile Test Chamber #1 and TOW and Dragon Missile Test Chamber #2. Shaped charges were tested under water at the small pond (i.e., Shaped Charge Test Pond, herein referred to as the “Former Test Pond”). An additional building was located adjacent to the pond that was used for testing shaped charges (Shaped Charge Test Chamber). Less than 900 kg of the explosives TNT, Comp B [a combination of TNT and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)], and Octol [a mixture of TNT and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)] were used by Firestone per year. Only the Shaped Charge Test Chamber and Former Test Pond from the former Firestone Test Facility make up the current Munitions Response Site (MRS), designated as MRS RVAAP-033-R-01 (CB&I 2014).
- 1981–1989 – Physics International was a tenant at Load Line 6 and operated a pink water evaporation unit (historically designated as AOC RVAAP-14). This unit was closed under Resource Conservation and Recovery Act (RCRA) regulations.

- 1987–1989 – The Load Line 6 Treatment Plant (historically designated as AOC RVAAP-15) was operable. The pink water treatment plant was discharged under a National Pollutant Discharge Elimination System (NPDES) permit to the George Road Sewage Treatment Plant (STP) (RVAAP-22).

No historical information exists to indicate Load Line 6 was used for any other processes other than what is presented above.

All buildings, with the exception of four production buildings, were thermally decontaminated in 2002. Between 2005 and 2007, the remaining four production buildings were demolished by conventional methods, and all footers and floor slabs were removed to a minimum of 4 ft bgs. Remaining features at Load Line 6 include a one-lane asphalt perimeter road that enters the AOC from the north that surrounded the former production buildings. Remnants of the Firestone Test Facility (MRS RVAAP-033-R-01) include the Shaped Charge Test Chamber foundation, Former Test Pond, concrete blocks around the pond, and access road to the pond.

The Load Line 6 perimeter fence is still in place, but it is not currently maintained. Small construction drainage ditches border the perimeter road. Load Line 6 is currently overgrown with grass, trees, and scrub vegetation.

2.2.2 Potential Sources

Historical facilities at Load Line 6 included 26 production and support buildings ranging in size from 178-32,894 ft^2. In addition to the World War II production and support buildings, three experimental test chambers (i.e., TOW and Missile Test Chamber #1, TOW and Missile Test Chamber #2, and Shaped Charge Test Chamber), and the Former Test Pond used by Firestone were located at Load Line 6. The locations of the former primary operational and support buildings and test chambers are shown on Figure 2-1 and in the aerial photograph in Figure 2-2.

Former buildings and site features that are not expected be potential sources of contamination are presented and described below.

- Building 6-51 – Utilized as gate house for Load Line 6.
- Building 2F-21 – Utilized for inert material storage (located outside AOC boundary) during the production era.
- Building 2F-22 – Utilized for shipping (located outside AOC boundary) during the production era.
- Building 1101 – Utilized as Fire Station No. 3 (located outside AOC boundary).
- Drainage ditches.

Table 2-1 presents a summary of potential sources of contamination at Load Line 6. This table identifies potential sources, previous uses, if there were documented releases to the environment, and potential contaminants associated with the previous use. Some of the potential contaminants are documented; however, some professional judgment was made to determine if additional contaminants should be considered as a product of historical use of the site.

The 1978 Installation Assessment identified the major contaminants of the former RVAAP as TNT, Comp B (a combination of TNT and RDX), sulfates, nitrates, lead styphnate, and lead azide. Appendix A of the *Sampling and Analysis Plan Addendum for the Remedial Investigation at Load Line 6* (MKM 2003) presents the Load Line 6 Process Summary. An evaluation of this process summary identified additional potential site-specific contaminants from munitions assembly: black powder, tetryl, RDX, potassium nitrate, mercury fulminate, PETN, antimony sulfide, lead thiocyanate, potassium chlorate, lead, cadmium, barium, mercury, and arsenic. In addition to the chemicals previously mentioned, Octol (a mixture of TNT and HMX) was processed and used at selected buildings and test chambers. Other potential contaminants at Load Line 6 include volatile organic compounds (VOCs) from former Building 2F-35 that were utilized for solvent storage, polychlorinated biphenyls (PCBs) from on-site transformers, and PAHs from former Building 2F-2 that was used as a heater house. In summary, the following chemicals are targeted to investigate these potential SRCs:

- Target inorganic chemicals – Antimony, arsenic, barium, cadmium, chromium, lead, and mercury
- Target explosives – HMX, PETN RDX, tetryl, and TNT,
- Other – PAHs, PCBs, and VOCs

Many other chemicals were analyzed in the site investigations and are discussed in this report.

2.2.3 Building Decontamination and Demolition

2.2.3.1 Building Thermal Decontamination and 5X Certification

In May 2002, Thermal Decontamination and 5X Certification of all buildings except Buildings 2F–3, 2F–4, 2F–7, and 2F–8 at Load Line 6 were initiated to burn structures in-place to remove potentially explosive residue from building material in order to achieve 5X status. These activities and their results are presented in the *Thermal Decomposition and 5X Certification of Load Lines 6, 9 and Wet Storage Area Igloos 1, 1A, 2, & 2A* (MKM 2005) and are described below.

1. Paint on the interior of each building was sampled for PCBs and determined to be less than 50 parts per million (ppm) in all buildings except 2F-3, 2F-7, 2F-8, and 2F-9.
2. The floors of each building were swept to remove the loose paint chips and other potentially contaminated debris. One cubic yard of paint chips and debris was removed from the floors, containerized, sampled, and disposed.
3. Hazardous items of environmental concern, including mercury-containing fluorescent lights and PCB light ballasts, were removed from all buildings in order to promote safe execution of decontamination, burning, demolition, and removal operations.
4. Asbestos-containing roofing material (i.e., transite and composition rolled roof material) was removed from all the buildings; 131,774 ft^2 of asbestos-containing roofing material was

removed from Load Line 6. All asbestos-containing material (ACM) was disposed offsite in accordance with federal, state, and local rules laws and regulations.

Based upon historical use of explosives at these facilities, the target decomposition temperature for Load Line 6 was 800°F. The buildings were loaded with clean, wooden pallets to augment the burning process. The target temperature was sustained for 30 minutes.

Prior to demolition and disposal, all hazardous and non-hazardous material (e.g., fluorescent light fixtures and mercury switches) from the buildings were removed. PCB-contaminated material was removed offsite. The ACM was removed from all buildings prior to initiating building demolition and removal operations. ACM removal operations occurred from October to November 2002. All above-ground structures, including floor slabs and footers, were removed completely or to a minimum depth of 1 ft bgs. Precautions were taken to avoid disturbing soil beneath the slabs and footers.

To prevent contaminant migration outside the AOC boundary, one building sump at Building 2F-3 was removed prior to demolition activities. Basements at Buildings 2F-36 and 2F-14 and Test Chamber #1 were demolished in place to 3 ft bgs. Then the cavities were backfilled to grade using approved fill (LES 2007). Prior to removal, the water contained in the sumps and basements were sampled to determine proper disposition. Based upon analytical results, all sump water (i.e., a portion of 1,100 gal between Load Lines 6 and 9) was disposed offsite as hazardous waste. There were no indications of poor integrity of the sump noted in the completion report. The lead liner was removed and recycled. The asbestos liner was removed, double bagged, and disposed as asbestos containing materials. However, contaminant concentrations in the basement water were low enough to allow for ground application as per conditions of the Ohio EPA, but no indications of the amount of water discharged. Sewer lines were not excavated, as the lines exist below the groundwater table.

Due to high concentrations of PCBs in wall paint, Buildings 2F–3, 2F–4, 2F–7, and 2F–8 were not thermally decontaminated but were inspected and tested for explosive hazards before conventional demolition in July 2005 (MKM 2005). All painted brick and painted concrete from these buildings were loaded for off-site disposal as PCB bulk product waste at the approved facility. All the structural steel from these buildings was transported offsite for recycling since the paint on the structural steel contained PCBs at concentrations less than 50 ppm. The footers of Buildings 2F-7 and 2F-8 were completely removed and the footers at Buildings 2F-3 and 2F-9 were removed to 1 ft bgs.

2.2.3.2 Footer and Floor Slab Removal

From May 2006 to July 2007, Lakeshore Engineering Services, Inc. (LES) demolished and disposed buildings and their contents within Load Line 5, Load Line 7, Building 1039, and Building T-1604. As part of this effort, LES removed aboveground structures and floor slabs and footers to a minimum of 4 ft bgs at Load Line 6. These activities are discussed in the *Project Completion Report Munitions Response for the Demolition of Load Lines 5, 7, Building 1039, Transite Removal at Building T-1604, Removal of Remaining Concrete and Miscellaneous Debris at Load Lines 6, 9 and 11* (LES 2007).

At Load Line 6, the floor slabs, foundations, and footers of former Buildings 2F-1 through 2F-4, 2F-6 through 2F-15, 2F-18 through 2F-22, 2F-31 through 2F-36, and 6-51 were removed to minimum of 4 ft bgs. All unused telephone poles and steam stanchions were removed from the load line and disposed accordingly. Upon completion, all disturbed areas were re-graded and seeded. Re-grading was performed in a manner to ensure positive drainage and allow for unimpeded mowing and ground maintenance. A site walkthrough was completed with the RVAAP Facility Manager to identify and remove any miscellaneous debris. Final AOC restoration operations were completed in July 2007.

2.2.4 AOC Boundary

The Load Line 6 AOC boundary is presented in Figure 2-1. Load Line 6 is located immediately south of Fuze and Booster Road at the intersection of Fuze and Booster Spur Road. The AOC is located in the south-central portion of Camp Ravenna, west of Load Line 5 and east of Load Line 8. Separate investigations have occurred at these surrounding AOCs.

For this RI, Load Line 6 was divided into two spatial aggregates for soil and two spatial aggregates for sediment/surface water, as presented on Figure 2-3. The AOC boundary encompasses the two soil spatial aggregates: the Former Production Area (FPA) and Non-Production Area (NPA). The FPA consists of 18.1 acres and is located in the central portion of the AOC. The FPA is defined as the area encompassed within the perimeter road and all former production buildings and operational areas.

The NPA is 25.3 acres and includes the area outside of the production area to the fence line and the area just north of the AOC near former Building 1011 (Fire Station No. 3) at Fuze and Booster Road. This additional area to the north of the AOC was included in the AOC boundary since the 2003 and 2010 investigations included samples in this area to assess Load Line 6. The former buildings located within the NPA were limited to administrative and storage functions.

The surface and subsurface soil investigation at Load Line 6 generally focused on soil within the AOC boundary or fence line and includes samples collected from the FPA and NPA. Potential off-AOC contaminant migration has been evaluated by the sediment and surface water samples collected in ditch lines leading to or just outside the northern, eastern, and southern fence lines. The Former Test Pond is a perennial body of water located at the south side of Load Line 6 adjacent to the perimeter fence line.

In addition to the samples collected within the AOC boundaries, this RI Report discusses surface water and wet sediment samples collected at potential exit points from the Fuze and Booster Hill area (which includes Load Lines 5 through 11) and near the southern boundary of RVAAP/Camp Ravenna to determine nature and extent. Although not within the AOC boundary, this report provides an evaluation of two of these samples (i.e., FWSsd/sw-101 and FWSsd/sw-103) that are south and southeast of Load Line 6. Sample location FWSsd/sw-101 was collected within the tributary directly south of Load Line 6, and sample location FWSsd/sw-103 was collected within the channel to the southeast of the AOC which drains to the east.

2.3 POTENTIAL RECEPTORS

The following sections discuss potential human and ecological receptors at Load Line 6.

2.3.1 Human Receptors

Camp Ravenna is a controlled access facility. Load Line 6 is located in the south-central portion of the facility and is not currently used for training (Figure 1-2).

In February 2014, the Army and Ohio EPA amended the risk assessment process to address changes in the RVAAP restoration program. The *Final Technical Memorandum: Land Uses and Revised Risk Assessment Process for the RVAAP Installation Restoration Program* (ARNG 2014) (herein referred to as the Technical Memorandum) identified three Categorical Land Uses and Representative Receptors to be considered during the RI phase of the CERCLA process, as presented below.

1. Unrestricted (Residential) Land Use – Resident Receptor (Adult and Child) (formerly called Resident Farmer).
2. Military Training Land Use – National Guard Trainee.
3. Commercial/Industrial Land Use – Industrial Receptor (USEPA Composite Worker).

Unrestricted (Residential) Land Use is considered protective for all three Land Uses at Camp Ravenna. Therefore, if an AOC meets the requirements for Unrestricted (Residential) Land Use, then the AOC is also considered to have met the requirements of the other Land Uses (i.e., Commercial/Industrial and Military Training), and the other Land Uses do not require evaluation.

2.3.2 Ecological Receptors

Camp Ravenna has a diverse range of vegetation and habitat resources. Habitats present within the facility include large tracts of closed-canopy hardwood forest, scrub/shrub open areas, grasslands, wetlands, open-water ponds and lakes, and semi-improved administration areas (OHARNG 2014).

An abundance of wildlife is present on the facility: 35 species of land mammals, 214 species of birds, 41 species of fish, and 34 species of amphibians and reptiles have been identified. The northern long-eared bat (*Myotis septentrionalis*; federally threatened) exists at Camp Ravenna. There are no other federally listed species and no critical habitat occurs (OHARNG 2014). Ohio state-listed plant and animal species have been identified through confirmed sightings and/or biological inventories at the facility and are presented in Table 2-2. With exception of the former perimeter and access roads at Load Line 6, the AOC is mostly vegetated with grasses, and has mature forest on the perimeter. Additional information specific to ecological resources at Load Line 6 is included in Section 7.3.

2.4 CO-LOCATED OR PROXIMATE SITES

The following subsections summarize sites that are co-located or proximate to Load Line 6 but are addressed separately.

2.4.1 Facility-wide Sewers

The defunct sewers within the perimeter of Load Line 6 are being investigated and assessed as part of the Facility-wide Sewers AOC (RVAAP-67). Storm sewers are not present at Load Line 6. Sanitary sewer sediment, pipe bedding material, and sewer water were evaluated as currently summarized in the *Draft Remedial Investigation/Feasibility Study Report for RVAAP-67 Facility-wide Sewers* (USACE 2012a). The sanitary sewers in the Load Line 6 functional area (FA) are part of network that flowed to the George Road STP network. While cracks and joint separations within the sanitary sewer system have been observed due to the advanced age of the system, the pipes are generally intact, which limits vertical migration from sewer sediment to the exterior of the piping system.

Sewer water samples were collected during the 2003 Phase I RI. The samples were collected at manholes; however, none of the sewer locations contained enough recoverable sediment to constitute a viable sample. Sewer sediment, water, and pipe bedding material (e.g., soil or backfill beneath the pipe) samples were also collected in 2009 and 2010 as part of the Facility-wide Sewers RI (USACE 2012a). The compiled data provided effective characterization of the nature and extent of the contamination at the Load Line 6 FA, and no further sampling was recommended. All SRCs found in the subsurface sewer media samples within the Load Line 6 FA and evaluated through the stepwise fate and transport screening evaluation were eliminated as posing future impacts to groundwater.

The HHRA did not identify COCs at the Load Line 6 FA for the National Guard Trainee or Resident Receptor. The point evaluation for the Load Line 6 FA identified four point evaluation chemicals of potential concern in sewer sediment. Lead and three PAHs exceeded screening criteria in one sanitary sewer sediment sample. Since the Load Line 6 FA has no sewer outfalls, no further action was recommended from an ecological perspective. In summary, the Facility-wide Sewers RI recommended no further action for the Load Line 6 sanitary sewers. The Facility-wide Sewers RI predated the Technical Memorandum that specified evaluation of a Commercial/Industrial Land Use; however, the Load Line 6 FA was determined to be protective for Unrestricted (Residential) Land Use. Therefore, an evaluation of Commercial/Industrial Land Use would not be required.

2.4.2 Facility-wide Groundwater

As part of the Installation Restoration Program (IRP), the Army implements the Facility-wide Groundwater Monitoring Program (FWGWMP) in accordance with previous agreements made with Ohio EPA. The FWGWMP was initiated in 2005 and involves quarterly sampling of selected wells within the former RVAAP and collecting groundwater depths at each existing monitoring well on a quarterly basis.

From 2008-2014, several different sampling events under the FWGWMP collected groundwater data from nine monitoring wells at Load Line 6 (EQM 2015). In 2008-2009, the FWGWMP collected groundwater samples from wells LL6mw-001 through LL6mw-007. In 2010, the FWGWMP collected groundwater data from wells LL6mw-001, LL6mw-004, and LL6mw-005. In 2011-2013, the FWGWMP collected groundwater data from LL6mw-002, LL6mw-005, and LL6mw-007. Wells LL6mw-008 and LL6mw-009 were added to the FWGWMP in 2012-2013 to evaluate groundwater in the vicinity of former Test Chamber #2. Most chemical concentrations in the groundwater were below the maximum contaminant level (MCL) and regional screening level (RSL) [target risk (TR) of 1E-05, hazard quotient (HQ) of 1]. The exceptions were aluminum, arsenic, iron, manganese, and bis(2-ethylhexyl)phthalate above the MCL and thallium above the RSL (TR of 1E-05, HQ of 1) in select wells and sampling events (EQM 2015).

Facility-wide groundwater is currently at the RI phase of the CERCLA process. Any future decisions or actions respective to groundwater contamination at Load Line 6 will be addressed as part of that AOC.

2.4.3 Load Line 6 Evaporation Unit

The Load Line 6 Evaporation Unit (historically designated as RVAAP-14) was operated by Physics International during research and development experiments from 1981-1987 at Load Line 6. The Load Line 6 Evaporation Unit was an 18 by 14 by 4-ft concrete tank with two compartments measuring 5 by 14 ft and 13 by 14 ft, enclosed in a 20 by 20 ft prefabricated metal building. It is estimated that the location of the evaporation unit was at Building 2F-6. Wastewater containing explosives (TNT, RDX, and HMX) from washdown was evaporated in the larger of the two concrete compartments. Residuals from the tank were removed and transferred to Demolition Area 2 (RVAAP-04) for thermal destruction (USAEHA 1988). In 1985, hairline cracks were observed in the unit. It was subsequently lined with polyvinyl chloride during a remedial action. In 1989, the tank was emptied, cleaned of explosive residues, and was issued a RCRA Closure Plan. A subsurface investigation was performed and revealed TNT and RDX in the perimeter soil (up to 2 ft bgs) in concentrations up to 200 ppm, and up to 100 ppm beneath the tank. The closure required removing all contaminated soils associated with the unit. No documents exist to indicate the extent of the remedial action; however, soil sampling conducted after the soil was removed confirmed clean closure of this unit. This unit was closed under RCRA regulations in 1989.

The *RCRA Facility Assessment* (Jacobs 1989) indicated that there is high potential for releases to soil, surface water, and groundwater. As stated above, there was a documented release to soil and RCRA remedial action was performed in 1989. The assessment indicated that no additional actions were necessary at that time. This site was also included in the *Preliminary Assessment for the Characterization of Areas of Contamination* (USACE 1996). As documented in the 2004 Installation Action Plan, this site attained Response Complete under the IRP in 2000 (RVAAP 2004).

2.4.4 Load Line 6 Treatment Plant

The Load Line 6 Treatment Plant (historically designated as RVAAP-15) was a pink water treatment plant in operation from 1987-1993. This treatment plant was used by Physics International Company under a NPDES permit for the filtration of pink water.

The plant consisted of two 167-lb activated carbon units to filter the pink water in a batch treatment process. The filters were enclosed in a 20 by 20 ft metal-sided building with a concrete pad. The building was located adjacent to the southwest side of Building 2F-7. Plant influent was stored in a

900-gal stainless steel holding tank prior to being pumped through a Cuno filter and two activated carbon units. The treated water was pumped into one of two 500-gal holding tanks, sampled, and discharged to George Road STP (RVAAP-22) or retreated through the system. The permit specified that the site may discharge a maximum allowable concentration of 0.14 ppm TNT, RDX, and HMX. Spent carbon was sent to the hazardous waste storage area until disposed offsite (Building 1601). The floors of the enclosed building sloped to a sump that also discharged to the George Road STP.

The *RCRA Facility Assessment* (Jacobs 1989) indicated that there is low potential for releases to soil, surface water, and groundwater. There were no documented releases, which was attributed to containerizing the carbon and enclosing the building. The assessment indicated that no additional actions were necessary at that time. This site was also included in the *Preliminary Assessment for the Characterization of Areas of Contamination* (USACE 1996). This assessment resulted in a Relative Risk Site Evaluation (RRSE) Risk Category of "Low." No explosives or metals were detected over screening criteria in the one soil sample (RVAP-151) collected outside the door to the building during the RRSE (USACHPPM 1996). The facility no longer exists and records documenting its removal are not available (Vista Technologies, Inc., 1998). As documented in the 2004 Installation Action Plan, this site attained Response Complete under the IRP in 2000 (RVAAP 2004).

2.4.5 Munitions Response Sites

The Firestone Test Facility was used for testing shaped charges in the 1950s through the late 1970s. Due to the classified nature of the research conducted at the facility, there is little available information regarding the activities that occurred or how the tests were conducted (USACE 1996). The tests that were conducted were reportedly contained, which limited any releases of munitions and explosives of concern (MEC) (e2M 2008).

The Firestone Test Facility was an approximately 1-acre area that consisted of Shaped Charge Test Chamber, Former Test Pond, TOW and Dragon Missile Test Chambers #1 and #2, and the Suspected Test Range. The Shaped Charge Test Chamber was located adjacent to the pond that was used for testing shaped charges. The building, which was 10 ft high and 10 ft square, was constructed of reinforced concrete and fitted with steel plates, and was surrounded by a barricade constructed of railroad ties. The TOW and Dragon Missile Test Chamber #1 was located outside the primary production area in a field immediately southeast of former Building 2F-12, and the TOW and Dragon Missile Test Chamber #2 was located in the vicinity of Buildings 2F-1 and 2F-3 within the FPA. The TOW and Dragon Missile Test Chambers were used for TOW missiles and Dragon missiles, while shaped charges were tested under water at the Former Test Pond.

All three buildings have been removed and the areas have been cleared of surface construction debris. Some buried construction debris is evident in the area around the pond due to mounded areas with rebar protruding through the ground surface. The suspected open test range was potentially located in the northeastern portion of the AOC near LL6mw-002, but no evidence of this range has been found.

Findings and conclusions of MRS investigations at Load Line 6 are provided in the *Final Site Inspection Report* (E2M 2008) and *Remedial Investigation Report for RVAAP-033-R-01 Firestone*

Test Facility MRS (CB&I 2014). No MEC or munitions debris (MD) were found during the 2007 site inspection (SI) field activities; however, various subsurface anomalies were detected that were not verified during the SI. In May-July 2011, geophysical and intrusive investigations were conducted to identify potential subsurface areas of MEC and/or MD at the Firestone Test Facility MRS. No MEC or MD was identified on the ground surface or at subsurface anomalies during the investigation. An underwater tactile investigation was performed at the Former Test Pond in August 2011 to examine for potential MEC items buried within the pond sediment. The underwater investigation included 100% coverage of the walls and floor of the 0.04-acre pond. No MEC or MD was identified in the pond during the RI field activities. One incremental sampling methodology (ISM) surface soil sample was collected around the edges of the test pond and two discrete sediment samples were collected in August 2011. Additionally, a surface water sample was collected from the Former Test Pond on May 5, 2011, to evaluate options for investigating the test pond sediment.

The current MRS is 0.41 acres and is the location of the former Shaped Charge Test Chamber and Former Test Pond and is being recommended for no further action under the Military Munitions Response Program (MMRP).

2.4.6 Compliance Restoration Sites

There are two CR sites within or adjacent to the AOC boundary, including a former underground storage tank (UST) and a former coal storage location.

2.4.6.1 Facility-wide USTs

A former No. 2 Fuel Oil UST (RV-41) was located on the west side of Building 2F-11 for tenant-owned building and process heat (Physics International Company). The 6,000-gal steel UST was installed in 1981 and was removed in 1993 (SAIC 2011). The UST removal inspection report indicates no visible signs of soil contamination or visible holes in the UST upon removal; however, the report did not specify whether closure sampling was conducted. Although the tank was not regulated (i.e., exempt) by Bureau of Underground Storage Tank Regulations (BUSTR), permits to remove the UST were filed with BUSTR. This UST was evaluated as part of the Facility-wide USTs AOC (CC-RVAAP-72) in the *Historical Records Review for the 2010 Phase I Remedial Investigation Services at Compliance Restoration Sites (9 Areas of Concern)* (SAIC 2011) under the Compliance Restoration Program. This report recommended further evaluation due to the lack of data.

A CERCLA SI was performed in December 2012 and August 2013, and was documented in the *Site Inspection Report, CC RVAAP-72 Facility-wide Underground Storage Tanks* (ECC 2015). A surface geophysical survey was conducted over 2,500 ft^2 to determine if former UST RV-41 remains in place. The geophysical survey did not suggest that a UST remains buried in place. The SI included collecting samples from six boring locations. Soil samples were analyzed for semi-volatile organic compounds (SVOCs), VOCs, total petroleum hydrocarbons gasoline range organics (TPH-GRO), total petroleum hydrocarbons diesel range organics (TPH-DRO), and Target Analyte List (TAL) metals to determine the presence or absence of potential contamination. Sample results were less than

BUSTR Soil Action Levels. No further action was recommended for this former UST in the SI Report.

2.4.6.2 Facility-wide Coal Storage

The Facility-wide Coal Storage AOC (CC-RVAAP-73) consists of 17 former documented coal storage locations located throughout the former RVAAP (Figure 1-2). Historical facility operations included the use of coal to fuel power houses, boiler houses, and for heating of other buildings at the former RVAAP. One coal storage location was located north of Fuze and Booster Road, west of Fuze and Booster Spur Road, and adjacent to Building 2F-21 (Inert Storage). Primary use of coal was boiler supply/steam generation at Building 2F-21 (SAIC 2011).

The coal storage area at Building 2F-21 was evaluated in the *Historical Records Review for the 2010 Phase I Remedial Investigation Services at Compliance Restoration Sites (9 Areas of Concern)* (SAIC 2011); however, no visual evidence of coal storage was observed at Building 2F-21. Therefore, no further action was recommended for this coal storage location.

2.5 POTENTIAL SITE-RELATED RELEASES

As presented in Table 2-1, there have been no documented site-related releases at Load Line 6, with the exception of the release to soil and RCRA remedial action performed as part of the Load Line 6 Evaporation Unit (RVAAP-14) discussed in Section 2.4.3. Table 2-1 presents potential contaminants that may be present in Load Line 6 media from previous use of the site.

Table 2–1. Potential Source Area Description and Potential Impacts

Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
Building 2F-1	1941-1945 - Utilized as fulminate dry house.	None	Mercury fulminate
Building 2F-2	1941-1945 – Heater house associated with Building 2F-1.	None	Metals, PAHs
Building 2F-3	1941-1945 - Utilized as fulminate mix house. One former sump inside 2F-3.	None	Mercury fulminate
Building 2F-4	1941-1945 - Utilized for primer loading.	None	Black powder, mercury fulminate
Building 2F-6	1941-1945 - Utilized as a black powder dry house. Estimated location of former Load Line 6 Evaporation Unit (former RVAAP-14).	TNT and RDX (Evaporation Unit, See Section 2.4.3)	Black powder, mercury fulminate, potassium nitrate; TNT, RDX, and HMX
Building 2F-7	1941-1945 - Utilized for black powder pelleting. Former Load Line 6 Treatment Plant was located in building on the southwest side of 2F-7.	None	Black powder, mercury fulminate, potassium nitrate
Building 2F-8	1941-1945 - Utilized for delay loading.	None	Black powder, mercury fulminate, potassium nitrate
Building 2F-9	1941-1945 - Utilized as a primer dry house.	None	Black powder, mercury fulminate
Building 2F-10	1941-1945 - Utilized as a detonator service magazine (manufactured at Load Line 9).	None	Mercury fulminate, lead azide
Building 2F-11	1941-1945 - Utilized for fuze assembly.	None	Black powder, mercury fulminate, lead azide, tetryl, RDX, TNT
Building 2F-12	1941-1945 - Utilized for fuze testing.	None	Black powder, mercury fulminate, lead azide, tetryl, RDX, TNT
Building 2F-13	1941-1945 and 1969-1970 - Utilized as change house where workers changed out of work clothing at end of shift.	None	Black powder, mercury fulminate, lead azide, tetryl, RDX, TNT
Building 2F-14	1941-1945 and 1969-1970 - Utilized as change house where workers changed out of work clothing at end of shift. Basement in Building 2F-14.	None	Black powder, mercury fulminate, lead azide, tetryl, RDX, TNT
Building 2F-15	1941-1945 - Utilized for paint storage.	None	Paints
Building 2F-18	1941-1945 - Utilized as a primer house/storage (some finished primers from Load Line 10).	None	Black powder, mercury fulminate; TNT, PETN, antimony sulfide, lead thiocyanate, potassium chlorate
Building 2F-19	1941-1945 - Utilized for booster pellet storage (manufactured at Load Lines 7 and 8).	None	Black powder, mercury fulminate, lead azide, tetryl, RDX, TNT
Building 2F-20	1941-1945 - Utilized for delay storage.	None	Black powder, mercury fulminate, potassium nitrate
Building 2F-31	1941-1945 - Utilized for delay loading.	None	Black powder, mercury fulminate, potassium nitrate

Table 2–1. Potential Source Area Description and Potential Impacts (continued)

Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
Building 2F-32	1941-1945 - Utilized for fuze assembly.	None	Black powder, mercury fulminate, lead azide, tetryl, RDX, TNT
Building 2F-33	1941-1945 - Utilized for booster pellet storage (manufactured at Load Lines 7 and 8).	None	Black powder, mercury fulminate, lead azide, tetryl, RDX, TNT
Building 2F-34	1941-1945 - Utilized for primer storage (some finished primers from Load Line 10).	None	Black powder, mercury fulminate; TNT, PETN, antimony sulfide, lead thiocyanate, potassium chlorate
Building 2F-35	1941-1945 - Utilized for solvent storage.	None	Solvents
Building 2F-36	1941-1945 and 1969-1970 - Utilized as change house where workers changed out of work clothing at end of shift. Basement in Building 2F-36	None	Black powder, mercury fulminate, lead azide, tetryl, RDX, TNT
Transformers	Historical records indicate 4 transformers serviced Load Line 6. All transformers were tested for PCBs; however, only one transformer contained a detected concentration of 2 ppm (i.e., not contaminated). All transformers were removed on July 21, 1993, and were stored at Building 854 (RVAAP-27, PCB Storage) awaiting final disposition by the Defense Reutilization Material Office.	None	PCBs
Firestone Test Facility			
Shaped Charge Test Chamber	1950-late 1970s - Utilized to perform research and development on shaped charges for armor penetration by the Firestone Tire and Rubber Company's Defense Research Division. This test chamber was located south of the FPA, immediately adjacent to the shaped charge test pond in the southern portion of the AOC. Also, there was an adjacent control house. Part of active Firestone Test Facility MRS (RVAAP-033-R-01).	None	Metals, TNT, Comp B, Octol
Shaped Charge Test Pond	1950-late 1970s - Utilized as an underwater test chamber for weapons experimentation by the Firestone Tire and Rubber Company's Defense Research Division from the 1950s through the late 1970s. It is located south of the Load Line 6 WWII production area, near the Shaped Charge Test Chamber. The test pond is still present at the AOC. Part of active Firestone Test Facility MRS (RVAAP-033-R-01).	None	Metals, TNT, Comp B, Octol

Table 2–1. Potential Source Area Description and Potential Impacts (continued)

Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
Tow and Dragon Missile Test Chamber #1	1950-late 1970s - The Tow and Dragon Missile Test Chamber #1 was located outside the primary production area in a field immediately southeast of former Building 2F-12. Formerly part of Firestone Test Facility MRS (RVAAP-033-R-01). Basement at test chamber building (demolished in place to 3 ft bgs).	None	Metals, TNT, Comp B, Octol
Tow and Dragon Missile Test Chamber #2	1950-late 1970s - The Tow and Dragon Missile Test Chamber #2 was located in the vicinity of Buildings 2F-1 and 2F-3. Formerly part of Firestone Test Facility MRS (RVAAP-033-R-01).	None	Metals, TNT, Comp B, Octol
Suspected Test Range Area	A suspected open test range was potentially located in the northeastern portion of the AOC near LL6mw-002, but no evidence of this range has been found. It was formerly associated with Firestone Test Facility MRS (RVAAP-033-R-01).	None	Metals, TNT, Comp B, Octol

Although the Phase I RI (MKM 2003) identified black powder and mercury fulminate were used at Buildings 2F-2, 2F-15, and 2F-35, current research does not indicate these buildings used these chemicals.
Target metals = Antimony, arsenic, barium, cadmium, chromium, lead, and mercury.
Target explosives = TNT, HMX, PETN, and tetryl.
AOC = Area of concern.
FPA = Former production area.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane.
MRS = Munitions response site.
PAHs = Polycyclic aromatic hydrocarbons.
PCB = Polychlorinated biphenyl.
PETN = Pentaerythritol tetranitrate.
ppm = Parts per million.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
TNT = 2,4,6-Trinitrotoluene.
VOC = Volatile organic compound.
WWII = World War II.

Table 2–2. Federal- and State-listed Species List

CAMP RAVENNA JOINT MILITARY TRAINING CENTER RARE SPECIES LIST	
December 2014	
I. Species confirmed to be on Camp Ravenna property by biological inventories and confirmed sightings.	
A. Federal Threatened	
1. Northern long-eared bat, *Myotis septentrionalis*	
B. State Endangered	
1. American bittern, *Botaurus lentiginosus* (migrant) 2. Northern harrier, *Circus cyaneus* 3. Sandhill Crane, *Grus Canadensis* (probable nester) 4. Black bear, *Ursus americanus* 5. Mountain Brook Lamprey, *Ichthyomyzon greeleyi* 6. Brush-tipped emerald, *Somatochlora walshii* 7. Graceful Underwing, *Catocala gracilis*	8. Tufted Moisture-loving Moss, *Philonotis Fontana var. caespitosa* 9. Appalachian quillwort, *Isoetes engelmannii* 10. Handsome sedge, *Carex formosa* 11. Narrow-necked Pohl's Moss, *Pohlia elongata var. elongate* 12. Philadelphia panic-grass, *Panicum philadelphicum* 13. Variegated scouring-rush, *Equisetum variegatum*
C. State Threatened	
1. Barn owl, *Tyto alba* *2.* Least bittern, *Ixobrychus exilis* 3. Trumpeter swan, *Cygnus buccinators* (migrant) 4. Bobcat, *Felis rufus* 5. Caddis fly, *Psilotreta indecisa*	6. Northern long-eared bat, *Myotis septentrionalis* 7. Hobblebush, *Viburnum alnifolium* 8. Simple willow-herb, *Epilobium strictum* 9. Lurking leskea, *Plagiothecium latebricola* 10. Strict blue-eyed grass, *Sisyrinchium montanum*
D. State Potentially Threatened Plants	
1. Arborvitae, *Thuja occidentalis* 2. False hop sedge, *Carex lupiliformis* 3. Greenwhite sedge, *Carex albolutescens* 4. Long Beech Fern, *Phegopteris connectilis* (*Thelypteris phegopteris*) 5. Pale sedge, *Carex pallescens*	6. Sharp-glumed manna-grass, *Glyceria acutifolia* 7. Straw sedge, *Carex straminea* 8. Water avens, *Geum rivale* 9. Woodland Horsetail, *Equisetum sylvaticum* 10. Shining ladies'-tresses, *Spiranthes lucida*
E. State Species of Concern	
1. Big brown bat, *Eptesicus fuscus* 2. Deer mouse, *Peromyscus maniculatus* 3. Eastern red bat, *Lasiurus borealis* 4. Hoary bat, *Lasiurus cinereus* 5. Little brown bat, *Myotis lucifugus* 6. Pygmy shrew, *Sorex hovi* 7. Southern bog lemming, *Svnaptomys cooperi* 8. Star-nosed mole, *Condylura cristata* 9. Tri-colored bat, *Perimyotis subflavus* 10. Woodland jumping mouse, *Napaeozapus insignis* 11. Sharp-shinned hawk, *Accipiter striatus* 12. Marsh wren, *Cistothorus palustris* 13. Henslow's sparrow, *Ammodramus henslowii* 14. Cerulean warbler, *Dendroica cerulean* 15. Prothonotary warbler, *Protonotaria citrea* 16. Bobolink, *Dolichonyx oryzivorus* 17. Northern bobwhite, *Colinus virginianus*	18. Common moorhen, *Gallinula chloropus* 19. Great egret, *Ardea alba* (migrant) 20. Sora, *Porzana carolina* 21. Virginia Rail, *Rallus limicola* 22. Yellow-bellied Sapsucker, *Sphyrapicus varius* 23. Creek heelsplitter, *Lasmigona compressa* 24. Eastern box turtle, *Terrapene carolina* 25. Four-toed Salamander, *Hemidacrylium scutatum* 26. Eastern garter snake, *Thamnophis sirtalis* 27. Smooth green snake, *Opheodrys vernalis* 28. Eastern sand darter, *Ammocrypta pellucida* 29. Mayfly, *Stenonema ithica* 30. Moth, *Apamea mixta* 31. Moth, *Brachylomia algens* 32. Scurfy quaker, *Homorthodes furfurata* 33. Sedge wren, *Cistothorus platensis*

Table 2–2. Federal- and State-listed Species List (continued)

CAMP RAVENNA JOINT MILITARY TRAINING CENTER RARE SPECIES LIST
December 2014

F. State Special Interest

1. American black duck, *Anas rubripes*
2. Canada warbler, *Wilsonia Canadensis*
3. Dark-eyed junco, *Junco hyemalis* (migrant)
4. Hermit thrush, *Catharus guttatus* (migrant)
5. Least flycatcher, *Empidonax minimus*
6. Magnolia warbler, *Dendroica magnolia*
7. Northern waterthrush, *Seiurus noveboracensis*
8. Winter wren, *Troglodytes troglodytes*
9. Back-throated blue warbler, *Dendroica caerulescens*
10. Brown creeper, *Certhia Americana*
11. Mourning warbler, *Oporornis Philadelphia*
12. Pine siskit, *Carduelis pinus*
13. Purple finch, *Carpodacus purpureus*
14. Red-breasted nuthatch, *Sitta Canadensis*
15. Golden-crowned kinglet, *Regulus satrapa*
16. Blackburnian warbler, *Dendroica fusca*
17. Gadwall, *Anas strepera*
18. Green-winged teal, *Anas crecca*
19. Northern shoveler, *Anas clypeata*
20. Redhead duck, *Aytya Americana*
21. Ruddy duck, *Oxyura jamaicensis*
22. Wilson’s snipe, *Gallinago delicata*
23. Subflava sedge borer, *Capsula subflava*

Note: The Integrated Natural Resources Management Plan (OHARNG 2014) indicated that no federally listed species are known to reside at Camp Ravenna, and no critical habitat occurs. However, the northern long-eared bat exists at Camp Ravenna and was expected to be listed as an endangered species in mid-2015. Accordingly, this table indicates the northern long-eared bat is federally threatened (USFWS 2016) and state threatened (ODNR 2016).

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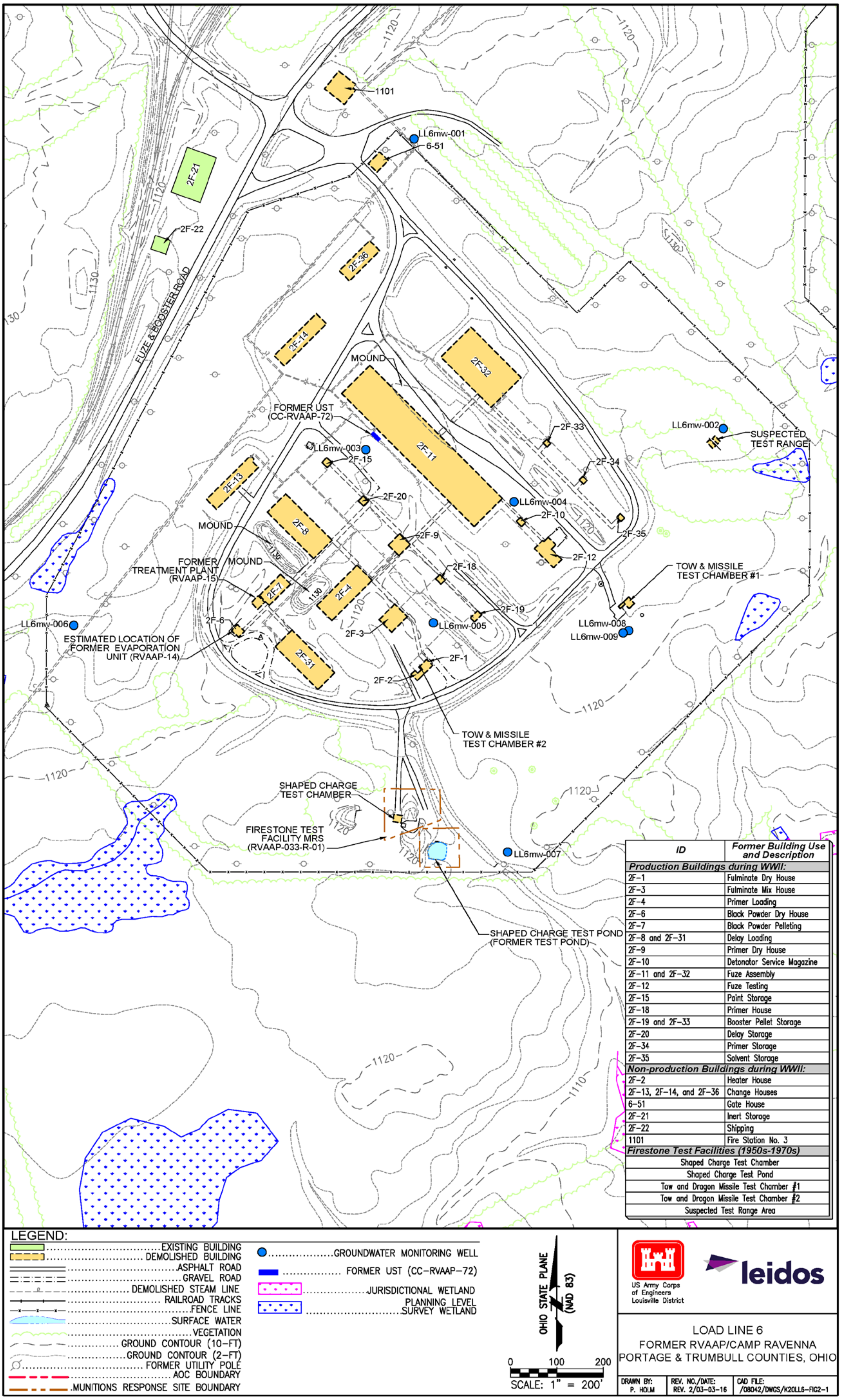
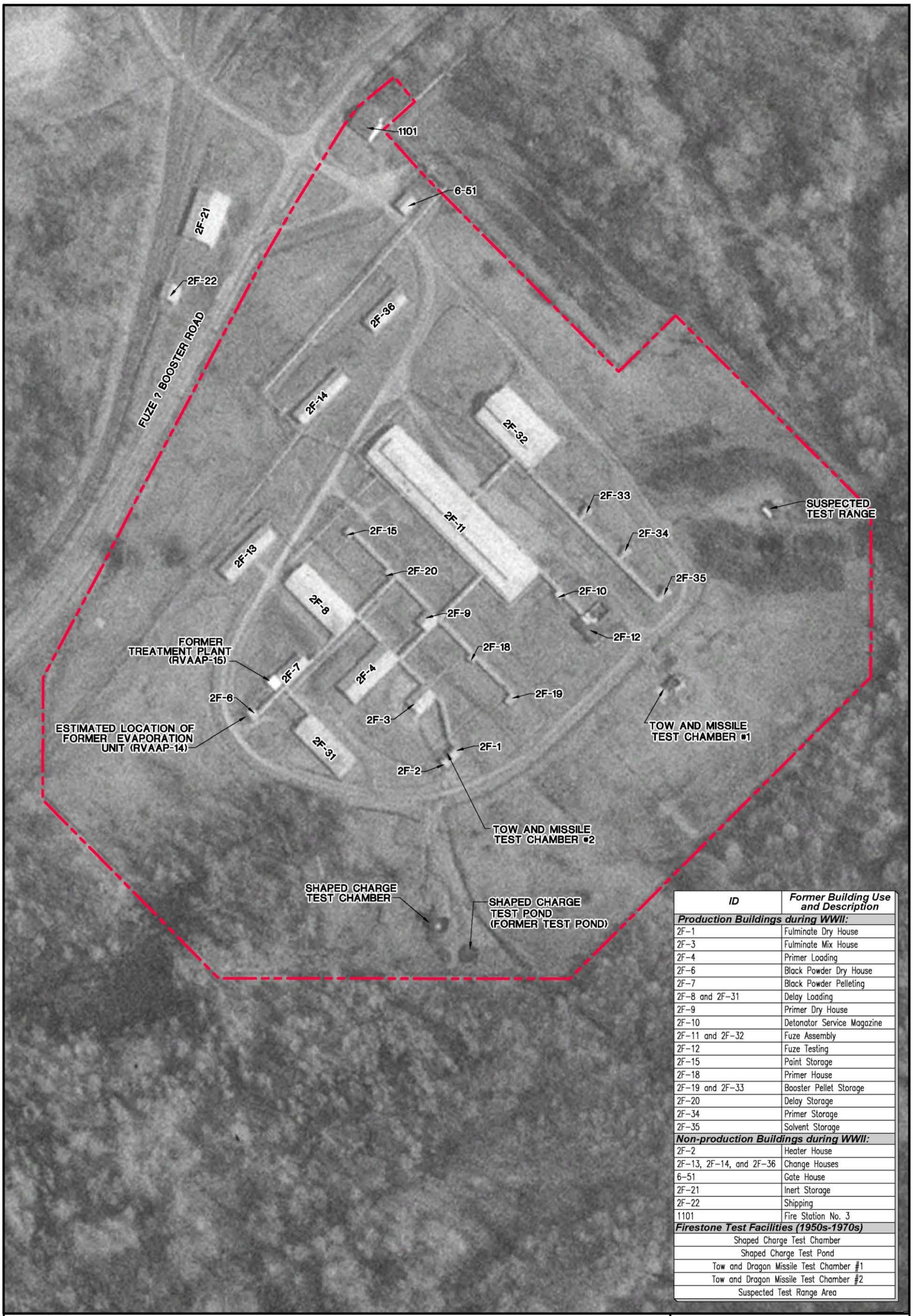


ID	*Former Building Use and Description*
Production Buildings during WWII:	
2F-1	Fulminate Dry House
2F-3	Fulminate Mix House
2F-4	Primer Loading
2F-6	Black Powder Dry House
2F-7	Black Powder Pelleting
2F-8 and 2F-31	Delay Loading
2F-9	Primer Dry House
2F-10	Detonator Service Magazine
2F-11 and 2F-32	Fuze Assembly
2F-12	Fuze Testing
2F-15	Paint Storage
2F-18	Primer House
2F-19 and 2F-33	Booster Pellet Storage
2F-20	Delay Storage
2F-34	Primer Storage
2F-35	Solvent Storage
Non-production Buildings during WWII:	
2F-2	Heater House
2F-13, 2F-14, and 2F-36	Change Houses
6-51	Gate House
2F-21	Inert Storage
2F-22	Shipping
1101	Fire Station No. 3
Firestone Test Facilities (1950s-1970s)	
Shaped Charge Test Chamber	
Shaped Charge Test Pond	
Tow and Dragon Missile Test Chamber #1	
Tow and Dragon Missile Test Chamber #2	
Suspected Test Range Area	

Figure 2-1. Load Line 6 Site Features



ID	Former Building Use and Description
Production Buildings during WWII:	
2F–1	Fulminate Dry House
2F–3	Fulminate Mix House
2F–4	Primer Loading
2F–6	Black Powder Dry House
2F–7	Black Powder Pelleting
2F–8 and 2F–31	Delay Loading
2F–9	Primer Dry House
2F–10	Detonator Service Magazine
2F–11 and 2F–32	Fuze Assembly
2F–12	Fuze Testing
2F–15	Paint Storage
2F–18	Primer House
2F–19 and 2F–33	Booster Pellet Storage
2F–20	Delay Storage
2F–34	Primer Storage
2F–35	Solvent Storage
Non-production Buildings during WWII:	
2F–2	Heater House
2F–13, 2F–14, and 2F–36	Change Houses
6–51	Gate House
2F–21	Inert Storage
2F–22	Shipping
1101	Fire Station No. 3
Firestone Test Facilities (1950s-1970s)	
Shaped Charge Test Chamber	
Shaped Charge Test Pond	
Tow and Dragon Missile Test Chamber #1	
Tow and Dragon Missile Test Chamber #2	
Suspected Test Range Area	

LEGEND:

▬ ▬ ▬	AOC BOUNDARY

NOTE:

1. SOURCE OF AERIAL PHOTO: GOOGLE EARTH, U.S. GEOLOGICAL SURVEY, IMAGE DATE: 4/13/1994.

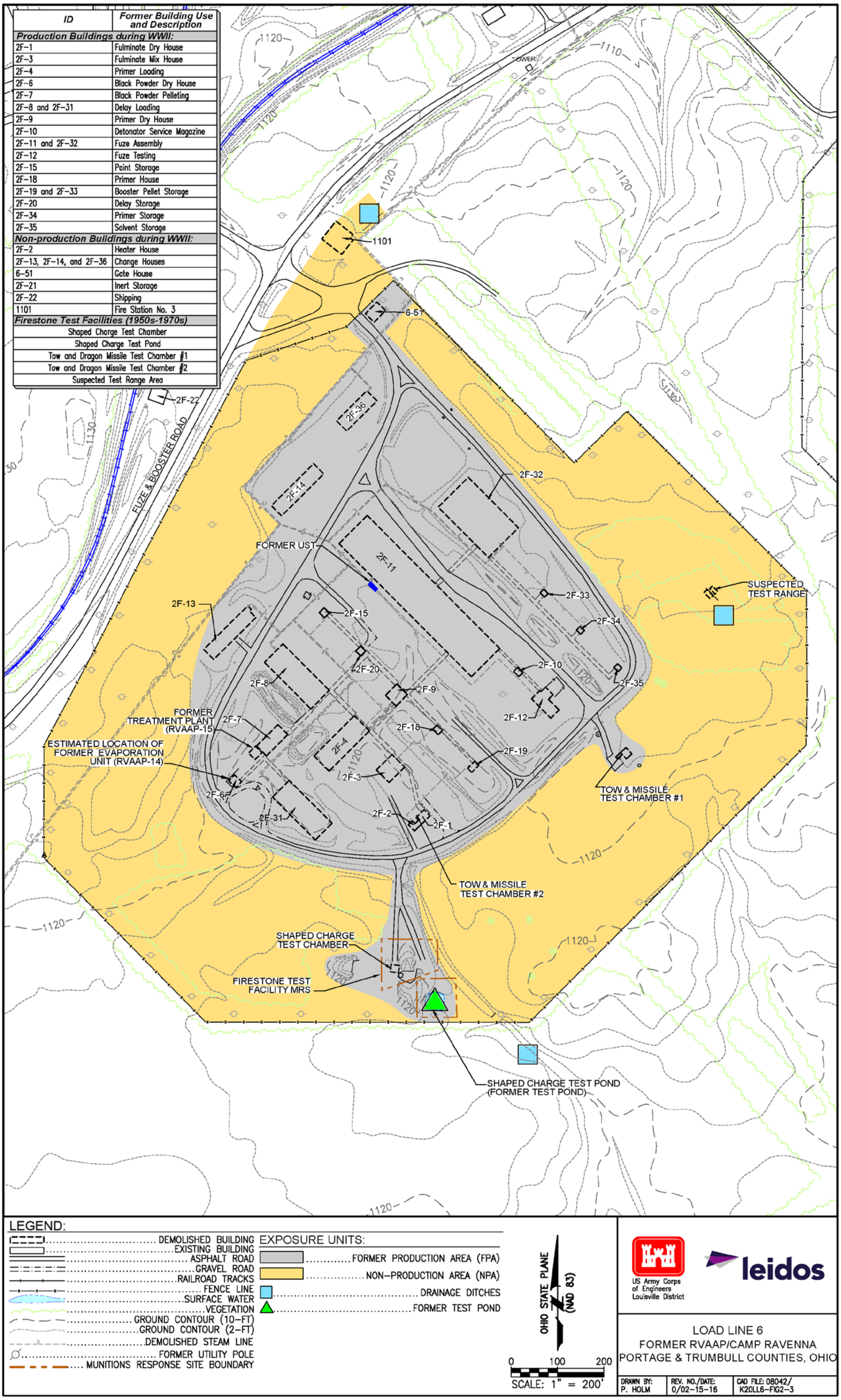
US Army Corps of Engineers Louisville District

leidos

LOAD LINE 6
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
P. HOLM	REV. 0/03–01–16	/08042/DWGS/K20LL6–FIG2–2

Figure 2-2. Load Line 6 Site Features Prior to Building Demolition (Aerial Photo dated 4/13/94)



ID	Former Building Use and Description
Production Buildings during WWII:	
2F–1	Fulminate Dry House
2F–3	Fulminate Mix House
2F–4	Primer Loading
2F–6	Black Powder Dry House
2F–7	Black Powder Pelleting
2F–8 and 2F–31	Delay Loading
2F–9	Primer Dry House
2F–10	Detonator Service Magazine
2F–11 and 2F–32	Fuze Assembly
2F–12	Fuze Testing
2F–15	Paint Storage
2F–18	Primer House
2F–19 and 2F–33	Booster Pellet Storage
2F–20	Delay Storage
2F–34	Primer Storage
2F–35	Solvent Storage
Non-production Buildings during WWII:	
2F–2	Heater House
2F–13, 2F–14, and 2F–36	Change Houses
6–51	Gate House
2F–21	Inert Storage
2F–22	Shipping
1101	Fire Station No. 3
Firestone Test Facilities (1950s-1970s)	
Shaped Charge Test Chamber	
Shaped Charge Test Pond	
Tow and Dragon Missile Test Chamber #1	
Tow and Dragon Missile Test Chamber #2	
Suspected Test Range Area	

Figure 2-3. Load Line 6 Aggregates

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3.0 ENVIRONMENTAL SETTING

This section describes the physical features, topography, geology, hydrogeology, and environmental characteristics of Camp Ravenna and Load Line 6 that are factors in identifying the potential contaminant transport pathways, receptor populations, and exposure scenarios to evaluate human health and ecological risks.

3.1 CAMP RAVENNA PHYSIOGRAPHIC SETTING

Camp Ravenna is located within the southern New York section of the Appalachian Plateaus physiographic province (USGS 1968). This province is characterized by elevated uplands underlain primarily by Mississippian and Pennsylvanian age bedrock units that are horizontal or gently dipping. The province is characterized by its rolling topography, with incised streams having dendritic drainage patterns. The southern New York section has been modified by glaciation, which rounded ridges, filled major valleys, and blanketed many areas with glacially-derived unconsolidated deposits (i.e., sand, gravel, and finer grained outwash deposits). As a result of glacial activity in this section, old stream drainage patterns were disrupted in many locales and extensive wetland areas developed.

3.2 SURFACE FEATURES AND AOC TOPOGRAPHY

The topography of Camp Ravenna is gently undulating, with an overall decrease in ground elevation from a topographic high of approximately 1,220 ft above mean sea level (amsl) in the far western portion of the facility, to low areas at approximately 930 ft amsl in the far eastern portion of the facility. USACE mapped the facility topography in February 1998 using a 2-ft (60.1-cm) contour interval with an accuracy of 0.02 ft (0.61 cm). USACE based the topographic information on aerial photographs taken during the spring of 1997. The USACE survey is the basis for the topographical information illustrated in figures found in this report.

Load Line 6 is a 43-acre AOC located immediately south of Fuze and Booster Road at the intersection of Fuze and Booster Spur Road. The AOC is located in the south-central portion of Camp Ravenna, west of Load Line 5 and east of Load Line 8 (Figure 1-2). All buildings and structures have been demolished and building slabs and footers have been removed. In addition, one building sump at Building 2F-3 was removed prior to demolition activities, and basements at Buildings 2F-36, 2F-14, and Test Chamber #1 were demolished in place to 3 ft bgs. Soil in the vicinity of former production buildings was extensively disturbed during building demolition activities. The work areas were re-graded and the area was vegetated (MKM 2005 and LES 2007). Remnant infrastructure at Load Line 6 consists of the asphalt perimeter road that surrounded the FPA, perimeter fence, and the shaped charge test chamber foundation and concrete blocks around the Former Test Pond.

The topography at Load Line 6 is generally flat to gently sloping in the FPA, which slopes downwards towards the perennial drainage channel at the south-central side of the AOC. The elevation at Load Line 6 averages 1,120 ft amsl, with a number of constructed ditches and conveyances located throughout the AOC (Figure 3-1).

Perennial surface water at Load Line 6 is limited to the Former Test Pond located at the south-central portion of the AOC. The underwater tactile investigation revealed that the pond is conical shaped with approximate 50-60 degree side slopes. The Former Test Pond is approximately 35 ft in diameter with a maximum depth of 14 ft.

Perennial surface water features exist outside the fenced AOC boundary to the southwest (within a planning level wetland) and to the south/southeast (as two small, unnamed headwater streams that eventually drain to the Michael J. Kirwan Reservoir). Surface water also occurs intermittently throughout the AOC as storm water runoff within constructed drainage ditches or natural conveyances. The surface water drainage generally follows the topography of the AOC, from the north towards the south. At the south end of the AOC, surface runoff that follows the constructed drainage ditches feeds into a natural drainage channel in the south-central portion of the AOC, immediately east of and adjacent to the Former Test Pond. This natural drainage channel becomes the downstream perennial headwater streams to the Michael J. Kirwan Reservoir.

3.3 SOIL AND GEOLOGY

3.3.1 Regional Geology

The regional geology at Camp Ravenna consists of horizontal to gently dipping bedrock strata of Mississippian and Pennsylvanian age overlain by varying thicknesses of unconsolidated glacial deposits. The bedrock and unconsolidated geology at Camp Ravenna and the geology specific to Load Line 6 are presented in the following subsections.

3.3.2 Soil and Glacial Deposits

Bedrock at Camp Ravenna is overlain by deposits of the Wisconsin-aged Lavery Till in the western portion of the facility and the younger Hiram Till and associated outwash deposits in the eastern two-thirds of the facility (Figure 3-2). Unconsolidated glacial deposits vary considerably in their character and thickness across Camp Ravenna, from zero in some of the eastern portions of the facility, to an estimated 150 ft (46 m) in the south-central portion.

A thin covering of glacial material has been completely removed as a consequence of human activities at locations such as Ramsdell Quarry. Bedrock is present at or near the ground surface in many locations, such as at Load Line 1 and the Erie Burning Grounds (USACE 2001a). Where this glacial material is still present, its distribution and character indicate its origin as ground moraine. These tills consist of laterally discontinuous assemblages of yellow-brown, brown, and gray silty clays to clayey silts, with sand and rock fragments. Lacustrine sediment from bodies of glacial-age standing water has also been encountered in the form of deposits of uniform light gray silt greater than 50 ft thick in some areas (USACE 2001a).

Soil at Camp Ravenna is generally derived from the Wisconsin-age silty clay glacial till. Distributions of soil types are discussed and mapped in the *Soil Survey of Portage County, Ohio*, which describes soil as nearly level to gently sloping and poor to moderately well drained (USDA 1978). Much of the native soil at Camp Ravenna was disturbed during construction activities in former production and operational areas of the facility.

The Sharon Member of the Pennsylvanian Pottsville Formation is the primary bedrock beneath Camp Ravenna. In the western half of the facility, the upper members of the Pottsville Formation, including the Connoquenessing Sandstone (also known as the Massillon Sandstone), Mercer Shale, and uppermost Homewood Sandstone have been found. The regional dip of the Pottsville Formation measured in the western portion of Camp Ravenna is 5-11.5 ft per mile to the south.

3.3.3 Geologic Setting of Load Line 6

The bedrock formations underlying the unconsolidated deposits at Load Line 6, as inferred from existing geologic data, are the Pennsylvanian age Pottsville Formation, Homewood Sandstone Member, and Mercer Member (Figure 3-3). Bedrock was encountered at Load Line 6 at 12.9-20 ft bgs when monitoring wells were installed during the Phase I RI (MKM 2007). The Homewood Sandstone Member is the uppermost unit of the Pottsville Formation. It typically occurs as a caprock on bedrock highs in the subsurface and ranges from well-sorted, coarse-grained, white quartzose sandstone to a tan, poorly sorted, clay-bonded, micaceous, medium- to fine-grained sandstone. Thin shale layers are prevalent in the Homewood member, as indicated by a darker gray shade of color. The Mercer Member of the Pottsville Formation lies unconformably under the Homewood Sandstone and consists of silty to carbonaceous shale with abundant thin, discontinuous sandstone lenses in the upper portion. Regionally, the Mercer Shale Member has also been noted to contain interbeds of coal. During the PBA08 RI, the Mercer Shale Member was encountered in one of the soil borings (LL6sb-072) at 21.25 ft bgs.

Load Line 6 is located within Hiram Till glacial deposits. The soil type covering more than 95% of this AOC is the Mahoning silt loam (MgA) (0-2% slopes). Mahoning silt loam (MgB) (2-6% slopes) comprises the remaining 5% in southeastern portion of the AOC. Mahoning silt loam is a gently sloping, poorly drained soil formed in silty clay loam or clay loam glacial till, generally where bedrock is greater than 6 ft bgs. Mahoning silt loam has low permeability, with rapid runoff and seasonal wetness (USDA 2010).

Lithologic logs generated during the installation of the seven monitoring well soil borings indicated that lateral and vertical composition of the soil varied across the AOC, and included a mixture of clay, silty clay, clayey silt, sandy silt, sand, and silty sand (MKM 2007). These deposits are generally firm, low to moderately plastic, and tend to hold water where encountered. A consistent brown sand layer was encountered across the AOC at depths ranging from 12.5-18.2 ft bgs. The Phase I RI geotechnical analyses indicated that a grain size range of 8.4-26% sand, 35.7-53.3% silt, and 17.8-51.6% clay. The unconsolidated zone thickness observed at Load Line 6 during installation of the monitoring wells varied considerably between locations; the shallowest depth-to-bedrock observed was 12.9 ft bgs, while other locations advanced to a depth of 23 ft bgs without encountering bedrock.

As observed in PBA08 RI soil borings, the composition of unconsolidated deposits at Load Line 6 generally consist of yellowish-brown and brown, medium dense, clay and sand-rich silt tills. Brown, medium dense, fine-grained silty sand was observed in some soil borings, typically at 9-13 ft bgs. Groundwater, when observed, was encountered at approximately 11.5 ft bgs in soil borings. PBA08 RI boring logs containing geologic descriptions of unconsolidated deposits at Load Line 6 are included in Appendix A. Cross-sections of the Load Line 6 subsurface were created from monitoring well lithology records to illustrate lateral distribution and variation of the discontinuous glacial sediment (MKM 2007).

One soil boring was completed at Load Line 6 during the PBA08 RI for the purposes of obtaining geotechnical parameters to perform vadose zone soil leaching and groundwater transport modeling. Two samples, one each from the 4-5 and 9-10.5 ft bgs intervals, were collected from this soil boring. The sample from 4-5 ft bgs is categorized as a silty clay, and the sample from 9-10.5 ft bgs is categorized as a silty sand. Results are consistent with the Phase I RI and lithology observed across the AOC. A summary of geotechnical analysis, including porosity, density, and moisture content is presented in Section 5.6.

3.4 HYDROGEOLOGY

3.4.1 Regional Hydrogeology

Sand and gravel aquifers are present in the buried-valley and outwash deposits in Portage County as described in the *Phase I Remedial Investigation Report for High-Priority Areas of Concern* (USACE 1998). Generally, these saturated zones are too thin and localized to provide large quantities of water for industrial or public water supplies; however, yields are sufficient for residential water supplies. Lateral continuity of these aquifers is unknown. Recharge of these units comes from surface water infiltration of precipitation and surface streams. Specific groundwater recharge and discharge areas at Camp Ravenna has not been delineated.

The thickness of the unconsolidated interval at Camp Ravenna ranges from thin to absent in the eastern and northeastern portion of Camp Ravenna to an estimated 150 ft (45 m) in the south-central portion of the facility. The groundwater table occurs within the unconsolidated zone in many areas of the facility. Because of the heterogeneous nature of the unconsolidated glacial material, groundwater flow patterns are difficult to determine with a high degree of accuracy. Vertical recharge from precipitation likely occurs via infiltration along root zones and desiccation cracks and partings within the soil column. Laterally, most groundwater flow likely follows topographic contours and stream drainage patterns, with preferential flow along pathways (e.g., sand seams, channel deposits, or other stratigraphic discontinuities) having higher permeabilities than surrounding clay or silt-rich material. Figure 3-4 illustrates facility-wide potentiometric surface data in the unconsolidated interval from the January 2010 contemporaneous measurement event (EQM 2010).

Within bedrock units at Camp Ravenna, the principle water-bearing aquifer is the Sharon Sandstone/Conglomerate. Depending on the existence and depth of overburden, the Sharon Sandstone/Conglomerate ranges from an unconfined to a leaky artesian aquifer. Water yields from on-site water supply wells completed in the Sharon Sandstone/Conglomerate were 30-400 gal per minute (gpm) (USATHAMA 1978). Well yields of 5-200 gpm were reported for on-site bedrock wells completed in the Sharon Sandstone/Conglomerate (Kammer 1982). Other local bedrock units capable of producing water include the Homewood Sandstone, which is generally thinner and only capable of well yields less than 10 gpm, and the Connoquenessing Sandstone. Wells completed in the Connoquenessing Sandstone in Portage County have yields of 5-100 gpm but are typically less productive than the Sharon Sandstone/Conglomerate due to lower permeabilities (Winslow et al. 1966).

Figure 3-5 shows the potentiometric surface within bedrock strata at Camp Ravenna in January 2010 (EQM 2010). The bedrock potentiometric map shows a more uniform and regional eastward flow direction than the unconsolidated zone that is not as affected by local surface topography. Due to the lack of well data in the western portion of Camp Ravenna, general flow patterns are difficult to discern. For much of the eastern half of Camp Ravenna, bedrock potentiometric elevations are higher than the overlying unconsolidated potentiometric elevations, indicating an upward hydraulic gradient. This evidence suggests there is a confining layer that separates the two aquifers. In the far eastern area, the two potentiometric surfaces are at approximately the same elevation, suggesting hydraulic communication between the two aquifers is occurring.

3.4.2 Load Line 6 Hydrologic/Hydrogeologic Setting

Seven groundwater monitoring wells were installed at Load Line 6 under the Phase I RI (MKM 2007). During monitoring well installation, bedrock, if encountered, was observed at a depth of 12.9-20 ft bgs. Bedrock was encountered in one soil boring at 21.25 ft bgs during the PBA08 RI. Initial depths to groundwater encountered during well installation varied from 8.2-18.2 ft bgs. All monitoring well groundwater elevations were collected under the FWGWMP. All monitoring wells at Load Line 6 are screened primarily in overburden, with some screens extending into bedrock. LL6mw-003, 004, 005, and 007 are categorized as wells that monitor groundwater in bedrock.

The potentiometric surface of the AOC from the January 2010 monitoring event is shown in Figure 3-1. The estimated groundwater flow directions reflect the October 2009 facility-wide potentiometric data presented in the *Facility-wide Groundwater Monitoring Program Report on the October 2009 Sampling Event* (EQM 2010). The potentiometric surface shows the groundwater flow pattern to the east/southeast. Water level elevations at the AOC ranged from 1105.36 ft amsl in LL6-mw-002 to 1107.58 ft amsl in LL6-mw-006 (9.77-24 ft below top of casing), with the highest elevation at the unconsolidated well LL6mw-006. Potentiometric data indicate the groundwater table occurs within the unconsolidated zone throughout the AOC. Available historical data do not show large seasonal fluctuations in the general groundwater flow direction.

Results of slug tests performed at the seven monitoring wells under the Phase I RI indicate an average hydraulic conductivity of 4.47E-03 cm/s (MKM 2007). Table 3-1 presents the hydraulic conductivity for each well at Load Line 6.

3.4.3 Surface Water

The following sections describe the regional and AOC-specific surface water.

3.4.3.1 Regional Surface Water

Camp Ravenna resides within the Mahoning River watershed, which is part of the Ohio River basin. The west branch of the Mahoning River is the main 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 located to the south of State Route 5 (Figure 1-1). The west branch flows out of the reservoir and parallels the southern Camp Ravenna boundary before joining the Mahoning River east of Camp Ravenna. The western and northern portions of Camp Ravenna 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 is marked with marshy areas and flowing and intermittent streams whose headwaters are located in the upland areas of the facility.

The three primary watercourses that drain Camp Ravenna are (Figure 1-2):

- South fork of Eagle Creek,
- Sand Creek, and
- Hinkley Creek.

These watercourses have many associated tributaries. Sand Creek, with a drainage area of 13.9 square miles (36 km^2), generally flows in a northeast direction to its confluence with the south fork of Eagle Creek. In turn, the south fork of Eagle Creek continues in a northerly direction for 2.7 miles (4.3 km) to its confluence with Eagle Creek. The drainage area of the south fork of Eagle Creek is 26.2 square miles (67.8 km^2), 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 11 square miles (28.5 km^2), flows in a southerly direction through the facility and converges with the west branch of the Mahoning River south of the facility (USACE 2001a).

Approximately one-third of Camp Ravenna meets the regulatory definition of a wetland, with the majority of the wetland areas located in the eastern portion of the facility. Wetland areas at Camp Ravenna include seasonal wetlands, wet fields, and forested wetlands. Many of the wetland areas are the result of natural drainage or beaver activity; however, some wetland areas are associated with anthropogenic settling ponds and drainage areas.

Approximately 50 ponds are scattered throughout the facility. Many were constructed 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. Water bodies at Camp Ravenna support aquatic vegetation and biota, as described in Section 2.3.2. Storm water runoff is controlled primarily by natural drainage except in former operations areas where an extensive storm sewer network helps direct runoff to drainage ditches and settling ponds. In addition, the storm sewer system was one of the primary drainage mechanisms for process effluent while production facilities were operational.

3.4.3.2 Load Line 6 Surface Water

Surface water flow is the primary migration pathway for contamination to leave the AOC flowing through ditches or surface water drainage features that exit the AOC (Figure 3-1). A storm sewer system is not present at Load Line 6. The storm water drainage generally follows the topography of the AOC from the north towards the south. At the south end of the AOC, surface runoff that follows the constructed drainage ditches feeds into a natural drainage channel in the south-central portion of the AOC. This natural drainage channel becomes the downstream perennial headwater streams to the Michael J. Kirwan Reservoir.

The only perennial surface water body feature at the AOC is the Former Test Pond in the southern portion of the AOC.

3.5 CLIMATE

The general climate of Camp Ravenna is continental and characterized by moderately warm and humid summers, reasonably cold and cloudy winters, and wide variations in precipitation from year to year. The climate data presented below for Camp Ravenna were obtained from available National Weather Service records for the 30-year period of record from 1981-2010 at the Youngstown Regional Airport, Ohio (http://www.weather.gov/climate/xmacis.php?wfo=cle). Wind speed data for Youngstown, Ohio are from the National Climatic Data Center for the available 30-year period of record from 1984-2014 (http://www1.ncdc.noaa.gov/pub/data/ccd-data/wndspd14.txt).

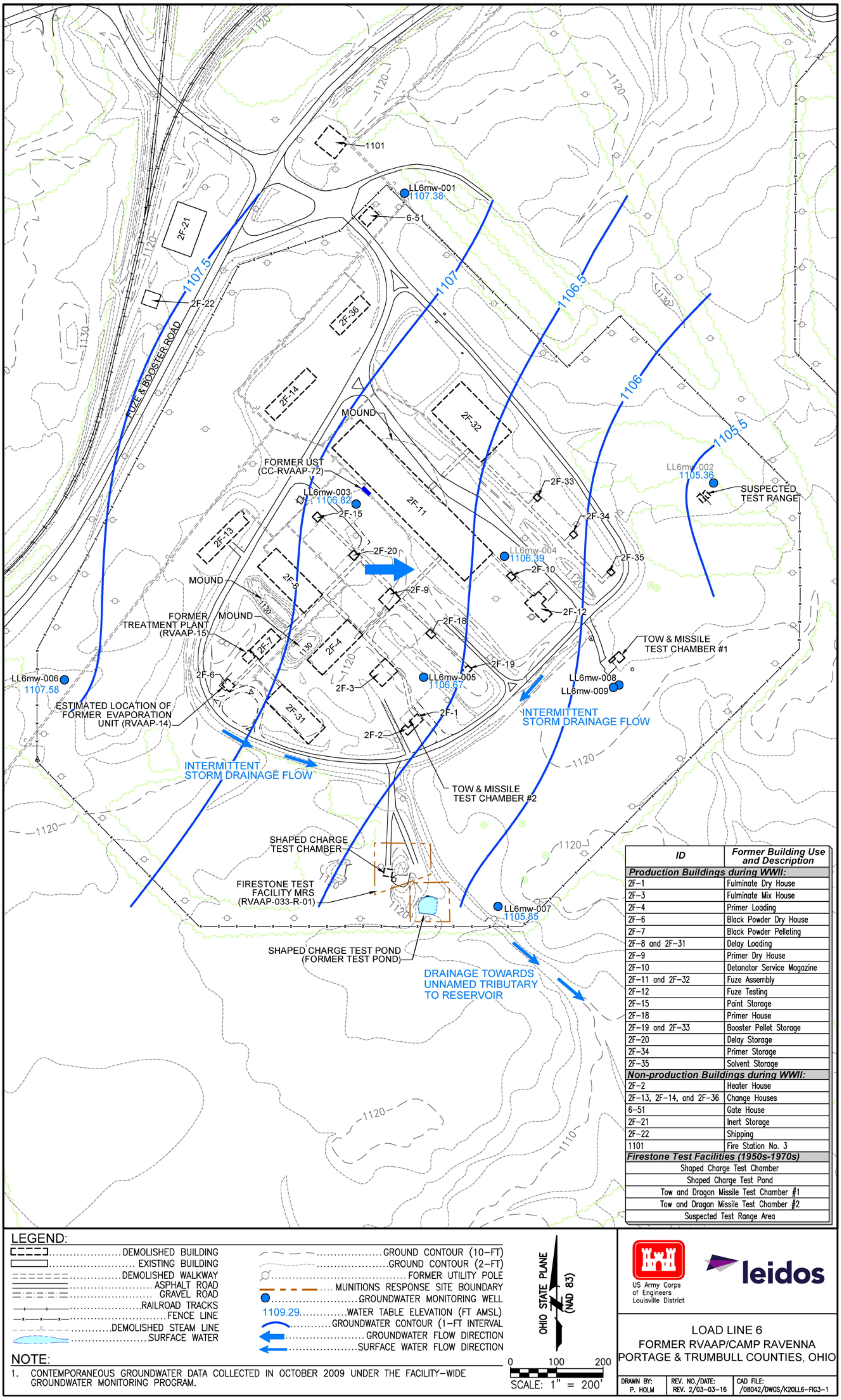
Average annual rainfall at Camp Ravenna is 38.86 inches, with the highest monthly average occurring in July (4.31 inches) and the lowest monthly average occurring in February (2.15 inches). Average annual snowfall totals approximately 62.9 inches, with the highest monthly average occurring in January (17.1 inches). Due to the influence of lake-effect snowfall events associated with Lake Erie (located approximately 35 miles to the northwest of Camp Ravenna), snowfall totals vary widely throughout northeastern Ohio.

The average annual daily temperature in the Camp Ravenna area is 49.3ºF, with an average daily high temperature of 70.9ºF and an average daily low temperature of 26.1ºF. The record high temperature of 100ºF occurred in July 1988, and the record low temperature of -22ºF occurred in January 1994. The prevailing wind direction at Camp Ravenna is from the southwest, with the highest average wind speed occurring in January (10.3 miles per hour) and the lowest average wind speed occurring in August (6.5 miles per hour). Thunderstorms occur approximately 35 days per year and are most abundant from April through August. Camp Ravenna is susceptible to tornadoes; minor structural damage to several buildings on facility property occurred as the result of a tornado in 1985.

Table 3-1. Hydraulic Conductivities Measured During the Phase I RI

Monitoring Well ID	Screened Interval (ft bgs)	Groundwater Formation Screened	Hydraulic Conductivity (cm/s)
LL6mw-001	7–17	Unconsolidated	NA
LL6mw-002	12.5–22.5	Unconsolidated	9.54E-03
LL6mw-003	12.5–22.5	Bedrock	2.36E-03
LL6mw-004	12.5–22.5	Bedrock	8.35E-03
LL6mw-005	9.5–19.5	Bedrock	7.05E-04
LL6mw-006	7–17	Unconsolidated	5.11E-04
LL6mw-007	9.5–19.5	Bedrock	5.37E-03

Source: *Report for the Phase I Remedial Investigation for Load Line 6 at the Ravenna Army Ammunition Plant* (MKM 2007).
bgs = Below ground surface.
cm/s = Centimeters per second.
ft = Feet.
ID = Identification.
NA = Not applicable; not enough static water to perform slug test.



ID	Former Building Use and Description
Production Buildings during WWII:	
2F–1	Fulminate Dry House
2F–3	Fulminate Mix House
2F–4	Primer Loading
2F–6	Black Powder Dry House
2F–7	Black Powder Pelleting
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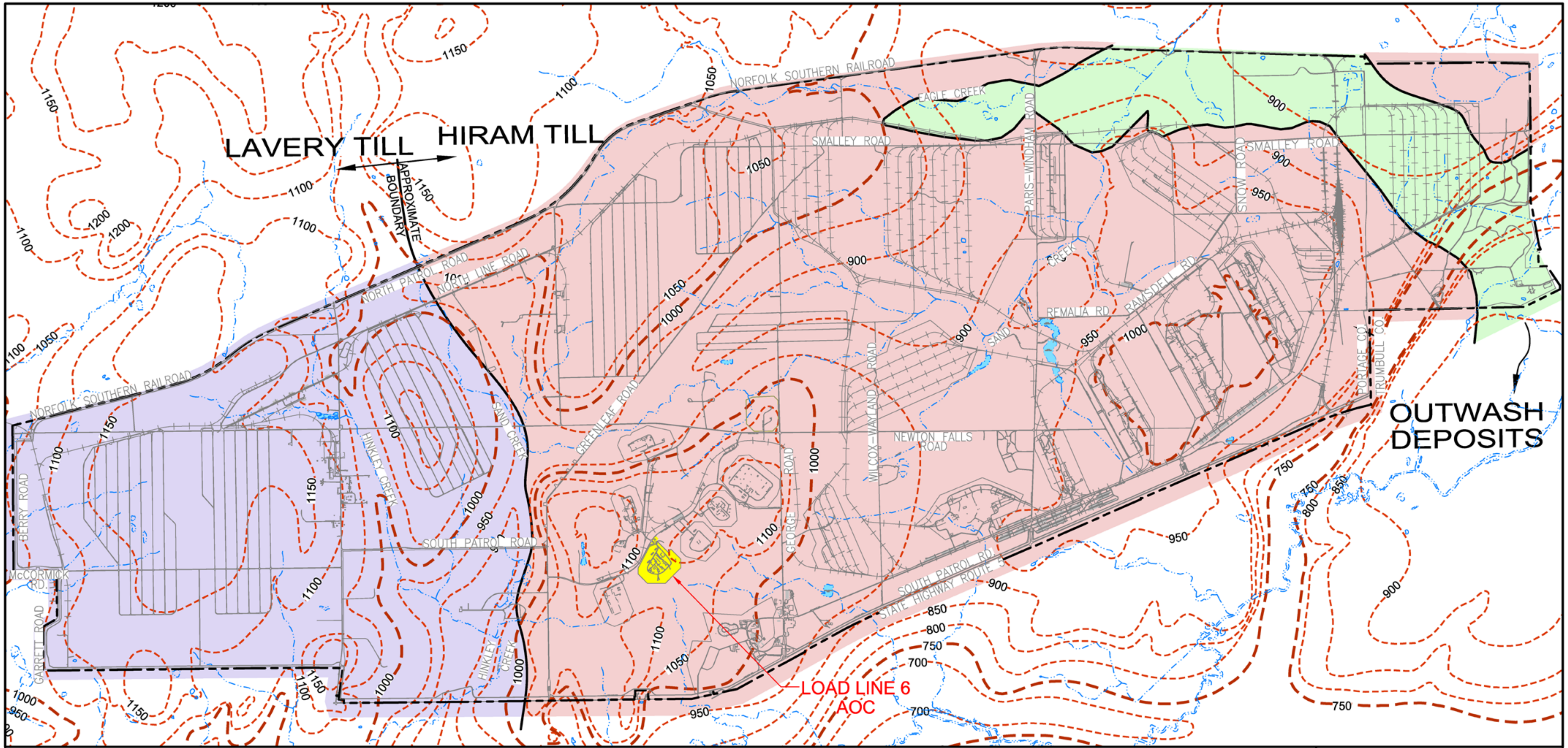
2F–9	Primer Dry House
2F–10	Detonator Service Magazine
2F–11 and 2F–32	Fuze Assembly
2F–12	Fuze Testing
2F–15	Paint Storage
2F–18	Primer House
2F–19 and 2F–33	Booster Pellet Storage
2F–20	Delay Storage
2F–34	Primer Storage
2F–35	Solvent Storage
Non-production Buildings during WWII:	
2F–2	Heater House
2F–13, 2F–14, and 2F–36	Change Houses
6–51	Gate House
2F–21	Inert Storage
2F–22	Shipping
1101	Fire Station No. 3
Firestone Test Facilities (1950s-1970s)	
Shaped Charge Test Chamber	
Shaped Charge Test Pond	
Tow and Dragon Missile Test Chamber #1	
Tow and Dragon Missile Test Chamber #2	
Suspected Test Range Area	

NOTE:

1. CONTEMPORANEOUS GROUNDWATER DATA COLLECTED IN OCTOBER 2009 UNDER THE FACILITY–WIDE GROUNDWATER MONITORING PROGRAM.

Figure 3-1. Topography, Groundwater Flow, and Surface Water Flow at Load Line 6



LEGEND:

▬ · ▬	PROPERTY BOUNDARY
∼	STREAM OR CREEK
●	POND
- - -	BEDROCK SURFACE CONTOUR (50-FT INTERVAL)
▬ ▬	BEDROCK SURFACE CONTOUR (250-FT INTERVAL)
▨	LAVERY TILL
🟥	HIRAM TILL
🟩	OUTWASH DEPOSITS

DATA SOURCES:

1.) BEDROCK TOPOGRAPHY, STATE OF OHIO DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGICAL SURVEY, PUBLISHED 2003, REVISED 2004. ELEVATION FEET ABOVE SEA LEVEL, 50 FOOT INTERVAL.

2.) WHITE, G. W. 1982. GLACIAL GEOLOGY OF NORTHEASTERN OHIO. STATE OF OHIO DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGICAL SURVEY, BULLETIN 68.

OHIO STATE PLANE (NAD83)

0 2000 4000 8000

SCALE: 1" = 4000'

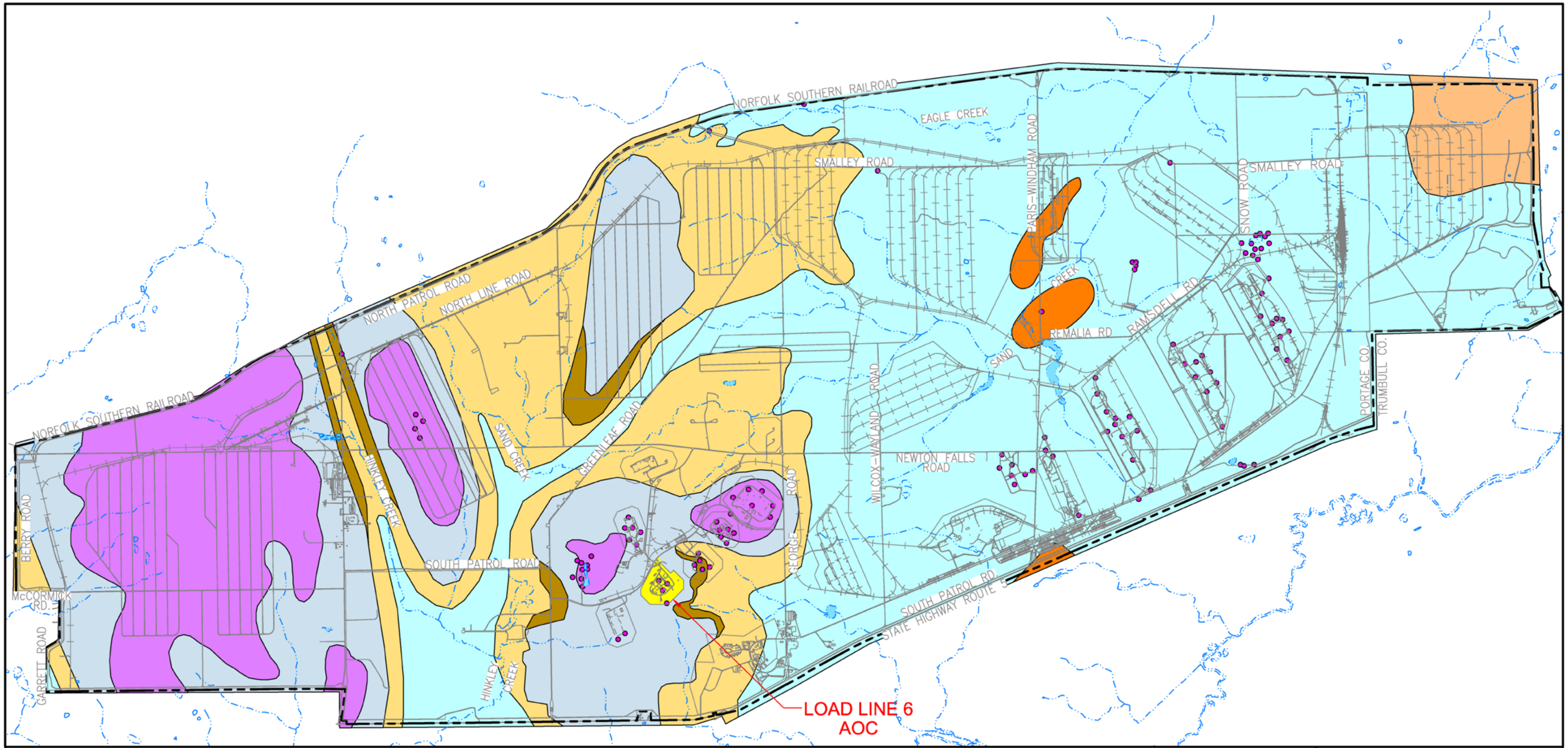
US Army Corps of Engineers Louisville District

leidos

FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
P. HOLM	1/11-18-15	08042/DWGS/K20LL6-FIG3-2

Figure 3-2. Geologic Map of Unconsolidated Deposits at Camp Ravenna



LEGEND:

- ▬ ▬ ▬ .... PROPERTY BOUNDARY
- ═══ .... PAVED SURFACE AREA
- ┼┼┼┼ .... RAILROAD TRACKS
- .... SURFACE WATER
- ● .... BEDROCK GROUNDWATER MONITORING WELL

🟧	**BEREA SANDSTONE**	MASSIVE, MODERATELY HARD, MEDIUM TO FINE GRAINED SANDSTONE.
🟫	**CONNOQUENESSING SANDSTONE MEMBER**	COARSE TO FINE GRAINED SANDSTONE AND SILTY TO SANDY SHALE. BOTH UNITS ARE MICACEOUS AND CONTAIN PLANT FRAGMENTS. SHALE UNITS INDICATED BY DARKER SHADE OF COLOR.
🟧	**CUYAHOGA GROUP**	MEDIUM TO DARK GRAY SHALE WITH THINLY BEDDED SANDSTONE AND ZONES OF SIDERITE CONCRETIONS. INCLUDES THE ORANGEVILLE, SHARPSVILLE, AND MEADVILLE FORMATIONS.
🟪	**HOMEWOOD SANDSTONE MEMBER**	COARSE TO FINE CLAY-BONDED MICACEOUS SANDSTONE INCLUDES A FEW THIN SHALE LENSES INDICATED BY DARKER SHADE OF COLOR.
🟦	**MERCER MEMBER**	GRAY TO BLACK SANDY TO SILTY MICACEOUS SHALE; INCLUDES THIN SANDSTONE, COAL, UNDERCLAY, LIMESTONE, AND SIDERITE ZONES.
🟨	**SHARON MEMBER - SHALE UNIT**	GRAY TO BLACK SANDY TO MICACEOUS SHALE CONTAINING THIN COAL, UNDERCLAY, SANDSTONE AND SIDERITE ZONES.
🟦	**SHARON SANDSTONE - CONGLOMERATE UNIT**	COARSE TO FINE GRAINED SANDSTONE, LOCALLY CONGLOMERITIC. INCLUDES A FEW SHALE LENSES INDICATED BY DARKER SHADE OF COLOR.

OHIO STATE PLANE (NAD83)

0 2000 4000 8000

SCALE: 1" = 4000'

US Army Corps of Engineers
Louisville District

leidos

FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
P. HOLM	2/12-08-15	08042/DWGS/K20LL6-FIG3-3

Figure 3-3. Geologic Bedrock Map and Stratigraphic Description of Units on Camp Ravenna

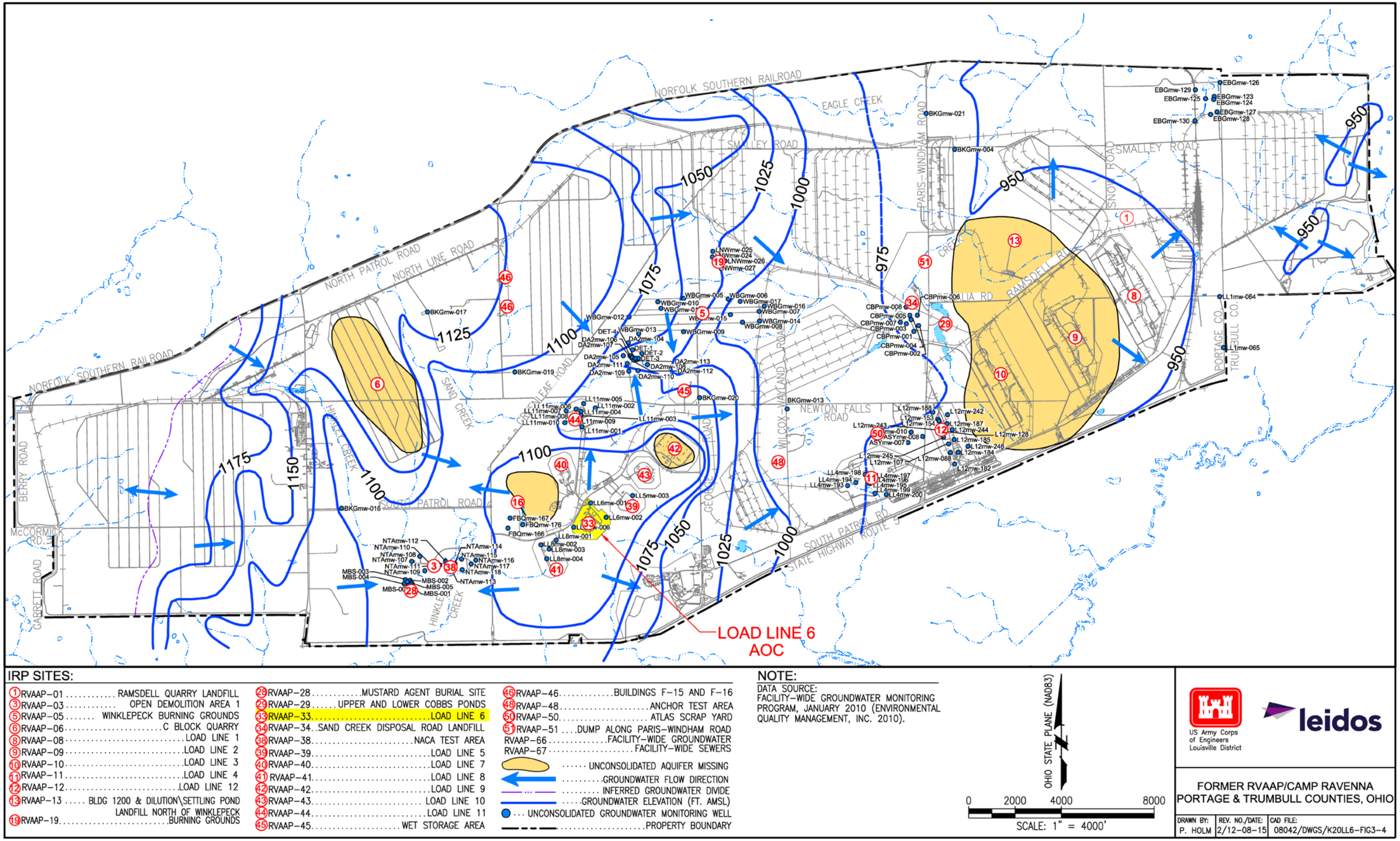


Figure 3-4. Potentiometric Surface of Unconsolidated Aquifer at Camp Ravenna

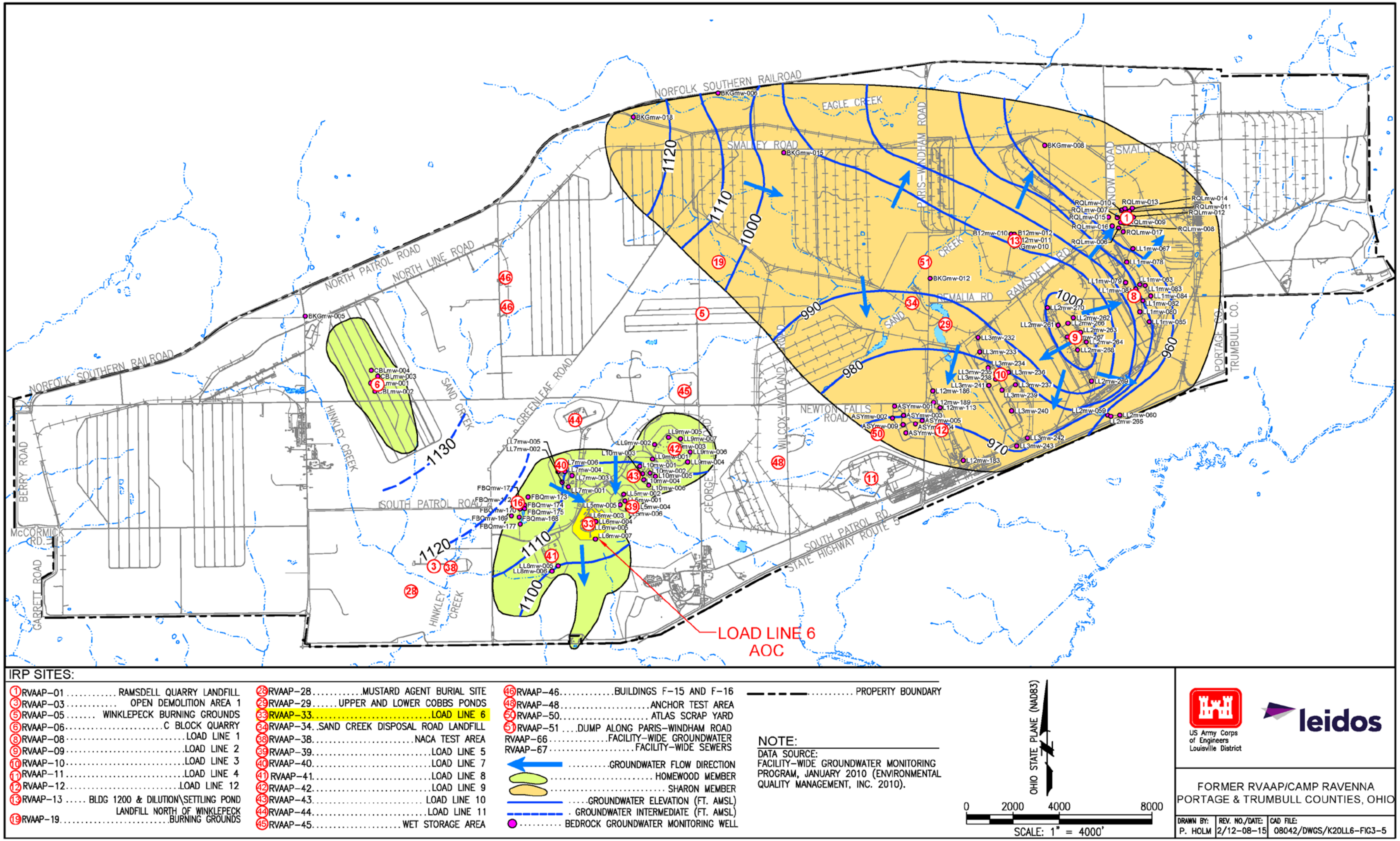


Figure 3-5. Potentiometric Surface of Bedrock Aquifers at Camp Ravenna

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4.0 SITE ASSESSMENTS, INVESTIGATIONS, AND DATA ASSEMBLY

This section summarizes all previous site assessments and investigations conducted at Load Line 6. These previous activities include assessments to prioritize the AOC and investigations that collected data used in support of this RI.

4.1 LOAD LINE 6 PREVIOUS ASSESSMENTS AND EVALUATIONS

This section summarizes previous assessments and evaluations conducted at Load Line 6. These activities were generally performed to provide an initial evaluation and/or prioritization assessment of the AOC. The data collected as part of these prioritization assessments and evaluations are not used in the nature and extent, fate and transport, HHRA, or ERA due to their age and lack of data quality documentation.

4.1.1 Installation Assessment of Ravenna Army Ammunition Plant

The *Installation Assessment of Ravenna Army Ammunition Plant* (USATHAMA 1978) incorporated a review of historical operational information and available environmental data to assess the potential for contaminant releases from operational facilities. No sampling was performed at Load Line 6 as part of the assessment. The assessment identified the following conditions at RVAAP as applicable to Load Line 6:

- Areas of RVAAP, including the load lines, burning grounds, test areas, and demolition areas were identified as AOCs contaminated with explosive waste, including TNT, Comp B, lead azide, lead styphnate, and black powder;
- Explosives were identified as the potential contaminants;
- Load lines were rehabilitated in 1951; and
- No environmental stress was identified at RVAAP.

4.1.2 RCRA Facility Assessment

The purpose of the RCRA Facility Assessment was to perform a visual inspection of known AOCs and conduct historical documentation research to identify new AOCs and solid waste management units, as applicable (Jacobs 1989). The RCRA Facility Assessment did not include specific assessments or conclusions regarding Load Line 6, and no sampling was performed at Load Line 6 as part of the assessment. However, the RVAAP-14 Load Line 6 Evaporation Unit and RVAAP-15 Load Line 6 Treatment Plant AOCs were included in the assessment, as discussed in Sections 2.4.3 and 2.4.4.

4.1.3 Preliminary Assessment Screening of Boundary Load Line Areas

Load Line 6 was included in the *Preliminary Assessment Screening of Boundary Load Line Areas* conducted by the U.S. Army Environmental Hygiene Agency (USAEHA 1994). This assessment included a review of historical records and facility personnel interviews. No sampling was performed at Load Line 6 as part of the assessment.

The assessment indicated potential contaminants could be expected on interior surfaces of buildings, in exterior soil, and in holding tanks and settling ponds. In addition, as wastewaters were discharged to the storm sewer following treatment, storm sewer and surface water discharge points may be potential contaminant pathways. The assessment recommended further environmental investigation for Load Line 6 (USAEHA 1994).

4.1.4 RVAAP Preliminary Assessment

The *Preliminary Assessment for the Characterization of Areas of Contamination* researched RVAAP history, process operations, and historical data to identify AOCs (USACE 1996). Load Line 6 was included in the assessment, in addition to the RVAAP-14 Load Line 6 Evaporation Unit and RVAAP-15 Load Line 6 Treatment Plant AOCs, as discussed in Sections 2.4.3 and 2.4.4.

The assessment provided the following general conclusions for RVAAP AOCs (all conclusions may not apply to Load Line 6; rather, these are general conclusions for all AOCs):

- COPCs at RVAAP AOCs were identified as explosives (TNT, RDX, HMX, Comp B, and lead azide) and heavy metals (lead and mercury).
- The primary sources of potential contamination were identified as wastewater effluent from the munitions assembly and demilitarization process, open burning and detonation of explosives, and landfill operations. Primary contaminant release mechanisms from load lines were process effluent discharges to surface water (drainage ditches, settling ponds, and streams) and process building wastewater wash-out to surface soil. Media of concern were identified as soil, sediment, groundwater, and surface water.
- The greatest potential for release of contaminants from load lines to groundwater likely occurred from wastewater effluent discharge to unlined earthen settling ponds. Concrete settling tanks, open drainage ditches, and storm sewers were also identified as concerns relative to groundwater.
- Known releases of contamination to surface water and soil have occurred from load line (assembly and demilitarization) operations.

The greatest potential for historical off-site contaminant migration during load line operations was identified as surface water. The greatest potential for current off-site contaminant migration was identified as groundwater and surface water.

The report provided a preliminary assessment scoring, subsequent prioritization of AOCs through evaluation of exposure pathways, and an RRSE model. Load Line 6 was ranked as a medium-priority AOC.

4.1.5 Relative Risk Site Evaluation

In 1996, the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) conducted an RRSE at Load Line 6. This evaluation was completed to prioritize future remedial or corrective activities at RVAAP. The RRSE does not provide any risk assessment for human health or ecology.

The RRSE also included collection of surface soil, sediment, and surface water samples at Load Line 6. The data collected at the site "…are minimal Level III data, as defined by U.S. EPA, and are not intended to be used as definitive evidence of contamination presence or absence or to support health risk assessment." This section summarizes the samples collected as part of the RRSE data, the chemicals detected, and the associated prioritization recommendations, but the analytical results are not presented and are not used in subsequent evaluations in this RI Report.

The RRSE evaluated the soil pathway (human receptor endpoint) using data from seven surface soil samples collected at the AOC and analyzed the soil for explosives and inorganic chemicals. One sediment sample and one surface water sample were collected for explosives and inorganic chemicals from the Former Test Pond to evaluate the sediment pathway for human and ecological receptor endpoints. Subsurface soil and groundwater were not evaluated as part of this RRSE. No explosives were detected in the samples, but several inorganic chemicals were detected in surface soil, sediment, and surface water. Concentrations of analytes detected are presented in Appendix C of the *Relative Risk Site Evaluation* (USACHPPM 1996).

The surface soil, sediment, and surface water pathways were evaluated as follows:

1. Surface soil
    a. Contaminant Hazard Factor: Significant.
    b. Migration Pathway Factor: Potential. There is no evidence that site contaminants are migrating. However, there are no physical barriers in place to prevent migration.
    c. Receptor Pathway Factor: Potential. While this area is surrounded by a fence with locked gates, hunters, scrappers, and firewood cutters may have access to the site.
2. Sediment
    a. Contaminant Hazard Factor: Minimal.
    b. Migration Pathway Factor: Potential. There is no evidence that site contaminants are migrating. However, there are no physical barriers in place to prevent migration.
    c. Receptor Pathway Factor: Potential. While this area is surrounded by a fence with locked gates, hunters, scrappers, and firewood cutters may have access to the site.
3. Surface water
    a. Contaminant Hazard Factor: Moderate.

b. Migration Pathway Factor: Potential. There is no evidence that site contaminants are migrating. However, there are no physical barriers in place to prevent migration.
c. Receptor Pathway Factor: Potential. While this area is surrounded by a fence with locked gates, hunters, scrappers, and firewood cutters may have access to the site.

Human receptor endpoints were evaluated based on the available surface soil, sediment, and surface water data. The RRSE scored Load Line 6 as a "high-priority" AOC due to potentially contaminated surface soil potentially migrating and affecting human and ecological receptors (USACHPPM 1996).

4.2 LOAD LINE 6 REMEDIAL INVESTIGATIONS

This section summarizes previous investigations conducted at Load Line 6. These investigations collected data of sufficient provenance and quality to be used to support the evaluations in this RI, including the nature and extent, fate and transport, HHRA, and/or ERA.

The previous Phase I RI Report presented SRCs and/or COPCs based on data evaluation protocols in use at the time the investigation was completed. The data and information is used in this RI; however, an updated screening process and addition of new data and information may result in a different list of SRCs and/or COPCs.

References to the "RVAAP full-suite analytes" generally include analyses of TAL metals, explosives, propellants (nitrocellulose and nitroguanidine), SVOCs, VOCs, PCBs, and pesticides.

4.2.1 Lead Azide Screening

The U.S. Army Operations Support Command contracted MKM Engineers, Inc., in conjunction with USACE, to perform a lead azide screening operation at Load Lines 6, 9, and 10 for health and safety purposes and to obtain additional information on areas of potential contamination. The purpose of this lead azide screening operation is three fold:

1. Provide necessary data to ensure the safety of workers during RI sampling activities (e.g., azide concentrations greater than 20,000 ppm).
2. Use screening data in conjunction with historical data to help determine the appropriate analytical suite, location, and number of samples required for completing subsequent RIs at the load lines.
3. Substantiate the accuracy of new General Physics Laboratory screening method for explosives·(modified 8330).

The rationale and results of the lead azide screening are presented in Appendices A and B of the *Sampling and Analysis Plan Addendum for the Remedial Investigation of Load Line 6* (MKM 2003). The field activities were conducted in March 2002 and the results are summarized in the *Report for the Phase I Remedial Investigation at Load Line 6 (RVAAP 33)* (MKM 2007). Figure 4-1 presents the locations of samples collected during this investigation.

Nine surface soil samples from locations LL6ss-001 through LL6ss-009 were collected during the March 2002 azide screening event. Four of the soil samples were field screened for lead azide, and all nine samples were field tested for TNT and RDX using the Jenkins method. Additionally, three of the soil samples from LL6ss-001, LL6ss-002, and LL6ss-003 were analyzed for explosives and metals at an off-site laboratory. One surface water sample (LL6sw-001) was from the Former Test Pond collected and submitted for metals and explosives analysis. One sediment sample (LL6sd-001) was collected during the lead azide screening. The sediment sample was co-located with the surface water sample location.

The screening results for azides showed no significant positive concentrations that would constitute a safety concern at Load Line 6. The screening results for the modified Jenkins tests showed no detectable concentrations of TNT at any of the nine sample locations, and only one sample showed detectable concentrations of RDX (i.e., 1.2 ppm at Building 2F-l8). Additionally, none of the samples submitted for laboratory analysis reported explosives in excess of laboratory reporting limits. However, metals were reported in excess of RVAAP background values in each of the three soil samples, the surface water sample, and the sediment sample (MKM 2003).

4.2.2 Phase I Remedial Investigation

In 2003, sampling was conducted at Load Line 6 in accordance with the *Sampling and Analysis Plan Addendum for the Remedial Investigation at Load Line 6* (MKM 2003).

The Phase I RI was performed to accomplish the following:

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

Results of this characterization are presented in the *Report for the Phase I Remedial Investigation at Load Line 6 (RVAAP 33)* (MKM 2007) (herein referred to as the Phase I RI), and are summarized in the following subsections.

4.2.2.1 Field Activities

The following field activities were conducted during the Phase I RI in 2003 at Load Line 6 to assess the potential impacts from former operations:

- Excavating test trenches,
- Collecting discrete surface soil (0-1 ft bgs) samples,
- Collecting subsurface soil (greater than 1 ft bgs) samples,
- Collecting surface water samples,
- Collecting sediment samples,

- Collecting subfloor samples, and
- Surveying sampling locations.

In addition, the Phase I RI field activities assessed VOCs at a "Suspect VOC Disposal Pit," which was in an area most likely to be used for disposal purposes. The 50 ft grid was placed in close proximity to the solvent building (Building 2F–35), downgradient from the load line operations, and in an area that was not used for any load line function (i.e., open field). Each sample location was field screened using head space techniques. Screening samples were collected at 10 direct-push soil borings (i.e., LL6sb–046 through LL6sb–055). The following four samples were sent to a laboratory for TPH (DRO and GRO), SVOC, and VOC analysis:

- LL6sb-049 from 4-6 ft bgs,
- LL6sb-050 from 6-8 ft bgs,
- LL6sb-051 from 6-8 ft bgs, and
- LL6sb-055 from 3-5 ft bgs.

The following activities also were conducted; however, these activities are pertinent to other co-located AOCs associated with Load Line 6 (e.g., Facility-wide Groundwater and Facility-wide Sewers), and are not discussed in this section, nor are they pertinent to this RI:

- Excavated five test trenches until bedrock or saturated soil was encountered (14-15.5 ft bgs),
- Installing, developing, and sampling seven monitoring wells,
- Conducting in-situ permeability testing (slug tests),
- Collecting sanitary sewer manhole water samples,
- Collecting samples adjacent to sanitary sewers,
- Collecting geotechnical samples from monitoring well borings, and
- Surveying monitoring well locations.

Soil (surface and subsurface), sediment, and surface water samples were analyzed for TAL metals and explosives. Additionally, 10% of samples were analyzed for RVAAP full-suite analytes.

Figure 4-1 presents the locations sampled under the Phase I RI. Table 4-1 presents the sample locations, associated operations, and suite of chemicals analyzed as part of the Phase I RI. Tables 4-2 through 4-5 present the results of the analytes detected from samples collected during the Phase I RI (including the 2002 lead azide screening).

Analytical laboratory procedures were completed in accordance with applicable professional standards, USEPA requirements, government regulations and guidelines, and specific project goals and requirements. Samples were analyzed as specified by the Facility-wide Sampling and Analysis Plan (FWSAP) current at the time of the investigation, the *Final Sampling and Analysis Plan Addendum for the Remedial Investigation of Load Line 6* (MKM 2003), and USACE Louisville Chemistry Guideline (USACE 2002). The data quality objectives (DQOs) were established for the Phase I RI and complied with USEPA Region 5 guidance. The requisite number of quality assurance (QA)/quality control (QC) samples was obtained during the investigation. The data validation determined that the data met the completeness requirements for the project (100% complete), was usable, and that it satisfied the DQOs for the project.

4.2.2.2 Nature and Extent of Contamination

A total of 15 metals, 2 SVOCs, 1 explosive, and 1 propellant were detected in surface soil (0-1 ft bgs) and 8 metals, 1 SVOC, and 1 propellant in subsurface soil (1-14 ft bgs) were detected above RVAAP background concentrations (USACE 2001b) and/or Region 9 residential soil preliminary remediation goals (PRGs) in effect at that time. A total of 14 metals, 1 SVOC, 1 propellant, and 2 explosives were detected in surface water above RVAAP background concentrations and/or Region 9 tap water PRGs. Eight metals, one propellant, one pesticide, one PCB, and three SVOCs were detected in sediment above RVAAP background concentrations and/or Region 9 residential soil PRGs. Figure 4-4 presents locations that exceed current screening criteria.

Regarding the analysis of the Suspect VOC Disposal Pit, none of the borings had VOCs detected during the field screening. Also, of the four samples sent to the analytical laboratory, none had detections of TPH (DRO and GRO) or VOCs. The only SVOC detected was at LL6sb-049 with an estimated concentration of 0.02J mg/kg of di-n-octylphthalate.

4.2.2.3 Human Health Risk Screening

A BHHRA was included in the Phase I RI for Load Line 6. The BHHRA utilized the screening process in effect at that time, based on the protocol established in the *RVAAP Facility-wide Human Health Risk Assessors Manual – Amendment 1* (herein referred to as the FWHHRAM), in order to identify potential contaminants of concern (USACE 2005a). The COPCs identified in the quantitative BHHRA are summarized in Table 4-6.

4.2.2.4 Ecological Risk Screening

The SERA compared chemical concentrations detected in Load Line 6 environmental media to RVAAP facility-wide background concentrations for inorganic chemicals and ecological screening values (ESVs). The SERA followed screening methodology guidance presented in the *2003 RVAAP Facility-wide Ecological Risk Work Plan* (USACE 2003a) (herein referred to as the FWERWP) and *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2003). Chemicals were retained if they did not have screening values. Table 4-7 presents a summary of the COPCs identified per type of species based on the ecological risk calculations.

4.2.2.5 Conclusions

The results of the Phase I RI indicated the lateral and vertical extent of contamination for explosives, propellants, metals, and SVOCs in surface soil, subsurface soil, sediment, and surface water were not fully delineated, and additional investigation to address data gaps at Load Line 6 was recommended.

4.2.3 PBA08 Remedial Investigation – March 2010

In November 2008, Science Applications International Corporation (SAIC) scientists performed a site walk of Load Line 6. The site walk was conducted to develop the *Performance-based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1* (USACE 2009) (herein referred to as the PBA08 SAP), which supplemented the Phase I RI and completed the RI phase of the CERCLA process. Numerous physical changes occurred at Load Line 6 between the Phase I RI sampling and the development of the PBA08 SAP. As discussed in Section 2.2.3, 4 buildings were demolished in 2005 and foundations and footers from 26 former buildings were removed. The sampling scheme, with consideration of the 2003 Phase I RI, took that into consideration. Section 4.4.4 discusses the suitability and use of samples collected to support this RI, with respect to changes in AOC conditions. The PBA08 SAP was reviewed and approved by representatives of the Army and Ohio EPA in January 2010.

As part of the PBA08 RI DQOs, an initial screening approach was used to help focus the investigation on specific chemicals and areas to be further evaluated by assessing the nature and extent of contamination observed in historical samples (Section 3.2.2 of the PBA08 SAP). Decision flowcharts for PBA08 RI surface and subsurface sampling are presented in Figures 4-2 and 4-3, respectively. The screening approach presented in the PBA08 SAP compared sample results from previous investigations at Load Line 6 to chemical-specific facility-wide cleanup goals (FWCUGs) at the 1E-06 cancer risk level and non-carcinogenic risk HQ of 0.1, as presented within the FWHHRAM (USACE 2005a). The most protective FWCUGs for the Resident Farmer Adult, Resident Farmer Child, and National Guard Trainee were referred to as “screening criteria.” Previous results were also compared to FWCUGs at the higher TR of 1E-05 and HQ of 1 to facilitate identifying potential source areas that may require additional sampling to refine the extent of contamination. Table 4-8 lists the chemicals with detected concentrations that exceeded screening criteria at the time of the PBA08 SAP in historical soil samples.

In February-April 2010, the PBA08 RI was implemented by collecting surface soil, subsurface soil, surface water, and sediment using discrete sampling techniques. The results of the PBA08 RI sampling, combined with the results of the Phase I RI, were used to evaluate the nature and extent of contamination, assess potential future impacts to groundwater, conduct HHRAs and ERAs, and evaluate the need for remedial alternatives.

No groundwater samples were collected during the PBA08 RI; the current conditions of groundwater will be evaluated as an individual AOC for the entire facility (designated as RVAAP-66) and addressed in a separate RI/FS Report.

A sample log for each sample and a lithologic soil description for each soil boring collected during the PBA08 RI are included in Appendix A. The DQOs, field activities, sampling methodologies, QA/QC, and management of analytical data for the PBA08 RI are further expanded upon in Appendix I.

4.2.3.1 Surface Soil Sampling Rationale – Source Area Investigation

Samples were collected during the PBA08 RI to assess contaminant occurrence and distribution in surface soil. The PBA08 RI samples were designed to delineate the extent of areas previously identified as having the greatest likelihood of contamination (e.g., adjacent to production buildings). Table 4-9 presents the specific rationale for each surface soil sample collected during the PBA08 RI in February-March 2010. Table 4-10 presents the results of the analytes detected from surface soil samples collected during the PBA08 RI in February-March 2010. All PBA08 RI sample locations are presented in Figure 4-4.

A total of 10 surface soil samples were collected at Load Line 6 during the PBA08 RI to further define the lateral extent of surface soil contamination above screening criteria and to completely characterize the AOC (Figure 4-4). Three discrete samples were collected to evaluate chromium speciation (Section 4.2.3.2). All surface soil samples collected during the PBA08 RI were collected from 0-1 ft bgs in accordance with the bucket hand auger method described in Section 4.5.2.1.1 of the FWSAP (USACE 2001a). An updated version of the FWSAP was developed in February 2011 and approved by the Ohio EPA; however, the PBA08 RI was implemented prior to approval of this updated version. As only historical discrete data were available for Load Line 6, the Army and Ohio EPA agreed to “maintain consistency at each AOC and avoid mixing of sample types in future risk management decisions” in the FWSAP. Discrete surface soil samples were analyzed for TAL metals, explosives, and PAHs. One sample (10% of the total number of samples collected) was analyzed for RVAAP full-suite analytes. One QC field duplicate and one QA split sample were collected to satisfy the QA/QC requirement of 10% of the total samples collected.

4.2.3.2 Surface Soil Sampling Rationale – Chromium Speciation

As part of the PBA08 RI, three discrete chromium speciation samples were collected to evaluate the potential contribution of hexavalent chromium to the total chromium concentrations in soil. Samples were collected from 0-1 ft bgs in accordance with the bucket hand auger method described in Section 4.5.2.1.1 of the FWSAP (USACE 2001a). Two samples were collected from areas previously identified as having elevated total chromium concentrations, and one sample was collected from an area previously identified as having a total chromium concentration near background concentrations. The rationale for the samples collected as part of the PBA08 RI is summarized in Table 4-9. The locations of these samples are presented in Figure 4-4 and results are presented in Table 4-11.

4.2.3.3 Subsurface Soil Sampling Rationale and Methods

The PBA08 RI used discrete samples from five soil borings to characterize the subsurface soil. Subsurface soil sampling was conducted according to the decision rules approved in the PBA08 SAP. The subsurface soil borings were located based on three objectives:

- Borings at locations where previous surface soil sampling results exceeded screening criteria and vertical delineation was warranted.

- Borings at locations where previous surface soil sampling results only slightly exceeded screening criteria to confirm that contaminant concentrations did not increase with depth.
- Borings at locations not previously sampled to provide full characterization of surface and subsurface soil.

The subsurface soil was characterized by placing borings in various areas, including areas with previous surface soil results greater than the screening criteria, areas with previous results only slightly greater than the screening criteria, and areas not previously sampled. In all cases, subsurface borings were installed to further define the vertical extent of contamination in subsurface soil at the AOC (Figure 4-4). Table 4-12 presents the specific rationale for each subsurface soil sample collected for the PBA08 RI in February-March 2010. Results of detected analytes are presented in Table 4-13.

To assess the depths of exposure to the Resident Receptor, each soil boring was sampled at the following intervals: 0-1, 1-4, 4-7, and 7-13 ft bgs. These sample intervals were selected to be able to evaluate surface and subsurface exposure depths for the Resident Receptor (0-1 and 1-13 ft bgs) and National Guard Trainee (0-4 and 4-7 ft bgs). The deep sample interval was archived on site, while the 4–7 ft bgs interval sample was analyzed under an expedited five-day turnaround time. As specified in the PBA08 SAP, the deep sample interval (7-13 ft bgs) was analyzed for the following reasons:

1. One chemical had a concentration that exceeded screening criteria in the 4–7 ft bgs sample; or
2. To ensure at least 10% of all subsurface samples from 7–13 ft bgs were submitted for laboratory analysis for adequate characterization of subsurface soil to 13 ft bgs.

No samples from 7-13 ft bgs were analyzed due to preliminary screening criteria exceedances within the 4-7 ft bgs sample intervals. One sample collected from the 7-13 ft bgs sample interval was submitted for laboratory analysis to ensure samples from 7-13 ft bgs were adequately characterized.

All samples were analyzed for TAL metals, explosives, and PAHs, and four samples were analyzed for the RVAAP full-suite analytes to satisfy the PBA08 SAP sample requirements of a minimum of 10% frequency for full-suite analysis. Two QC field duplicate and two QA split samples were collected to satisfy the QA/QC sample requirements of 10% frequency for subsurface soil samples.

4.2.3.4 Surface Water and Sediment Rationale and Methods

Surface water and sediment samples were collected to characterize current conditions and assess potential entrance and exit pathways from the AOC (Figure 4-4). Three AOC-specific, co-located surface water and sediment samples were collected during the PBA08 RI from a drainage ditch, stream, and Former Test Pond within and exiting the AOC. The samples were collected in accordance with the following decision rules approved in the PBA08 SAP:

- At AOCs where overland flow of contaminants could occur to nearby perennial streams, those streams will be sampled. The sample locations may be outside of the AOC boundaries, but the samples represent the areas potentially impacted by the AOCs (Load Lines 5, 6, 7, 9, 10, and Wet Storage Area).

- At points where contamination may migrate out of the AOC area, such as a ditch, stream, or the Former Test Pond near the AOC boundary, samples will be collected to characterize current conditions and determine whether contaminant migration may occur at surface water runoff exit points.

In addition to the samples collected within the AOC boundaries, surface water and wet sediment samples were collected during the PBA08 RI at potential exit points from the Fuze and Booster Hill area (which includes Load Lines 5 through 11) and near the southern boundary of RVAAP/Camp Ravenna to determine nature and extent. Four surface water and co-located composite wet sediment samples were collected from these areas in order to characterize current conditions and assess potential exit pathways from the area. This report provides an evaluation of two of these samples (FWSsd/sw-101 and FWSsd/sw-103) that are south and southeast of Load Line 6. Sample location FWSsd/sw-10 was collected within the tributary directly south of Load Line 6, and sample location FWSsd/sw-103 was collected within the channel to the southeast of the AOC which drains to the east.

The surface water grab samples were collected by the handheld bottle method in accordance with Section 4.3 of the PBA08 SAP and analyzed for the RVAAP full-suite analytes. Additionally, water quality parameters for temperature, pH, conductivity, dissolved oxygen, and turbidity were collected using calibrated water quality meters (Hanna Instrument Models 9828 and 98703). The sediment samples were collected in accordance with Section 4.2 of the PBA08 SAP, except the sediment sample from the Former Test Pond was collected as a composite sample using a Ponar® sediment sampler lowered from the side of a boat. The samples consisted of a multi-aliquot composite with 10 aliquots selected randomly within a 5-ft radius of the identified sample location. Each aliquot was collected by a push probe to a maximum depth of 0.5 ft bgs. One sediment sample (and its associated QA/QC samples) from the AOC and the facility-wide sediment samples were analyzed for RVAAP full-suite analytes. Table 4-14 presents the specific rationale for the surface water and sediment samples collected for the PBA08 RI in February and April 2010. The locations of these samples are presented in Figure 4-4 and results are presented in Tables 4-15 and 4-16 for surface water and sediment, respectively.

4.2.3.5 Changes from the Work Plan

Changes to the PBA08 SAP are documented in field change requests (FCRs) provided in Appendix B. Changes made in the field based on AOC-specific conditions are not documented on FCRs but on the field sampling logs (Appendix A). These changes are presented on Table 4-17. Revised coordinates for all locations can be found in the field sampling logs.

4.2.3.6 Ordnance and Explosives Avoidance and Field Reconnaissance

MEC avoidance subcontractor support staff were present during sampling of the Former Test Pond at location LL6sd/sw-084 during the PBA08 RI. The shaped charge test chamber and test pond from the former Firestone Test Facility comprise the active MRS (RVAAP-33-R-01) at the AOC. The MEC team leader led an initial safety briefing on MEC to train all field personnel to recognize and stay away from propellants and MEC. Daily tailgate safety briefings included reminders regarding MEC avoidance. Documentation of these safety meetings and daily activities are included in Appendix I. Prior to beginning sampling activities, access routes into areas from which samples were to be collected were assessed for potential MEC using visual surveys and hand-held magnetometers. Once access to the pond was cleared, the Foerster Ferex®, MK 26 Ordnance Detector was lowered from the side of the boat into the water to identify areas void of anomalies by using the drag screening method. The MEC avoidance technician selected the location within the pond to lower the Ponar®. The ordnance and explosive technician remained on site while sampling was performed to visually examine sediment for any unusual material indicative of potential ordnance and explosive. No MEC were identified during this investigation.

4.2.4 2011/2012 Former Test Pond Investigations

Subsequent to the PBA08 RI sampling performed in February-March 2010, CB&I collected soil, sediment, and surface water samples from the Former Test Pond within the Former Firestone Test Facility MRS in support of the MMRP in May and August 2011 (CB&I 2014). These samples were analyzed for metals and explosives and are summarized below.

- Soil sample FTFSS-004(I)-0001-SS - Characterized for MC in surface soil area surrounding the pond where kick-out from testing activities may have occurred.
- Sediment sample FTFSD-002-SD - Characterized for MC in sediment at the northeast side of the pond that may have been impacted from testing activities.
- Sediment sample FTFSD-003-SD - Characterized for MC in sediment at the southwest side of the pond that may have been impacted from testing activities.
- Surface water sample FTFSW-001-0001-SW - Initially collected to characterize surface water for potential discharge to ground surface and evaluate health risk to divers if diving is considered most appropriate option. This sample also characterized for MC in surface water that may have been impacted from testing activities.

In addition, SAIC collected one additional sediment sample (LL6sd-096-5870-SD) and surface water sample (LL6sw-096-5871-SW) from the Former Test Pond in August 2012. Both these samples were analyzed for RVAAP full-suite. Figure 4-5 depicts the sample locations. Tables 4-18 through 4-20 present the results of these additional samples that are also summarized below:

- In the soil sample, no explosives were detected. The only metal that exceeded the screening criteria of HQ of 0.1, TR or1E-06) was chromium. Chromium had a concentration of 147 mg/kg, which is less than the trivalent chromium FWCUG.
- In the sediment samples, the only analyte that exceeded the screening level (SL) was aluminum. However, the maximum detection of aluminum (14,700 mg/kg) was only slightly higher than the background criteria (13,900 mg/kg). No explosives were detected.
- In the surface water samples, all chemicals were either below their background concentration or their screening criteria of HQ of 0.1, TR of 1E-06.

As these samples were collected after the original PBA08 RI and did not identify a risk, these results were used solely for qualitative purposes and are not included as part of the SRC screen or in the HHRA or ERA.

4.3 FACILITY-WIDE BACKGROUND EVALUATION

Facility-wide background values for inorganic constituents in soil, sediment, surface water, and groundwater were developed in 1998, as documented in the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds* (USACE 2001b). These facility-wide background values were employed in the data reduction and screening process described in Section 4.4.2 and the remainder of the evaluations in this RI (e.g., nature and extent, fate and transport). Background locations were selected using aerial photographs and after site visits were conducted for areas believed to be unaffected by RVAAP activities. Soil, sediment, surface water, and groundwater samples were collected from those locations to determine the range of background concentrations that could be expected in these media. Results from the site-specific background data collection were used to determine if detected metals and potential anthropogenic compounds (such as PAHs) are site-related or naturally occurring, or from non-RVAAP-related anthropogenic sources.

A total of 14 wells were installed in established background locations to collect filtered and unfiltered samples from the bedrock and unconsolidated zones. These samples were analyzed for TAL metals and cyanide for determining background concentrations.

Soil samples were collected from each of the background monitoring well locations from three intervals: 0-1, 1-3, and greater than 3 ft bgs. Because boring locations were changed during sampling based on the lithological requirements for well screen intervals, all depth intervals for soil were not sampled for each boring. Background surface soil samples were analyzed for TAL metals, cyanide, SVOCs, TOC, pesticides, PCBs, and VOCs.

Seven stream locations upstream of RVAAP activities were sampled for sediment and surface water to characterize background conditions. Seven locations for sampling sediment and surface water representative of background conditions were selected along Hinkley, Sand, and Eagle Creeks. Background sediment samples were analyzed for TAL metals, cyanide, SVOCs, pesticides, PCBs, and VOCs. Surface water samples were analyzed for TAL metals and cyanide.

Using the sampling results, an evaluation of outliers, data assessment, and statistical analysis were performed to determine background concentrations for each medium. For surface soil samples, PAHs, in addition to metals, were elevated in four samples. PAHs are related to combustion products and could indicate human disturbance at the locations where they were detected. Visits to the sampling locations and a review of aerial photography prior to the establishment of RVAAP indicated that these sampling locations were near homes or farms and could have been influenced by activities associated with those structures.

During the finalization of background concentrations at the former RVAAP, the Army and Ohio EPA agreed that the facility-wide background concentrations would only be applicable for inorganics. All organic analytes (e.g., PAHs, metals, VOCs, explosives) were classified as anthropogenic and potentially related to RVAAP operations; therefore, no background values were established for these classes of compounds. The final, approved facility-wide background concentrations for inorganics are presented in Table 4-21.

4.4 DATA EVALUATION METHOD

Data evaluation methods for Load Line 6 are consistent with those established in the FWCUG Report. These methods were specified in the PBA08 SAP (USACE 2009). The processes used to evaluate the analytical data involved three general steps: (1) defining data aggregates; (2) conducting data verification, reduction, and screening; and (3) presenting data.

4.4.1 Definition of Aggregates

Load Line 6 data were grouped (aggregated) in three ways for evaluating contaminant nature and extent and complete the HHRA and ERA. The initial basic aggregation of data was by environmental medium: surface soil, subsurface soil, sediment, and surface water. For each medium-specific aggregate, an evaluation was conducted to determine if further aggregation was warranted with respect to AOC characteristics, historical operations, ecological habitat, and potential future remedial strategy and Land Use (e.g., spatial aggregates). Data for soil were further aggregated based on depth and sample type for consistency with RVAAP human health risk exposure units (EUs) and guidance established in the FWHHRAM and FWCUG Report. Data aggregates for evaluating the nature and extent of contamination at Load Line 6 are as follows:

- **Surface Soil (0-1 ft bgs).** Using the above data aggregation criteria, surface soil within the geographic area of Load Line 6 were subdivided into two spatial aggregates: FPA and NPA. The FPA includes the area inside the perimeter road and all former buildings and operational areas. The NPA includes the area outside the production area to the fence line and the area just northwest of the AOC near Building 1101 at Fuze and Booster Road. The FPA contains all known or potential primary contaminant sources such as the former operational buildings. The former buildings located within the NPA were limited to administrative and storage functions.
- **Subsurface Soil (greater than 1 ft bgs).** This medium is subdivided into the FPA and NPA spatial aggregates on the same basis as surface soil.
- **Sediment.** Sediment samples were divided into two spatial aggregates: Former Test Pond and Drainage Ditches. The Former Test Pond is a perennial body of water located on the south side of Load Line 6 and adjacent to the perimeter fence line. The Drainage Ditches aggregate encompasses the intermittent drainage conveyances and gullies, which were constructed to direct surface water runoff ultimately toward the natural channel at the south side of Load Line 6.
- **Surface Water.** This medium is subdivided into the Former Test Pond and Drainage Ditches spatial aggregates on the same basis as sediment. While the Former Test Pond is a perennial water body, the Drainage Ditches only intermittently convey surface water.

The soil data aggregates are further subdivided to define human health and ecological risk EUs in the risk assessments, as discussed in Section 7.1.1 (e.g., shallow surface soil, deep surface soil, subsurface soil).

4.4.2 Data Verification, Reduction, and Screening

4.4.2.1 Data Verification

Data verification was performed on 31 surface soil, subsurface soil, sediment, and surface water samples (including QC duplicates) collected during the PBA08 RI in February-April 2010, and the sediment and surface water sample collected in August 2012. Data from the Phase I RI and Former Firestone Test Facility MRS RI were verified and completed as presented in their respective summary reports. Analytical results were reported by the laboratory in electronic format and loaded into the RVAAP Environmental Information Management System database. Data verification was performed to ensure all requested data were received and complete. Data qualifiers were assigned to each result based on the laboratory QA review and verification criteria.

Results were qualified as follows:

- “U” not detected;
- “UJ” not detected, reporting limit estimated;
- “J” indicates the analyte was positively identified, but the associated numerical value is an approximate concentration of the analyte in the sample; and
- “R” result not usable.

In addition to assigning qualifiers, the verification process also selected the appropriate result to use when re-analyses or dilutions were performed. Where laboratory surrogate recovery data or laboratory QC samples were outside of analytical method specifications, the verification chemist determined whether laboratory re-analysis should be used in place of an original reported result. If the laboratory reported results for diluted and undiluted samples, diluted sample results were used for those analytes that exceeded the calibration range of the undiluted sample. A complete discussion of verification process results is contained in the data QC summary report (Appendix C). The data QC summary report also includes a summary table of the assigned data qualifiers and an accompanying rationale. Independent, third-party validation of 10% of the RI data, and 100% of the USACE QA laboratory data, was performed by a subcontractor to the USACE, Louisville District.

4.4.2.2 Data Reduction

Calculating data summary statistics was the initial step in the data reduction process to identify SRCs. Eligible historical and current AOC data were extracted from the database. Results from QC splits and field duplicates, as well as rejected results, were excluded from the data screening process. As stated in Section 5.4.7 of the FWSAP, “The duplicate is submitted as ‘blind’ to the laboratory and is used to determine whether the field sampling technique is reproducible and to check the accuracy of reported laboratory results.” Therefore, duplicates are not used in the data screening process. All analytes having at least one detected value were included in the data reduction process.

Summary statistics calculated for each data aggregate included the minimum, maximum, and average (mean) values and the proportion of detected results to the total number of samples collected. For calculating mean values, non-detected results were addressed by using one-half of the reported detection limit as a surrogate value for each compound (USEPA 1989). Non-detected results with elevated detection limits (more than five times the contract-required detection limit) were excluded from the summary statistics in order to avoid skewing the mean value calculations.

4.4.2.3 Data Screening

After reduction, the data were screened to identify SRCs using the processes outlined below. Additional screening of identified SRCs against applicable criteria (e.g., EPA RSLs, FWCUGs, and ESVs) was conducted: (1) in the fate and transport evaluation (Section 6.0) to identify CMCOPCs, (2) in the HHRA to identify human health COPCs and COCs (Section 7.2), and (3) in the ERA to evaluate COPECs (Section 7.3). Figure 4-6 illustrates the screening process to identify SRCs and COPCs at Load Line 6 in accordance with the FWCUG Report. All chemicals that were not eliminated during the screening steps were retained as SRCs. The steps involved in the SRC screening are summarized below:

- **Data Quality Assessment.** Review of the usability of the RI data set with respect to established DQOs, as discussed in Section I.4.5 of Appendix I.
- **Background Screening.** The maximum detected concentrations (MDCs) of inorganic chemicals were compared to background concentrations. If background concentrations were exceeded, the respective inorganic chemicals were retained as SRCs. No background concentrations were established for organic chemicals. As such, all detected organic chemicals were retained as SRCs.
- **Screening of Essential Human Nutrients.** Chemicals that are considered essential nutrients (e.g., calcium, chloride, iodine, iron, magnesium, potassium, phosphorous, and sodium) are an integral part of the human food supply and are often added to foods as supplements. USEPA recommends these chemicals not be evaluated unless they are grossly elevated relative to background concentrations or would exhibit toxicity at the observed concentrations at an AOC (USEPA 1989). Recommended dietary allowance (RDA) and recommended daily intake (RDI) values are available for all of these chemicals (Table 4-22). Screening values were calculated for receptors ingesting 100 mg of soil per day or 1 L of groundwater per day to meet their RDA/RDI. In the case of calcium, magnesium, phosphorous, potassium, and sodium, a receptor ingesting 100 mg of soil per day would receive less than the RDA/RDI value, even if the soil consisted of the pure mineral (i.e., soil concentrations at 1,000,000 mg/kg). Essential nutrients detected at or below their RDA/RDI-based SLs were eliminated as SRCs.
- **Frequency of Detection/WOE Screening.** The FWCUG Report (USACE 2010a) and *Final (Revised) USACE RVAAP Position Paper for the Application and Use of Facility-wide Human Health Cleanup Goals* (USACE 2012b) (hereafter referred to as the Position Paper

for Human Health CUGs), establish the protocol for frequency of detection and WOE screening. These guidance documents denote that analytes (with the exception of explosives and propellants) detected in less than 5% of the samples are screened out from further consideration, if the sample population is 20 or more samples and evidence exists that the analyte is not AOC related. Chemicals that were never detected in a given medium were eliminated as SRCs. For chemicals with at least 20 samples and a frequency of detection of less than 5%, a WOE approach was used to determine if the chemical is AOC-related. The WOE evaluated magnitude and location (clustering) of detected results and if the distribution of detected results indicated a potential source of the chemical. If the detected results for a chemical showed: (1) no clustering, (2) concentrations were not substantially elevated relative to detection limit, and (3) the chemical did not have an evident source, the results were considered spurious, and the chemical was eliminated from further consideration. This screen was applied to all organic and inorganic chemicals (with the exception of explosives and propellants); all detected explosives and propellants were considered SRCs regardless of frequency of detection. Frequency-of-detection/WOE screenings were only performed for FPA surface and subsurface soils, as these were the only aggregates with greater than 20 samples.

4.4.3 Data Presentation

Data summary statistics and screening results for SRCs in surface soil, subsurface soil, sediment, and surface water at Load Line 6 are presented for each medium and spatial aggregate in Section 4.0. Analytical results for SRCs are presented in data summary Tables 4-23 and 4-24 for surface soil, Tables 4-25 and 4-26 for subsurface soil, Tables 4-27 and 4-28 for sediment, and Tables 4-29 and 4-30 for surface water.

The complete laboratory analytical data packages are included in Appendix D. In order to maximize efficiency for laboratory reporting and data management activities, all of the samples received at the laboratory on a given day were reported in a single data package. Therefore, results may be present in the data packages in Appendix D, which are associated with different AOCs. All samples for Load Line 6 have sample identifications beginning with “LL6.” Each table in Appendix D presents the results for each sampling location for a specific medium aggregate (e.g., surface soil, subsurface soil, sediment, and surface water), spatial aggregate (i.e., FPA, NPA, Former Test Pond, Drainage Ditches), and class of analyte (e.g., explosives, inorganic chemicals, SVOCs, and VOCs).

The tables in Appendix D present the analytical results for samples collected during the 2002 lead azide sampling, 2003 Phase I RI (MKM 2007), 2010 PBA08 RI, and 2011 samples at the Former Test Pond. Sample locations from these two investigations are presented in Figure 4-7. Analytical results are grouped by media (e.g., surface soil, subsurface soil) and class of analyte (e.g., explosives, inorganic chemicals) for ease of reference.

4.4.4 Data Evaluation

All quality-assured sample data were further evaluated to determine suitability for use in the RI under two primary considerations: (1) representativeness with respect to current AOC conditions, and (2) sample collection methods (e.g., discrete versus ISM). Table 4-31 presents the designated use for all available Load Line 6 samples.

All previous surface and subsurface soil, sediment, and surface water samples from the Phase I RI (MKM 2007) were collected using discrete sample methods, as were those collected under the PBA08 RI.

4.4.4.1 Surface Soil

Surface and subsurface soil samples at Load Line 6 were collected during the Phase I RI and PBA08 RI. Soil in the vicinity of former production buildings was extensively disturbed during building demolition activities at Load Line 6. The work areas were re-graded, and the area was vegetated in 2003. Samples from 2002-2003 were evaluated to determine if conditions had changed substantively between earlier characterization efforts and PBA08 RI activities. All buildings at Load Line 6 were demolished prior to the inception of the Phase I RI activities in 2003, with the exception of Buildings 2F-4, 2F-7, 2F-8, and 2F-9 (MKM 2007). Samples potentially affected by these demolition activities were surface and subsurface soil locations LL6ss-006, LL6ss-013, LL6ss-016, surface soil sample LL6ss-018, and subsurface sample LL6ss-039. The buildings were demolished conventionally, followed by slab removal in 2005. The surface and subsurface samples in proximity to the buildings that were later demolished were not omitted from the SRC screen and were classified as part of the FPA. Therefore, these data sets were considered representative of current conditions within and surrounding the footprints of the former buildings at Load Line 6.

The RRSE samples RV-331 to RV-338 were not included in this RI evaluation, as the RRSE data collected at the site "…are minimal Level III data, as defined by U.S. EPA, and are not intended to be used as definitive evidence of contamination presence or absence or to support health risk assessment." Soil sample FTFSS-004(I)-0001-SS was collected during the Former Firestone Test Facility MRS RI and was included in this report solely for qualitative purposes to evaluate the Former Test Pond qualitatively, as presented in Section 4.2.4. This sample was not included as part of the SRC screen or in the HHRA or ERA.

4.4.4.2 Subsurface Soil

The SRC data set for subsurface soil is composed of Phase I RI and PBA08 RI samples. The subsurface samples in proximity to the buildings that were later demolished in 2005 were not omitted from the SRC screen and were classified as part of the FPA. The only 2003 soil samples omitted from the SRC screening were subsurface soil samples LL6sb-032 and LL6sb-034 collected below a depth of 13 ft bgs, as this interval is below the exposure depth of all receptors; however, these samples were retained for purposes of nature and extent and contaminant migration evaluation. Additionally, two subsurface soil samples (from one soil boring) were collected during the PBA08 RI for geotechnical analysis only.

4.4.4.3 Sediment

Sediment samples collected from dry ditches during the Phase I RI were later designated as surface soil samples. There was not enough sediment in the sanitary sewer to collect a sample during the Phase I RI; however, samples were collected during the Facility-wide Sewers RI in 2009-2010 (USACE 2012a). Sediment samples collected from the sanitary sewer system are not included in the evaluation within this report, as those samples will be evaluated as part of the Facility-wide Sewers AOC (designated as RVAAP-67).

For sediment data from the Drainage Ditches and Former Test Pond, if a PBA08 RI sample was obtained from a 2003 location, the PBA08 RI result was considered to represent current conditions and screened for SRCs. If no PBA08 RI data were available for a sediment location sampled previously, the historical data were utilized in the SRC screening. All historical sediment samples superseded in the SRC screen by PBA08 RI data were only used for evaluation of contaminant nature and extent (e.g., temporal trends).

The RRSE sample RV-33B was not included in this RI evaluation, as the RRSE data collected at the site "…are minimal Level III data, as defined by U.S. EPA, and are not intended to be used as definitive evidence of contamination presence or absence or to support health risk assessment."

Sediment samples FTFSD-002-SD and FTFSD-003-SD were collected during the Former Firestone Test Facility MRS RI and sediment sample LL6sd-096-5870-SD was collected in August 2012 after the February-March 2010 PBA08 RI. These sediment samples were used in this report solely for qualitative purposes to evaluate the Former Test Pond qualitatively, as presented in Section 4.2.4. These samples were not included as part of the SRC screen or in the HHRA or ERA.

4.4.4.4 Surface Water

Surface water samples were collected from the sanitary sewer system during the Phase I RI and PBA08 RI, and the previously existing sump in former Building 2F-3 and basements in former Buildings 2F-14 and 2F-36. As noted in Section 2.2.3, the sump water was removed and disposed of offsite during building decontamination and demolition activities. Basement water was approved for discharge to the ground by Ohio EPA. Surface water samples LL6sw-006 and LL6sw-008 collected from the sanitary sewer system are not included in the evaluation within this report, as those samples will be evaluated as part of the Facility-wide Sewers AOC (designated as RVAAP-67).

For surface water data from the Drainage Ditches and Former Test Pond, if a PBA08 RI sample was obtained from a 2004 sample location, the PBA08 RI result was considered to represent current conditions and screened for SRCs. If no PBA08 RI data were available for a surface water location sampled previously, the historical data were utilized in the SRC screening. All historical surface water samples superseded in the SRC screen by PBA08 RI data were only used for evaluating contaminant nature and extent (e.g., temporal trends).

The RRSE sample RV-33W was not included in this RI evaluation, as the RRSE data collected at the site "…are minimal Level III data, as defined by U.S. EPA, and are not intended to be used as definitive evidence of contamination presence or absence or to support health risk assessment."

Surface water sample FTFSW-001-0001-SW was collected during the Former Firestone Test Facility MRS RI and surface water sample LL6sw-096-5871-SW was collected in August 2012 after the February-March 2010 PBA08 RI. These samples were used in this report solely for qualitative purposes to evaluate the Former Test Pond qualitatively, as presented in Section 4.2.4. These samples were not included as part of the SRC screen or in the HHRA or ERA.

Table 4-1. Phase I RI Sampling Locations

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
LL6ss-001	0.0-1.0	Lead Azide and TNT/RDX Screening; Metals, Explosives	Building 2F-10	1941-1945 – Utilized as a Detonator Service Magazine (manufactured at Load Line 9). 2 QC surface soil samples collected.	None	Mercury fulminate, lead azide
LL6ss-001	0.0-1.0	Metals, Explosives				
LL6ss-001	0.0-1.0	Metals, Explosives				
LL6sb-001	1.0-3.0	Metals				
LL6ss-002	0.0-1.0	Lead Azide and TNT/RDX Screening; Metals, Explosives	Building 2F-11	1941-1945 – Utilized for Fuze Assembly. 2 QC surface soil samples collected.	None	Black powder, mercury fulminate, lead azide, tetryl, RDX, TNT
LL6ss-002	0.0-1.0	Metals, Explosives				
LL6ss-002	0.0-1.0	Metals, Explosives				
LL6sb-002	1.0-3.0	Metals				
LL6ss-003	0.0-1.0	Lead Azide and TNT/RDX Screening; Metals, Explosives	Building 2F-9	1941-1945 – Utilized as a Primer Dry House. 2 QC surface soil samples collected.	None	Black powder, mercury fulminate
LL6ss-003	0.0-1.0	Metals, Explosives				
LL6ss-003	0.0-1.0	Metals, Explosives				
LL6sb-003	1.0-3.0	Full Suite				
LL6ss-004	0.0-1.0	Lead Azide and TNT/RDX Screening; Metals	Building 2F-34	1941-1945 – Utilized for primer storage.	None	Black powder, mercury fulminate, TNT, PETN, Antimony sulfide, lead thiocyanate, potassium chlorate
LL6sb-004	1.0-3.0	Metals				
LL6ss-005	0.0-1.0	TNT/RDX Screening; Metals	Shaped Charge Test Chamber	1950-late 1970s – Utilized to perform research and development on shaped charges for armor penetration by the Firestone Tire and Rubber Company's Defense Research Division. This test chamber was located south of the FPA, immediately adjacent to the shaped charge test pond in the southern portion of the AOC. Also, there was an adjacent control house which was part of active Firestone Test Facility MRS (RVAAP-033-R-01).	None	Metals, TNT, Comp B, Octol
LL6sb-005	1.0-3.0	Metals				
LL6ss-006	0.0-1.0	TNT/RDX Screening; Metals	Building 2F-7	1941-1945 – Utilized for black powder pelleting. Former Load Line 6 Treatment Plant was located in building on the southwest side of 2F-7.	None	Black powder, mercury fulminate, potassium nitrate
LL6sb-006	1.0-3.0	Full Suite				
LL6sb-006	1.0-3.0	Full Suite		QC sample collected.		
LL6ss-007	0.0-1.0	TNT/RDX Screening; Metals	Building 2F-32	1941-1945 – Utilized for fuze assembly.	None	Black powder, mercury fulminate, lead azide, tetryl, RDX, TNT
LL6sb-007	1.0-3.0	Metals				
LL6ss-008	0.0-1.0	TNT/RDX Screening; Metals	Building 2F-33	1941-1945 – Utilized for booster pellet storage (manufactured at Load Lines 7 and 8).	None	Black powder, mercury fulminate, lead azide, tetryl, RDX, TNT
LL6sb-008	1.0-3.0	Metals				
LL6ss-009	0.0-1.0	TNT/RDX Screening; Metals	Building 2F-19	1941-1945 – Utilized for booster pellet storage (manufactured at Load Lines 7 and 8).	None	Black powder, mercury fulminate, lead azide, tetryl, RDX, TNT
LL6sb-009	1.0-3.0	Metals				
LL6ss-010	0.0-1.0	Full Suite	Building 2F-11	1941-1945 – Utilized for fuze assembly.	None	Black powder, mercury fulminate, lead azide, tetryl, RDX, TNT
LL6ss-010	0.0-1.0	Explosives				
LL6sb-010	1.0-3.0	Metals				
LL6ss-011	0.0-1.0	Metals	Building 2F-11	1941-1945 – Utilized for fuze assembly.	None	Black powder, mercury fulminate, lead azide, tetryl, RDX, TNT
LL6sb-011	1.0-3.0	Metals				
LL6ss-012	0.0-1.0	Metals	Building 2F-15	1941-1945 – Utilized for paint storage.	None	Paints
LL6sb-012	1.0-3.0	Metals				
LL6sb-012	1.0-3.0	Metals		QC sample collected.		
LL6ss-013	0.0-1.0	Metals	Building 2F-9	1941-1945 – Utilized as a primer dry house.	None	Black powder, mercury fulminate
LL6sb-013	1.0-3.0	Metals				
LL6ss-014	0.0-1.0	Metals	Building 2F-35	1941-1945 – Utilized for solvent storage.	None	Solvents
LL6sb-014	1.0-3.0	Full Suite				

Table 4–1. Phase I RI Sampling Locations (continued)

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
LL6ss-015	0.0-1.0	Metals	Building 2F-12	1941-1945 – Utilized for fuze testing.	None	Black powder, mercury fulminate lead azide, tetryl, RDX, TNT
LL6sb-015	1.0-3.0	Metals, Explosives				
LL6sb-015	1.0-3.0	Metals, Explosives		QC sample collected.		
LL6ss-016	0.0-1.0	Metals	Building 2F-8	1941-1945 – Utilized for delay loading.	None	Black powder, mercury fulminate, potassium nitrate
LL6sb-016	1.0-3.0	Metals				
LL6ss-017	0.0-1.0	Metals	Building 2F-4	1941-1945 – Utilized for primer loading.	None	Black powder, mercury fulminate
LL6sb-017	1.0-3.0	Metals				
LL6ss-018	0.0-1.0	Metals	Building 2F-3	1941-1945 – Utilized as fulminate mix house.	None	Mercury fulminate
LL6sb-018	1.0-3.0	Metals, Explosives				
LL6sb-018	1.0-3.0	Metals, Explosives		QC sample collected.		
LL6ss-019	0.0-1.0	Metals	Building 2F-1	1941-1945 – Utilized as fulminate dry house.	None	Mercury fulminate
LL6sb-019	1.0-3.0	Metals				
LL6ss-020	0.0-1.0	Full Suite	Building 2F-14	1941-1945 – Utilized as Change House where workers changed out of work clothing at end of shift. QC surface soil sample collected.	None	Black powder, mercury fulminate lead azide, tetryl, RDX, TNT
LL6ss-020	0.0-1.0	Full Suite				
LL6sb-020	1.0-3.0	Metals				
LL6ss-023	0.0-1.0	Full Suite	Downgradient of Shaped Charge Test Chamber	1950-late 1970s – Utilized to perform research and development on shaped charges for armor penetration by the Firestone Tire and Rubber Company's Defense Research Division. This test chamber was located south of the FPA, immediately adjacent to the shaped charge test pond in the southern portion of the AOC. Also, there was an adjacent control house which was part of active Firestone Test Facility MRS (RVAAP-033-R-01).	None	Metals, TNT, Comp B, Octol
LL6sb-023	1.0-3.0	Metals				
LL6ss-024	0.0-1.0	Metals	Building 2F-12	1941-1945 – Utilized for fuze testing.	None	Black powder, mercury fulminate, lead azide, tetryl, RDX, TNT
LL6sb-024	1.0-3.0	Full Suite				
LL6ss-025	0.0-1.0	Metals	Northern portion of AOC	Characterized open field along perimeter fence, northeast of the FPA.	None	None
LL6sb-025	1.0-3.0	Metals				
LL6ss-026	0.0-1.0	Metals	Downgradient from Suspected Test Range Area near eastern boundary of AOC	1950-late 1970s – A suspected open test range was potentially located in the northeastern portion of the AOC near LL6mw-002, but no evidence of this range has been found. It was formerly associated with Firestone Test Facility MRS (RVAAP-033-R-01). Sample location adjacent to planning level survey wetland.	None	Metals, TNT, Comp B, Octol
LL6sb-026	1.0-3.0	Metals				
LL6ss-027	0.0-1.0	Metals	East of FPA	Characterized area east of the perimeter road and FPA.	None	None
LL6sb-027	1.0-3.0	Metals				
LL6ss-028	0.0-1.0	Metals	Southeastern portion of AOC	Characterized area southeast of perimeter road and FPA.	None	None
LL6sb-028	1.0-3.0	Metals				
LL6ss-029	0.0-1.0	Metals	Downgradient from Shaped Charge Test Chamber at AOC perimeter fence	1950-late 1970s – Utilized to perform research and development on shaped charges for armor penetration by the Firestone Tire and Rubber Company's Defense Research Division. This test chamber was located south of the FPA, immediately adjacent to the shaped charge test pond in the southern portion of the AOC. Also, there was an adjacent control house which was art of active Firestone Test Facility MRS (RVAAP-033-R-01).	None	Metals, TNT, Comp B, Octol
LL6ss-029	0.0-1.0	Metals		QC sample collected.		
LL6ss-030	0.0-1.0	Metals	West of FPA	Characterized area west of perimeter road and FPA.	None	None
LL6sb-030	1.0-3.0	Metals				
LL6ss-031	0.0-1.0	Metals	LL6mw-001 proposed location	Characterized area immediately outside the northern perimeter of AOC, east of Building 6-51 (Gate House) at upgradient monitoring well location LL6mw-001.	None	None
LL6sb-031	6.0-8.0	Metals				
LL6ss-032	0.0-1.0	Metals, Explosives	LL6mw-002 proposed location adjacent to Suspected Test Range	Characterize suspected test range area, formerly associated with Firestone Test Facility MRS (RVAAP-033-R-01), at monitoring well location LL6mw-002.	None	Metals, TNT, Comp B, Octol
LL6ss-032	0.0-1.0	Metals, Explosives		QC sample collected.		
LL6ss-033	0.0-1.0	Metals	LL6mw-003 proposed location near Building 2F-11	Characterize area at monitoring well location LL6mw-003 near Building 2F-11 (1941-1945 – Fuze Assembly).	None	Black powder, mercury fulminate
LL6sb-033	6.0-8.0	Metals, Explosives				
LL6sb-033	6.0-8.0	Metals, Explosives		QC sample collected.		

Table 4–1. Phase I RI Sampling Locations (continued)

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
LL6ss-034	0.0-1.0	Full Suite	LL6mw-004 proposed location near Building 2F-11	Characterize area at monitoring well location LL6mw-004 near Building 2F-11 (1941-1945 – Fuze Assembly).	None	Black powder, mercury fulminate
LL6ss-035	0.0-1.0	Full Suite	LL6mw-005 proposed location east of Building 2F-3	Characterize depressed area in FPA between former production Buildings 2F-1, 2F-3, 2F-18, and 2F-19 at monitoring well location LL6mw-005.	None	Mercury fulminate
LL6sb-035	11.0-13.0	Metals				
LL6ss-036	0.0-1.0	Metals	LL6mw-006 proposed location in southwestern corner of AOC	Characterized area southwest of the FPA at monitoring well location LL6mw-006.	None	None
LL6sb-036	6.0-8.0	Metals				
LL6ss-037	0.0-1.0	Metals	LL6mw-007 proposed location east of Shaped Charge Test Pond	Characterized area east of shaped charge test pond and test chamber, associated with Firestone Test Facility MRS (RVAAP-033-R-01) at monitoring well location LL6mw-007.	None	Metals, explosives
LL6sb-037	12.0-14.0	Metals				
LL6ss-038	0.0-1.0	Metals	Sanitary Sewer manhole MH-1B1	These samples were located at manhole MH-1B1 where sanitary sewer integrity was potentially suspect. Building 2F-11 (Fuze Assembly from 1941-1945) connected to the sanitary sewer at this manhole.	None	Metals, TNT, Comp B, Octol
LL6sb-038	8.0-10.0	Metals				
LL6ss-039	0.0-1.0	Metals	Sanitary Sewer manhole MH-2F6	These samples were located at manhole MH-2F6 where sanitary sewer integrity was potentially suspect. Junction point with sewer from Buildings 2F-8, 2F-4, and 2F-3 (production buildings from 1941-1945).	None	Black powder, mercury fulminate
LL6sb-039	8.0-10.0	Metals, Explosives				
LL6ss-040	0.0-1.0	Metals, Explosives	Tow & Missile Test Chamber 1	The Tow and Dragon Missile Test Chamber #1 was located outside the primary production area in a field immediately southeast of former Building 2F-12. Formerly part of Firestone Test Facility MRS (RVAAP-033-R-01). QC surface soil sample collected.	None	Metals, TNT, Comp B, Octol
LL6ss-040	0.0-1.0	Metals, Explosives				
LL6sb-040	4.0-6.0	Metals				
LL6sb-041	7.0-7.0	Metals	Building 2F-3 Sump/Tow & Missile Test Chamber 2	1941-1945 – 2F-3 utilized as Fulminate Mix House. 1950s-late 1970s – Utilized as tow & missile test chamber as part of the Firestone Test Facility. Characterized subsurface soil underneath sump at Building 2F-3, at approximately the bottom elevation of the sump.	None	Black powder, mercury fulminate
LL6sb-042	1.0-3.0	Metals	Building 2F-11	1941-1945 – Utilized for fuze assembly. Subfloor sample was collected at the soil/sub-base interface to assess potential impact on the underlying soils from historical activities at Building 2F-11.	None	Black powder, mercury fulminate lead azide, tetryl, RDX, TNT
LL6sb-044	1.0-3.0	Full Suite	Building 2F-4	1941-1945 – Utilized for primer loading. Subfloor sample was collected at the soil/sub-base interface to assess potential impact on the underlying soils from historical activities at Building 2F–4.	None	Black powder, mercury fulminate
LL6sb-045	1.0-3.0	Metals	Building 2F-3	1941-1945 – Utilized for fuze assembly. Subfloor sample was collected at the soil/sub-base interface to assess potential impact on the underlying soils from historical activities at Building 2F–3.	None	Mercury fulminate
LL6sb-049	4.0-6.0	VOCs, SVOCs, TPH	Suspected spent VOC disposal pit near Building 2F-35	A VOC grid was established at Load Line 6 in response to the findings of a spent VOC disposal pit at Load Line 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 former solvent storage building (Building 2F-35), downgradient from the load line operations, and in an area that was not used for any load line function (i.e., open field). Screening points were then 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 through LL6SB–055) from the VOC grid. 4 of the 10 soil samples (LL6SB–049, LL6SB–050, LL6SB–051, and LL6SB–055) were sent to laboratory for confirmation analysis. Samples selected for analysis were collected from the borings exhibiting the highest head space readings.	None	Solvents
LL6sb-050	6.0-8.0	VOCs, SVOCs, TPH				
LL6sb-051	6.0-8.0	VOCs, SVOCs, TPH				
LL6sb-055	3.0-5.0	VOCs, SVOCs, TPH				
LL6ss-056	0.0-1.0	Metals	Northwest portion of AOC	Characterized northwestern portion of AOC, northwest of Buildings 2F-14 and 2F-36 (1941-1945 – Change Houses).	None	Black powder, mercury fulminate
LL6sb-056	1.0-3.0	Metals				
LL6sd-001	0.0 -1.0	Lead Azide Screening; Metals, Explosives	Shaped Charge Test Pond	1950-late 1970s – Utilized as an underwater test chamber for weapons experimentation by the Firestone Tire and Rubber Company’s Defense Research Division from the 1950s through the late 1970s. It is located south of the Load Line 6 WWII production area, near the shaped charge test chamber. The test pond is still present at the AOC. Part of active Firestone Test Facility MRS (RVAAP-033-R-01). Collected during lead azide screening in March 2002.	None	Metals, TNT, Comp B, Octol
LL6sw-001	NA	Metals, Explosives				

Table 4–1. Phase I RI Sampling Locations (continued)

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
LL6sw-001	NA	Metals, Explosives		QC sample collected.		
LL6sd-002	0.0-0.5	Metals	Drainage Ditch	Drainage ditch receiving drainage from the suspected test range area (1950s-late 1970s).	None	Metals, TNT, Comp B, Octol
LL6sw-002	NA	Full Suite				
LL6sw-002	NA	Full Suite		QC sample collected.		
LL6sd-003	0.0-0.5	Full Suite	Drainage Ditch	Drainage ditch outside perimeter fence leading away from the southern end of the AOC.	None	Metals, Explosives
LL6sw-003	NA	Metals, Explosives, and Cyanide				
LL6sd-004	0.0-0.5	Metals	Drainage Ditch	Drainage ditch outside the northern end of the AOC, east of the Building 1101 (Fire Station No. 3).	None	None
LL6sw-004	NA	Metals, Explosives, and Cyanide				
LL6sd-005	0.0-0.5	Metals	Drainage Ditch	Drainage ditch constructed between Buildings 2F-20 and 2F-11 (1941-1945 – delay storage; fuze assembly). QC sediment sample collected.	None	Black powder, mercury fulminate
LL6sd-005	0.0-0.5	Metals				
LL6sw-005	NA	Metals, Explosives, and Cyanide				
LL6sd-006	NA	NS	Sanitary Sewer	Water sample collected from sanitary sewer located near Building 2F–11 (1941-1945 – fuze assembly). Sediment not collected because sewer sediment was not present at the time of sampling.	None	Black powder, Mercury fulminate
LL6sw-006	NA	Metals, Explosives, and Cyanide				
LL6sd-008	NA	NS	Sanitary Sewer	Water samples were collected from sanitary sewer located near Building 2F–3 (1941-1945 – fulminate mix house); however, sediment was not collected because sewer sediment was not present at the time of sampling.	None	Mercury fulminate
LL6sw-008	NA	Metals, Explosives, and Cyanide				
LL6sd-009	NA	NS	Sump at Building 2F-3	Sample was not collected during the RI because the sump near Building 2F-3 (1941-1945 – fulminate mix house) was excavated during the demolition operations that were conducted before the RI began.	None	Mercury fulminate
LL6sd-010	0.0-0.5	Full Suite	Drainage Ditch	Drainage ditch constructed south of Buildings 2F-34 and 2F-35 (1941-1945 – primer storage and solvent storage, respectively).	None	Black powder, Mercury fulminate; Solvents
LL6sd-011	0.0-1.0	Metals	Drainage Ditch	Drainage ditch leading away from Building 2F-13 (1941-1945 – Change House). Sediment sample collected as soil sample because water was not present during sampling.	None	Black powder, Mercury fulminate
LL6sd-012	0.0-1.0	Metals	Drainage Ditch	Drainage ditch leading away from Building 2F-13 (1941-1945 – Change House). Sediment sample collected as soil sample because water was not present during sampling.	None	Black powder, Mercury fulminate
LL6sd-013	0.0-1.5	Metals	Drainage Ditch	Drainage ditch constructed in southeastern portion of FPA, and likely received drainage from Buildings 2F-18, 2F-19, 2F-1, and 2F-3 (production buildings from 1941-1945).	None	Black powder, Mercury fulminate
LL6sd-014	0.0-0.5	Metals	Drainage Ditch	Drainage ditch constructed near Building 2F-6 and 2F-7 (1941-1945 – black powder pelleting and dry house).	None	Black powder, Mercury fulminate
LL6sd-015	0.0-0.5	Metals	Drainage Ditch	Drainage ditch constructed south of Buildings 2F-1 and 2F-2 (1941-1945 – fulminate dry house and Heater House).	None	Metals, PAHs, Mercury fulminate

Full Suite = Target analyte list metals, explosives, propellants, VOCs, SVOCs, polychlorinated biphenyls, pesticides, and cyanide.
AOC = Area of concern.
bgs = Below ground surface.
FPA = Former Production Area.
ft = Feet.
MRS = Munitions response site.
NA= Not applicable
NS= Not sampled.
PAH = Polycyclic aromatic hydrocarbon.
RI = Remedial Investigation.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
QC= Quality control.
TNT = 2,4,6-Trinitrotoluene
TPH = Total petroleum hydrocarbons.
VOC = Volatile organic compound.
WWII = World War II.

Table 4-2. Analytes Detected in Phase I RI Surface Soil Samples

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL6sd-005**	**LL6sd-005**	**LL6sd-010**	**LL6sd-010**	**LL6sd-011**	**LL6sd-012**	**LL6sd-013**	**LL6sd-014**	**LL6sd-015**	**LL6ss-001**
Sample ID		**LL6sd-005-0001-FD**	**LL6sd-005-0001-SD**	**LL6sd-010-0001-FD**	**LL6sd-010-0001-SD**	**LL6sd-011-0001-SD**	**LL6sd-012-0001-SD**	**LL6sd-013-0001-SD**	**LL6sd-014-0001-SD**	**LL6sd-015-0001-SD**	**LL6ss-001-0001-SO**
Date		**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**	**03/12/02**
Depth (ft)		**0.0-0.5**	**0.0-0.5**	**0.0-0.5**	**0.0-0.5**	**0.0-1.0**	**0.0-1.0**	**0.0-1.5**	**0.0-0.5**	**0.0-0.5**	**0.0-1.0**
Parameters Analyzed **Analyte**	**Background Criteria**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals, Explosives**
Metals (mg/kg)											
Aluminum	17700	11000	11000	8600	8900	12000	6700	7500	13000	12000	6500
Antimony	0.96	<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	0.3
Arsenic	15.4	11	11	**18 ***	15	11	**18 ***	12	14	6.8	3.2
Barium	88.4	66	67	70	81	76	40	30	83	80	**95.9 ***
Beryllium	0.88	0.43 J	0.45 J	0.46 J	0.43 J	0.74	0.47	0.49	0.82	0.73	0.44
Cadmium	0	**0.39 ***	**0.51 ***	**0.88 ***	**0.97 ***	<0.094 U	<0.09 U	<0.088 U	**0.22 J***	<0.13 U	**0.22 ***
Calcium	15800	3300	4000	**22000 ***	14000	10000	1600	1200	3300	2900	**89100 ***
Chromium	17.4	16	16	17	16	**18 ***	10	9.8	**18 ***	16	9.2
Cobalt	10.4	9.4	8.7	9.7	**11 ***	10	7.7	6.9	9.9	7.2	5.8
Copper	17.7	**24 ***	**24 ***	**29 ***	**25 ***	**21 ***	16	16	**97 ***	**21 ***	**17.8 ***
Iron	23100	23000	22000	22000	**24000 ***	**26000 ***	19000	16000	**25000 ***	21000	14100
Lead	26.1	**43 ***	**44 ***	**46 ***	**51 ***	**65 ***	19	11	**27 ***	39 *	17.8
Magnesium	3030	2900	2900	**3700 ***	**3600 ***	**4300 ***	2000	1800	**3500 ***	2600	2240
Manganese	1450	350	400	450	670	410	370	250	340	240	452
Mercury	0.036	**0.18 ***	**0.13 ***	0.031	0.026	0.026	0.018 J	0.014 J	**0.048 ***	**0.25 ***	**0.039 ***
Nickel	21.1	19	18	**31 ***	**31 ***	**23 ***	17	12	**25 ***	17	13.7
Potassium	927	**1100 ***	**1200 ***	**1300 ***	**1200 ***	**1500 ***	780	620	**1400 ***	**1200 ***	**1050 ***
Selenium	1.4	0.69 J	0.67 J	<0.52 U	0.66 J	<0.47 U	<0.45 U	<0.44 U	<0.63 U	<0.66 U	<0.82 U
Sodium	123	<120 U	<120 U	<110 U	<120 U	<100 U	<97 U	<95 U	<140 U	<140 U	**196 ***
Thallium	0	<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	<0.17 U
Vanadium	31.1	21	21	15	16	22	13	13	22	22	11.8
Zinc	61.8	**98 ***	**97 ***	**200 ***	**200 ***	**72 ***	56	49	**100 ***	**110 ***	46
Explosives(mg/kg)											
HMX	None	NR	NR	<0.11 U	<0.11 U	NR	NR	NR	NR	NR	<0.25 U
Nitrocellulose	None	NR	NR	**1.7 J***	**1.5 J***	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)											
2-Methylnaphthalene	None	NR	NR	**0.015 J***	**0.0099 J***	NR	NR	NR	NR	NR	NR
Acenaphthene	None	NR	NR	<0.002 U	<0.0019 U	NR	NR	NR	NR	NR	NR
Anthracene	None	NR	NR	<0.0012 U	<0.0012 U	NR	NR	NR	NR	NR	NR
Benz(a)anthracene	None	NR	NR	**0.03 J***	**0.028 J***	NR	NR	NR	NR	NR	NR
Benzo(a)pyrene	None	NR	NR	**0.038 J***	**0.03 J***	NR	NR	NR	NR	NR	NR
Benzo(b)fluoranthene	None	NR	NR	**0.044 J***	**0.034 J***	NR	NR	NR	NR	NR	NR
Benzo(ghi)perylene	None	NR	NR	**0.03 J***	**0.026 J***	NR	NR	NR	NR	NR	NR
Benzo(k)fluoranthene	None	NR	NR	**0.045 J***	**0.033 J***	NR	NR	NR	NR	NR	NR
Bis(2-ethylhexyl)phthalate	None	NR	NR	**0.036 J***	<0.013 U	NR	NR	NR	NR	NR	NR
Chrysene	None	NR	NR	**0.048 ***	**0.035 J***	NR	NR	NR	NR	NR	NR
Dibenz(a,h)anthracene	None	NR	NR	**0.0094 J***	<0.003 U	NR	NR	NR	NR	NR	NR
Fluoranthene	None	NR	NR	**0.074 ***	**0.053 ***	NR	NR	NR	NR	NR	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	**0.028 J***	**0.022 J***	NR	NR	NR	NR	NR	NR
Naphthalene	None	NR	NR	**0.013 J***	<0.0023 U	NR	NR	NR	NR	NR	NR
Phenanthrene	None	NR	NR	**0.033 J***	**0.025 J***	NR	NR	NR	NR	NR	NR
Pyrene	None	NR	NR	**0.058 ***	**0.039 J***	NR	NR	NR	NR	NR	NR

Table 4-2. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL6sd-005**	**LL6sd-005**	**LL6sd-010**	**LL6sd-010**	**LL6sd-011**	**LL6sd-012**	**LL6sd-013**	**LL6sd-014**	**LL6sd-015**	**LL6ss-001**
Sample ID		**LL6sd-005-0001-FD**	**LL6sd-005-0001-SD**	**LL6sd-010-0001-FD**	**LL6sd-010-0001-SD**	**LL6sd-011-0001-SD**	**LL6sd-012-0001-SD**	**LL6sd-013-0001-SD**	**LL6sd-014-0001-SD**	**LL6sd-015-0001-SD**	**LL6ss-001-0001-SO**
Date		**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**	**03/12/02**
Depth (ft)		**0.0-0.5**	**0.0-0.5**	**0.0-0.5**	**0.0-0.5**	**0.0-1.0**	**0.0-1.0**	**0.0-1.5**	**0.0-0.5**	**0.0-0.5**	**0.0-1.0**
Parameters Analyzed	**Background Criteria**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals, Explosives**
PCBs (mg/kg)											
4,4'-DDE	None	NR	NR	**0.0015 J***	**0.0024 ***	NR	NR	NR	NR	NR	NR
PCB-1254	None	NR	NR	<0.0028 U	<0.0028 U	NR	NR	NR	NR	NR	NR
PCB-1260	None	NR	NR	**0.0065 J***	**0.0096 J***	NR	NR	NR	NR	NR	NR

Table 4-2. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate	**Background Criteria**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL6ss-001**	**LL6ss-001**	**LL6ss-002**	**LL6ss-002**	**LL6ss-002**	**LL6ss-003**	**LL6ss-003**	**LL6ss-003**	**LL6ss-004**	**LL6ss-005**
Sample ID		**LL6ss-001-D12S-FD**	**LL6ss-001-W12S-FD**	**LL6ss-002-0001-SO**	**LL6ss-002-D13S-FD**	**LL6ss-002-W13S-FD**	**LL6ss-003-0001-SO**	**LL6ss-003-D14S-FD**	**LL6ss-003-W14S-FD**	**LL6ss-004-0001-SO**	**LL6ss-005-0001-SO**
Date		**03/15/02**	**03/15/02**	**03/12/02**	**03/15/02**	**03/15/02**	**03/12/02**	**03/15/02**	**03/15/02**	**11/25/03**	**11/19/03**
Depth (ft)		**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**
Parameters Analyzed		**Explosives**	**Explosives**	**TAL Metals, Explosives**	**Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**Explosives**	**Explosives**	**TAL Metals**	**TAL Metals**
Analyte											
Metals (mg/kg)											
Aluminum	17700	NR	NR	1990	NR	2270	4960	NR	NR	17000	13000
Antimony	0.96	NR	NR	<0.19 U	NR	0.22 J	<0.21 U	NR	NR	<0.53 U	<0.46 U
Arsenic	15.4	NR	NR	3.3	NR	3.8	5.6	NR	NR	12	12
Barium	88.4	NR	NR	**150 ***	NR	**89.9 ***	84.6	NR	NR	64	64
Beryllium	0.88	NR	NR	0.2 J	NR	0.25 J	0.3 J	NR	NR	0.51	0.71
Cadmium	0	NR	NR	**6.8 ***	NR	**5.9 ***	**0.68 ***	NR	NR	<0.092 U	<0.09 U
Calcium	15800	NR	NR	**184000 ***	NR	**116000 ***	**138000 ***	NR	NR	2100	1900
Chromium	17.4	NR	NR	5.8	NR	6.9	8.7	NR	NR	**21 ***	17
Cobalt	10.4	NR	NR	3.6	NR	3.9	3.9	NR	NR	8.8	8.9
Copper	17.7	NR	NR	**627 ***	NR	**145 ***	15.7	NR	NR	**21 ***	**21 ***
Iron	23100	NR	NR	9940	NR	13900	13000	NR	NR	**28000 ***	**25000 ***
Lead	26.1	NR	NR	**33.8 ***	NR	**40.4 ***	**65.1 ***	NR	NR	**78 ***	14
Magnesium	3030	NR	NR	1650	NR	1780	1980	NR	NR	**3500 ***	2800
Manganese	1450	NR	NR	574	NR	558	451	NR	NR	300	350
Mercury	0.036	NR	NR	**0.063 ***	NR	**0.063 ***	**0.039 ***	NR	NR	0.031	0.024
Nickel	21.1	NR	NR	12	NR	13.4	11.1	NR	NR	**22 ***	19
Potassium	927	NR	NR	531	NR	535	**930 ***	NR	NR	**1700 ***	**1100 ***
Selenium	1.4	NR	NR	<0.98 U	NR	<0.85 U	<0.88 U	NR	NR	<0.46 U	<0.45 U
Sodium	123	NR	NR	119	NR	**152 ***	**146 ***	NR	NR	**1300 ***	<98 U
Thallium	0	NR	NR	<0.26 U	NR	<0.18 U	<0.28 U	NR	NR	<1.2 U	<0.2 U
Vanadium	31.1	NR	NR	5.6	NR	6.7	11.1	NR	NR	27	25
Zinc	61.8	NR	NR	**160 ***	NR	**180 ***	**101 ***	NR	NR	**77 ***	55
Explosives (mg/kg)											
HMX	None	<0.24 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	**0.19 J***	**0.2 J***	**0.17 J***	NR	NR
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)											
2-Methylnaphthalene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Acenaphthene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Anthracene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Benz(a)anthracene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Benzo(ghi)perylene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Benzo(k)fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bis(2-ethylhexyl)phthalate	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Chrysene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Dibenz(a,h)anthracene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Naphthalene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Phenanthrene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pyrene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 4-2. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL6ss-001**	**LL6ss-001**	**LL6ss-002**	**LL6ss-002**	**LL6ss-002**	**LL6ss-003**	**LL6ss-003**	**LL6ss-003**	**LL6ss-004**	**LL6ss-005**
Sample ID		**LL6ss-001-D12S-FD**	**LL6ss-001-W12S-FD**	**LL6ss-002-0001-SO**	**LL6ss-002-D13S-FD**	**LL6ss-002-W13S-FD**	**LL6ss-003-0001-SO**	**LL6ss-003-D14S-FD**	**LL6ss-003-W14S-FD**	**LL6ss-004-0001-SO**	**LL6ss-005-0001-SO**
Date		**03/15/02**	**03/15/02**	**03/12/02**	**03/15/02**	**03/15/02**	**03/12/02**	**03/15/02**	**03/15/02**	**11/25/03**	**11/19/03**
Depth (ft)		**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**
Parameters Analyzed		**Explosives**	**Explosives**	**TAL Metals, Explosives**	**Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**Explosives**	**Explosives**	**TAL Metals**	**TAL Metals**
Analyte	**Background Criteria**										
PCBs (mg/kg)											
4,4'-DDE	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
PCB-1254	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
PCB-1260	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 4-2. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL6ss-006**	**LL6ss-007**	**LL6ss-008**	**LL6ss-009**	**LL6ss-010**	**LL6ss-010**	**LL6ss-011**	**LL6ss-012**	**LL6ss-013**	**LL6ss-014**
Sample ID		**LL6ss-006-0001-SO**	**LL6ss-007-0001-SO**	**LL6ss-008-0001-SO**	**LL6ss-009-0001-SO**	**LL6ss-010-0001-SO**	**LL6ss-010-0002-SO**	**LL6ss-011-0001-SO**	**LL6ss-012-0001-SO**	**LL6ss-013-0001-SO**	**LL6ss-014-0001-SO**
Date		**11/21/03**	**11/14/03**	**11/14/03**	**11/20/03**	**12/02/03**	**01/14/04**	**12/03/03**	**11/25/03**	**11/21/03**	**11/25/03**
Depth (ft)		**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**
Parameters Analyzed											
Analyte	**Background Criteria**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**Explosives**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**
Metals (mg/kg)											
Aluminum	17700	11000	7400	12000	12000	12000	NR	11000	14000	13000	7300
Antimony	0.96	<0.45 U	<0.45 U	<0.52 U	<0.53 U	<0.49 U	NR	<0.49 U	<0.51 U	<0.52 U	<0.48 U
Arsenic	15.4	12	**41 ***	11	10	**16 ***	NR	13	11	12	12
Barium	88.4	64	47	67	58	**100 ***	NR	66	68	53	34
Beryllium	0.88	0.5	0.25 J	0.47	0.6	**0.95 ***	NR	0.41 J	0.44 J	0.32 J	0.25 J
Cadmium	0	<0.089 U	**0.13 J***	<0.092 U	<0.091 U	<0.088 U	NR	<0.089 U	<0.094 U	**0.11 J***	<0.085 U
Calcium	15800	3300	4900	2400	890	3200	NR	2600	2300	1700	1600
Chromium	17.4	14	11	15	15	16	NR	16	**18 ***	16	10
Cobalt	10.4	9.6	8.7	9.3	9.9	**12 ***	NR	9	9.5	6.2	6.4
Copper	17.7	**21 ***	**20 ***	17	16	**20 ***	NR	**19 ***	14	12	**24 ***
Iron	23100	**27000 ***	19000	21000	22000	23000	NR	21000	**24000 ***	22000	18000
Lead	26.1	**30 ***	**53 ***	**32 ***	19	17	NR	**29 ***	26	**40 ***	26
Magnesium	3030	2600	2400	2800	2500	**3400 ***	NR	2800	**3100 ***	2300	1900
Manganese	1450	700	430	350	480	200	NR	400	520	280	370
Mercury	0.036	**0.038 ***	0.018	0.032	0.026	0.02	NR	**0.082 ***	**0.041 ***	**0.043 ***	0.032
Nickel	21.1	16	16	20	17	**23 ***	NR	18	18	13	15
Potassium	927	870	**930 ***	**1300 ***	**980 ***	**1100 ***	NR	**990 ***	**1400 ***	**940 ***	760
Selenium	1.4	0.52 J	<0.41 U	<0.46 U	<0.46 U	<0.44 U	NR	0.45 J	0.57 J	<0.45 U	<0.42 U
Sodium	123	<96 U	**960 ***	**1200 ***	<99 U	<96 U	NR	<97 U	**1400 ***	<98 U	**960 ***
Thallium	0	<0.19 U	<0.2 U	<0.22 U	<1.1 U	<0.21 U	NR	<0.21 U	<0.22 U	<0.22 U	<1 U
Vanadium	31.1	21	14	19	21	19	NR	20	24	23	12
Zinc	61.8	**71 ***	**82 ***	**65 ***	**68 ***	**62 ***	NR	60	58	**63 ***	**81 ***
Explosives (mg/kg)											
HMX	None	NR	NR	NR	NR	<0.11 U	NR	NR	NR	NR	NR
Nitrocellulose	None	NR	NR	NR	NR	NR	10.1 *	NR	NR	NR	NR
SVOCs (mg/kg)											
2-Methylnaphthalene	None	NR	NR	NR	NR	<0.0018 U	NR	NR	NR	NR	NR
Acenaphthene	None	NR	NR	NR	NR	<0.0017 U	NR	NR	NR	NR	NR
Anthracene	None	NR	NR	NR	NR	<0.001 U	NR	NR	NR	NR	NR
Benz(a)anthracene	None	NR	NR	NR	NR	<0.0013 U	NR	NR	NR	NR	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	<0.0026 U	NR	NR	NR	NR	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	<0.0025 U	NR	NR	NR	NR	NR
Benzo(ghi)perylene	None	NR	NR	NR	NR	<0.0022 U	NR	NR	NR	NR	NR
Benzo(k)fluoranthene	None	NR	NR	NR	NR	<0.0033 U	NR	NR	NR	NR	NR
Bis(2-ethylhexyl)phthalate	None	NR	NR	NR	NR	**0.027 J***	NR	NR	NR	NR	NR
Chrysene	None	NR	NR	NR	NR	<0.0021 U	NR	NR	NR	NR	NR
Dibenz(a,h)anthracene	None	NR	NR	NR	NR	<0.0026 U	NR	NR	NR	NR	NR
Fluoranthene	None	NR	NR	NR	NR	<0.0013 U	NR	NR	NR	NR	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	NR	<0.0025 U	NR	NR	NR	NR	NR
Naphthalene	None	NR	NR	NR	NR	<0.002 U	NR	NR	NR	NR	NR
Phenanthrene	None	NR	NR	NR	NR	<0.0012 U	NR	NR	NR	NR	NR
Pyrene	None	NR	NR	NR	NR	<0.0024 U	NR	NR	NR	NR	NR

Table 4-2. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL6ss-006**	**LL6ss-007**	**LL6ss-008**	**LL6ss-009**	**LL6ss-010**	**LL6ss-010**	**LL6ss-011**	**LL6ss-012**	**LL6ss-013**	**LL6ss-014**
Sample ID		**LL6ss-006-0001-SO**	**LL6ss-007-0001-SO**	**LL6ss-008-0001-SO**	**LL6ss-009-0001-SO**	**LL6ss-010-0001-SO**	**LL6ss-010-0002-SO**	**LL6ss-011-0001-SO**	**LL6ss-012-0001-SO**	**LL6ss-013-0001-SO**	**LL6ss-014-0001-SO**
Date		**11/21/03**	**11/14/03**	**11/14/03**	**11/20/03**	**12/02/03**	**01/14/04**	**12/03/03**	**11/25/03**	**11/21/03**	**11/25/03**
Depth (ft)		**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**
Parameters Analyzed											
Analyte	**Background Criteria**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**Explosives**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**
						PCBs (mg/kg)					
4,4'-DDE	None	NR	NR	NR	NR	<0.00076 U	NR	NR	NR	NR	NR
PCB-1254	None	NR	NR	NR	NR	**0.033 ***	NR	NR	NR	NR	NR
PCB-1260	None	NR	NR	NR	NR	<0.0016 U	NR	NR	NR	NR	NR

Table 4-2. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL6ss-015**	**LL6ss-016**	**LL6ss-017**	**LL6ss-018**	**LL6ss-019**	**LL6ss-020**	**LL6ss-020**	**LL6ss-021**	**LL6ss-022**	**LL6ss-023**
Sample ID		**LL6ss-015-0001-SO**	**LL6ss-016-0001-SO**	**LL6ss-017-0001-SO**	**LL6ss-018-0001-SO**	**LL6ss-019-0001-SO**	**LL6ss-020-0001-FD**	**LL6ss-020-0001-SO**	**LL6ss-021-0001-SO**	**LL6ss-022-0001-SO**	**LL6ss-023-0001-SO**
Date		**11/25/03**	**11/21/03**	**11/19/03**	**12/02/03**	**11/19/03**	**12/02/03**	**12/02/03**	**11/19/03**	**11/14/03**	**11/19/03**
Depth (ft)		**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**
Parameters Analyzed											
Analyte	**Background Criteria**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**
Metals (mg/kg)											
Aluminum	17700	10000	14000	12000	11000	15000	13000	15000	11000	7100	12000
Antimony	0.96	<0.5 U	<0.46 U	<0.44 U	<0.53 U	<0.52 U	<0.49 U	<0.49 U	<0.5 U	<0.51 U	<0.52 U
Arsenic	15.4	14	12	11	10	12	14	12	8.9	12	8.9
Barium	88.4	57	71	84	64	80	69	68	63	73	76
Beryllium	0.88	0.43 J	0.54	**1.2 ***	0.64	0.83	0.69	0.56	0.59	0.33 J	0.76
Cadmium	0	<0.092 U	**0.25 ***	**0.92 ***	<0.095 U	<0.092 U	<0.09 U	<0.079 U	<0.093 U	**1.5 ***	<0.094 U
Calcium	15800	8900	5900	**20000 ***	1300	4200	4000	2700	2300	**80000 ***	2200
Chromium	17.4	**20 ***	**19 ***	11	15	**19 ***	17	17	14	15	16
Cobalt	10.4	9.6	**11 ***	6.2	9.2	**11 ***	8.4	5.5	7.4	6.5	10
Copper	17.7	**35 ***	**21 ***	**26 ***	14	**18 ***	**18 ***	17	14	**30 ***	**19 ***
Iron	23100	**24000 ***	**26000 ***	19000	22000	**26000 ***	**24000 ***	22000	19000	19000	**24000 ***
Lead	26.1	**44 ***	**48 ***	**61 ***	22	22	17	16	25	**90 ***	15
Magnesium	3030	**4100 ***	**3900 ***	**3600 ***	2400	4000 *	**3200 ***	2600	2200	2800	3000
Manganese	1450	390	330	980	530	370	270	120	430	440	420
Mercury	0.036	0.026	**0.1 ***	**0.6 ***	0.035	0.02 J	0.029	0.022	**0.14 ***	0.018 J	0.025
Nickel	21.1	**24 ***	**23 ***	15	16	**25 ***	20	15	15	20	20
Potassium	927	**1500 ***	**1400 ***	**1300** *	**1100 ***	**1600 ***	**1100 ***	**1000 ***	**1100 ***	**1400 ***	**1300 ***
Selenium	1.4	<0.46 U	0.56 J	<0.46 U	<0.48 U	<0.46 U	<0.45 U	<0.4 U	<0.46 U	0.48 J	<0.47 U
Sodium	123	**1400 ***	<100 U	**160 ***	<100 U	<100 U	<97 U	<86 U	<100 U	**790 ***	<100 U
Thallium	0	<1.1 U	<0.2 U	<0.19 U	<0.23 U	<0.22 U	<0.21 U	<0.21 U	<0.22 U	<0.22 U	<0.22 U
Vanadium	31.1	17	23	16	21	26	21	21	19	12	22
Zinc	61.8	**93 ***	**78 ***	**88 ***	58	59	53	39	55	**160 ***	55
Explosives (mg/kg)											
HMX	None	NR	NR	NR	NR	NR	<0.11 U	<0.11 U	NR	NR	<0.11 U
Nitrocellulose	None	NR	NR	NR	NR	NR	**1.8 J***	**1.1 J***	NR	NR	**2.4 ***
SVOCs (mg/kg)											
2-Methylnaphthalene	None	NR	NR	NR	NR	NR	<0.0018 U	<0.0018 U	NR	NR	<0.0018 U
Acenaphthene	None	NR	NR	NR	NR	NR	<0.0017 U	<0.0016 U	NR	NR	**0.0046 J***
Anthracene	None	NR	NR	NR	NR	NR	**0.0017 J***	<0.001 U	NR	NR	**0.0092 J***
Benz(a)anthracene	None	NR	NR	NR	NR	NR	**0.0072 J***	**0.0055 J***	NR	NR	**0.041 ***
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	**0.0075 J***	<0.0026 U	NR	NR	**0.04 J***
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	**0.0073 J***	**0.0067 J***	NR	NR	**0.044 ***
Benzo(ghi)perylene	None	NR	NR	NR	NR	NR	**0.0055 J***	**0.0065 J***	NR	NR	**0.024 J***
Benzo(k)fluoranthene	None	NR	NR	NR	NR	NR	**0.0079 J***	**0.0042 J***	NR	NR	**0.028 J***
Bis(2-ethylhexyl)phthalate	None	NR	NR	NR	NR	NR	**0.019 J***	**0.11 J***	NR	NR	**0.045 J***
Chrysene	None	NR	NR	NR	NR	NR	**0.0078 J***	**0.007 J***	NR	NR	**0.043 ***
Dibenz(a,h)anthracene	None	NR	NR	NR	NR	NR	**0.028 J***	**0.028 J***	NR	NR	**0.013 J***
Fluoranthene	None	NR	NR	NR	NR	NR	**0.016 J***	**0.012 J***	NR	NR	**0.1 ***
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	NR	NR	**0.02 J***	**0.02 J***	NR	NR	**0.023 J***
Naphthalene	None	NR	NR	NR	NR	NR	<0.002 U	<0.002 U	NR	NR	<0.0021 U
Phenanthrene	None	NR	NR	NR	NR	NR	**0.0078 J***	**0.0077 J***	NR	NR	**0.04 J***
Pyrene	None	NR	NR	NR	NR	NR	**0.0096 J***	**0.0096 J***	NR	NR	**0.068 ***

Table 4-2. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		FPA	FPA	FPA	FPA	FPA	FPA	FPA	FPA	FPA	FPA
Station		**LL6ss-015**	**LL6ss-016**	**LL6ss-017**	**LL6ss-018**	**LL6ss-019**	**LL6ss-020**	**LL6ss-020**	**LL6ss-021**	**LL6ss-022**	**LL6ss-023**
Sample ID		**LL6ss-015-0001-SO**	**LL6ss-016-0001-SO**	**LL6ss-017-0001-SO**	**LL6ss-018-0001-SO**	**LL6ss-019-0001-SO**	**LL6ss-020-0001-FD**	**LL6ss-020-0001-SO**	**LL6ss-021-0001-SO**	**LL6ss-022-0001-SO**	**LL6ss-023-0001-SO**
Date		**11/25/03**	**11/21/03**	**11/19/03**	**12/02/03**	**11/19/03**	**12/02/03**	**12/02/03**	**11/19/03**	**11/14/03**	**11/19/03**
Depth (ft)		**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**
Parameters Analyzed											
Analyte	**Background Criteria**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**
PCBs (mg/kg)											
4,4'-DDE	None	NR	NR	NR	NR	NR	<0.00077 U	<0.00074 U	NR	NR	<0.00078 U
PCB-1254	None	NR	NR	NR	NR	NR	<0.0024 U	<0.0023 U	NR	NR	<0.0024 U
PCB-1260	None	NR	NR	NR	NR	NR	<0.0017 U	<0.0016 U	NR	NR	<0.0017 U

Table 4-2. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL6ss-024**	**LL6ss-033**	**LL6ss-034**	**LL6ss-035**	**LL6ss-038**	**LL6ss-039**	**LL6ss-025**	**LL6ss-026**	**LL6ss-027**	**LL6ss-028**
Sample ID		**LL6ss-024-0001-SO**	**LL6ss-033-0001-SO**	**LL6ss-034-0001-SO**	**LL6ss-035-0001-SO**	**LL6ss-038-0001-SO**	**LL6ss-039-0001-SO**	**LL6ss-025-0001-SO**	**LL6ss-026-0001-SO**	**LL6ss-027-0001-SO**	**LL6ss-028-0001-SO**
Date		**11/25/03**	**11/18/03**	**11/14/03**	**11/13/03**	**11/05/03**	**11/05/03**	**11/14/03**	**11/20/03**	**11/20/03**	**11/18/03**
Depth (ft)		**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**
Parameters Analyzed											
Analyte	**Background Criteria**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**
Metals (mg/kg)											
Aluminum	17700	12000	17000	10000	12000	13000	17000	14000	10000	17000	11000
Antimony	0.96	<0.45 U	<0.46 U	<0.48 U	<0.53 U	<0.49 U	<0.49 U	0.62 J	<0.52 U	<0.52 U	<0.5 U
Arsenic	15.4	11	11	8.5	9.3	10	13	9.7	13	11	13
Barium	88.4	52	**110 ***	71	67	61	73	60	46	**95 ***	60
Beryllium	0.88	0.3 J	**1 ***	0.49	0.69	0.47	0.47	0.44 J	0.53	**0.96 ***	0.58
Cadmium	0	<0.085 U	<0.086 U	**0.56 ***	<0.092 U	<0.087 U	<0.092 U	<0.093 U	<0.091 U	<0.091 U	<0.1 U
Calcium	15800	3400	**21000 ***	3800	5500	**16000 ***	2600	780	1200	2400	600
Chromium	17.4	15	**23 ***	16	17	17	**22 ***	15	13	**23 ***	14
Cobalt	10.4	6.5	**13 ***	8.1	8.2	8.7	8.6	9.1	5.5	**12 ***	7.7
Copper	17.7	**21 ***	**22 ***	**25 ***	15	17	16	9.1	6	**22 ***	8.5
Iron	23100	22000	**28000 ***	**24000 ***	22000	23000	**31000 ***	20000	23000	**31000 ***	21000
Lead	26.1	23	8.1	**180 ***	14	13	23	9.9	19	11	19
Magnesium	3030	2800	**7600 ***	2800	**3500 ***	**4700 ***	**3400 ***	2200	1500	**4100 ***	1800
Manganese	1450	310	380	520	320	320	340	540	510	460	700
Mercury	0.036	0.035	<0.0052 U	0.024	0.019 J	0.013 J	0.031	**0.037 ***	0.033	0.034	0.033
Nickel	21.1	17	**32 ***	21	20	21	19	14	8.6	**27 ***	10
Potassium	927	**1100 ***	**2800 ***	**1100 ***	**1500 ***	**1900 ***	**1800 ***	**1100 ***	580	**1700 ***	690
Selenium	1.4	0.51 J	**1.7 ***	0.49 J	1.3	<0.44 U	0.67 J	0.72 J	<0.45 U	<0.45 U	**1.4 ***
Sodium	123	**1100 ***	**130 ***	**1100 ***	<100 U	**1400 ***	**1300 ***	**1300 ***	<98 U	<98 U	<110 U
Thallium	0	<0.98 U	<0.2 U	<0.21 U	<0.23 U	<1.1 U	<1.1 U	<0.21 U	<1.1 U	<1.1 U	<1.1 U
Vanadium	31.1	20	27	18	20	21	29	23	25	30	23
Zinc	61.8	58	58	**96 ***	58	61	55	55	43	**66 ***	53
Explosives (mg/kg)											
HMX	None	NR	NR	<0.11 U	<0.11 U	NR	NR	NR	NR	NR	NR
Nitrocellulose	None	NR	NR	**3.1 ***	**0.72 ***	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)											
2-Methylnaphthalene	None	NR	NR	<0.0018 U	<0.0019 U	NR	NR	NR	NR	NR	NR
Acenaphthene	None	NR	NR	<0.0017 U	<0.0017 U	NR	NR	NR	NR	NR	NR
Anthracene	None	NR	NR	<0.0011 U	<0.0011 U	NR	NR	NR	NR	NR	NR
Benz(a)anthracene	None	NR	NR	**0.014 J***	**0.0049 J***	NR	NR	NR	NR	NR	NR
Benzo(a)pyrene	None	NR	NR	**0.014 J***	**0.0037 J***	NR	NR	NR	NR	NR	NR
Benzo(b)fluoranthene	None	NR	NR	**0.015 J***	**0.004 J***	NR	NR	NR	NR	NR	NR
Benzo(ghi)perylene	None	NR	NR	**0.009 J***	<0.0024 U	NR	NR	NR	NR	NR	NR
Benzo(k)fluoranthene	None	NR	NR	**0.012 J***	<0.0035 U	NR	NR	NR	NR	NR	NR
Bis(2-ethylhexyl)phthalate	None	NR	NR	<0.012 U	<0.012 U	NR	NR	NR	NR	NR	NR
Chrysene	None	NR	NR	**0.015 J***	**0.0047 J***	NR	NR	NR	NR	NR	NR
Dibenz(a,h)anthracene	None	NR	NR	<0.0027 U	<0.0027 U	NR	NR	NR	NR	NR	NR
Fluoranthene	None	NR	NR	**0.025 J***	**0.0072 J***	NR	NR	NR	NR	NR	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	<0.0026 U	<0.0026 U	NR	NR	NR	NR	NR	NR
Naphthalene	None	NR	NR	<0.0021 U	<0.0021 U	NR	NR	NR	NR	NR	NR
Phenanthrene	None	NR	NR	**0.0099 J***	<0.0012 U	NR	NR	NR	NR	NR	NR
Pyrene	None	NR	NR	**0.021 J***	**0.0058 J***	NR	NR	NR	NR	NR	NR

Table 4-2. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		FPA	FPA	FPA	FPA	FPA	FPA	NPA	NPA	NPA	NPA
Station		**LL6ss-024**	**LL6ss-033**	**LL6ss-034**	**LL6ss-035**	**LL6ss-038**	**LL6ss-039**	**LL6ss-025**	**LL6ss-026**	**LL6ss-027**	**LL6ss-028**
Sample ID		**LL6ss-024-0001-SO**	**LL6ss-033-0001-SO**	**LL6ss-034-0001-SO**	**LL6ss-035-0001-SO**	**LL6ss-038-0001-SO**	**LL6ss-039-0001-SO**	**LL6ss-025-0001-SO**	**LL6ss-026-0001-SO**	**LL6ss-027-0001-SO**	**LL6ss-028-0001-SO**
Date		**11/25/03**	**11/18/03**	**11/14/03**	**11/13/03**	**11/05/03**	**11/05/03**	**11/14/03**	**11/20/03**	**11/20/03**	**11/18/03**
Depth (ft)		**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**
Parameters Analyzed											
Analyte	**Background Criteria**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**
PCBs (mg/kg)											
4,4'-DDE	None	NR	NR	<0.00078 U	<0.0008 U	NR	NR	NR	NR	NR	NR
PCB-1254	None	NR	NR	<0.0024 U	<0.0024 U	NR	NR	NR	NR	NR	NR
PCB-1260	None	NR	NR	<0.0017 U	<0.0017 U	NR	NR	NR	NR	NR	NR

Table 4-2. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL6ss-029**	**LL6ss-029**	**LL6ss-030**	**LL6ss-031**	**LL6ss-032**	**LL6ss-032**	**LL6ss-036**	**LL6ss-037**	**LL6ss-040**	**LL6ss-040**	**LL6ss-056**
Sample ID		**LL6ss-029-0001-FD**	**LL6ss-029-0001-SO**	**LL6ss-030-0001-SO**	**LL6ss-031-0001-SO**	**LL6ss-032-0001-FD**	**LL6ss-032-0001-SO**	**LL6ss-036-0001-SO**	**LL6ss-037-0001-SO**	**LL6ss-040-0001-FD**	**LL6ss-040-0001-SO**	**LL6ss-056-0001-SO**
Date		**11/25/03**	**11/25/03**	**11/18/03**	**11/13/03**	**11/13/03**	**11/13/03**	**11/13/03**	**11/13/03**	**11/05/03**	**11/05/03**	**11/18/03**
Depth (ft)		**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**
Parameters Analyzed **Analyte**	**Background Criteria**	**TAL Metals LL6ss-029**	**TAL Metals LL6ss-029**	**TAL Metals LL6ss-030**	**TAL Metals LL6ss-031**	**TAL Metals, Explosives LL6ss-032**	**TAL Metals, Explosives LL6ss-032**	**TAL Metals LL6ss-036**	**TAL Metals LL6ss-037**	**TAL Metals, Explosives LL6ss-040**	**TAL Metals, Explosives LL6ss-040**	**TAL Metals LL6ss-056**
Metals (mg/kg)												
Aluminum	17700	15000	**18000 ***	14000	3300	15000	**18000 ***	14000	11000	13000	14000	11000
Antimony	0.96	<0.5 U	<0.52 U	<0.56 U	<0.42 U	<0.47 U	<0.48 U	<0.52 U	<0.57 U	<0.5 U	<0.49 U	<0.47 U
Arsenic	15.4	**17 ***	9.9	12	2.2	11	9.3	10	6.2	11	10	13
Barium	88.4	59	65	85	**110 ***	**100 ***	**180 ***	75	68	69	68	64
Beryllium	0.88	0.25 J	0.45 J	**0.94 ***	0.36 J	**2.1 ***	**2.1 ***	0.81	0.58	0.46	0.48	0.57
Cadmium	0	<0.098 U	<0.095 U	<0.1 U	**0.17 J***	<0.088 U	<0.087 U	<0.1 U	<0.11 U	<0.09 U	<0.092 U	<0.089 U
Calcium	15800	120	140	1900	**57000 ***	**53000 ***	**51000 ***	1800	450	5700	5500	1900
Chromium	17.4	**21 ***	**25 ***	**18 ***	5.7	8.6	10	**18 ***	13	17	17	15
Cobalt	10.4	6.3	8.5	10	3.6	4	4.2	8.9	9	9.2	9.7	7
Copper	17.7	**18 ***	**23 ***	12	8.9	8.5	9.9	14	12	17	**20 ***	15
Iron	23100	**27000 ***	**35000 ***	**31000 ***	10000	11000	12000	23000	16000	23000	23000	21000
Lead	26.1	18	19	11	14	15	21	18	21	13	16	19
Magnesium	3030	3000	**3900 ***	2600	910	**8300 ***	**8800 ***	2800	1700	**3600 ***	**3500 ***	2400
Manganese	1450	200	170	940	820	810	**1800 ***	580	870	340	370	310
Mercury	0.036	0.031	0.034	0.03	0.01 J	0.012 J	0.0081 J	0.03	**0.037 ***	0.019 J	0.024	0.02 J
Nickel	21.1	17	**27 ***	17	9.3	7.9	8.4	18	11	21	20	17
Potassium	927	**1400 ***	**1700 ***	**1100 ***	600	**1200 ***	**1500 ***	**1300 ***	860	**1500 ***	**1600 ***	**1200 ***
Selenium	1.4	<0.49 U	<0.47 U	**1.7 ***	0.65 J	**1.5 ***	**1.7 ***	**1.5 ***	1 J	0.59 J	<0.46 U	**1.6 ***
Sodium	123	**1100 ***	**1200 ***	<110 U	<84 U	**310 ***	**390 ***	<110 U	<110 U	**1300 ***	**1400 ***	<97 U
Thallium	0	<1.1 U	<1.1 U	<1.2 U	<0.18 U	<0.2 U	<0.21 U	<0.23 U	<0.25 U	<0.22 U	<1.1 U	<1 U
Vanadium	31.1	26	28	27	6.7	11	12	24	19	22	23	18
Zinc	61.8	58	**78 ***	57	58	28	33	61	59	55	56	60
Explosives (mg/kg)												
HMX	None	NR	NR	NR	NR	<0.11 U	<0.11 U	NR	NR	<0.11 U	<0.11 U	NR
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)												
2-Methylnaphthalene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Acenaphthene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Anthracene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Benz(a)anthracene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Benzo(ghi)perylene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Benzo(k)fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bis(2-ethylhexyl)phthalate	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Chrysene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Dibenz(a,h)anthracene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Naphthalene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Phenanthrene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pyrene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 4-2. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL6ss-029**	**LL6ss-029**	**LL6ss-030**	**LL6ss-031**	**LL6ss-032**	**LL6ss-032**	**LL6ss-036**	**LL6ss-037**	**LL6ss-040**	**LL6ss-040**	**LL6ss-056**
Sample ID		**LL6ss-029-0001-FD**	**LL6ss-029-0001-SO**	**LL6ss-030-0001-SO**	**LL6ss-031-0001-SO**	**LL6ss-032-0001-FD**	**LL6ss-032-0001-SO**	**LL6ss-036-0001-SO**	**LL6ss-037-0001-SO**	**LL6ss-040-0001-FD**	**LL6ss-040-0001-SO**	**LL6ss-056-0001-SO**
Date		**11/25/03**	**11/25/03**	**11/18/03**	**11/13/03**	**11/13/03**	**11/13/03**	**11/13/03**	**11/13/03**	**11/05/03**	**11/05/03**	**11/18/03**
Depth (ft)		**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**
Parameters Analyzed		**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals**	**TAL Metals**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals**
Analyte	**Background Criteria**	**LL6ss-029**	**LL6ss-029**	**LL6ss-030**	**LL6ss-031**	**LL6ss-032**	**LL6ss-032**	**LL6ss-036**	**LL6ss-037**	**LL6ss-040**	**LL6ss-040**	**LL6ss-056**
						PCBs (mg/kg)						
4,4'-DDE	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
PCB-1254	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
PCB-1260	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

DDE = Dichlorodiphenyldichloroethylene.
FPA = Former Production Area.
ft = Feet.
HMX = Octahydro-1,3,5,7-tetranitroi-1,3,5,7-tetrazocane.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
NR = Not reported/not analyzed.
PCB = Polychlorinated biphenyl.
RI = Remedial Investigation.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
TAL = Target analyte list.
U = Not detected.
UJ = Not detected, reporting limit estimated.
*** = Result exceeds background criteria or no background criteria was available.**
< = Less than.

Table 4-3. Analytes Detected in Phase I RI Subsurface Soil Samples

Aggregate		FPA	FPA	FPA	FPA	FPA	FPA	FPA	FPA	FPA	FPA
Station		**LL6sb-001**	**LL6sb-002**	**LL6sb-003**	**LL6sb-004**	**LL6sb-005**	**LL6sb-006**	**LL6sb-006**	**LL6sb-007**	**LL6sb-008**	**LL6sb-009**
Sample ID		**LL6sb-001-0001-SO**	**LL6sb-002-0001-SO**	**LL6sb-003-0001-SO**	**LL6sb-004-0001-SO**	**LL6sb-005-0001-SO**	**LL6sb-006-0001-FD**	**LL6sb-006-0001-SO**	**LL6sb-007-0001-SO**	**LL6sb-008-0001-SO**	**LL6sb-009-0001-SO**
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**	**11/20/03**
Depth (ft)		**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**
Parameters Analyzed		**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**TAL Metals**	**TAL Metals**	**VOCs**	**RVAAP Full-suite analytes**	**TAL Metals**	**TAL Metals**	**TAL Metals**
Analyte	**Background Criteria**										
					Metals (mg/kg)						
Aluminum	19500	11000	10000	7300	14000	13000	NR	13000	15000	16000	11000
Antimony	0.96	<0.5 U	<0.5 U	<0.49 U	<0.5 U	<0.45 U	NR	<0.51 U	<0.51 U	<0.5 U	<0.52 U
Arsenic	19.8	17	13	13	13	15	NR	14	17	11	16
Barium	124	60	47	39	94	75	NR	68	89	89	100
Beryllium	0.88	0.42 J	0.35 J	0.21 J	0.75	0.88	NR	0.57	0.55	0.69	**1.1 ***
Cadmium	0	<0.086 U	<0.092 U	<0.092 U	<0.09 U	<0.091 U	NR	<0.091 U	**0.67 ***	<0.092 U	<0.088 U
Calcium	35500	4900	4000	760	4400	4300	NR	1400	6900	3500	1100
Chromium	27.2	15	14	9.4	20	17	NR	16	22	20	16
Cobalt	23.2	10	6.9	5.3	12	11	NR	9	8.5	11	11
Copper	32.3	17	17	7.4	22	20	NR	11	28	19	20
Iron	35200	22000	21000	13000	28000	23000	NR	24000	28000	27000	27000
Lead	19.1	12	**20 ***	9.1	12	**20 ***	NR	**24 ***	**150 ***	17	8.5
Magnesium	8790	3800	2500	1400	4900	3100	NR	2300	4400	3900	3500
Manganese	3030	380	300	300	290	700	NR	660	500	230	810
Mercury	0.044	0.022	0.022	0.023	0.013 J	0.02 J	NR	0.044	0.032	0.024	0.029
Nickel	60.7	20	16	9.2	30	18	NR	15	27	26	32
Potassium	3350	1200	1000	580	1900	1300	NR	880	1800	1700	1100
Selenium	1.5	0.56 J	0.53 J	<0.46 U	<0.45 U	<0.45 U	NR	0.7 J	0.56 J	<0.46 U	<0.44 U
Sodium	145	<93 U	<100 U	<100 U	**1800 ***	<99 U	NR	<98 U	**1400 ***	**1600 ***	<95 U
Thallium	0.91	0.31	<0.22 U	<0.21 U	<0.22 U	<0.19 U	NR	<0.22 U	<0.22 U	<0.21 U	<1.1 U
Vanadium	37.6	18	17	12	23	24	NR	25	24	24	19
Zinc	93.3	51	52	31	65	54	NR	55	**190 ***	64	63
					Explosives (mg/kg)						
Nitrocellulose	None	NR	NR	**1.3 J***	NR	NR	NR	**0.88 ***	NR	NR	NR
					SVOCs (mg/kg)						
2-Methylnaphthalene	None	NR	NR	<0.0018 U	NR	NR	NR	<0.0018 U	NR	NR	NR
Acenaphthene	None	NR	NR	<0.0016 U	NR	NR	NR	<0.0017 U	NR	NR	NR
Anthracene	None	NR	NR	<0.001 U	NR	NR	NR	<0.001 U	NR	NR	NR
Benz(a)anthracene	None	NR	NR	<0.0013 U	NR	NR	NR	<0.0013 U	NR	NR	NR
Benzo(a)pyrene	None	NR	NR	<0.0026 U	NR	NR	NR	<0.0026 U	NR	NR	NR
Benzo(b)fluoranthene	None	NR	NR	<0.0025 U	NR	NR	NR	<0.0025 U	NR	NR	NR
Benzo(ghi)perylene	None	NR	NR	<0.0022 U	NR	NR	NR	<0.0023 U	NR	NR	NR
Benzo(k)fluoranthene	None	NR	NR	<0.0033 U	NR	NR	NR	<0.0034 U	NR	NR	NR
Bis(2-ethylhexyl)phthalate	None	NR	NR	**0.047 J***	NR	NR	NR	**0.016 J***	NR	NR	NR
Carbazole	None	NR	NR	<0.041 U	NR	NR	NR	<0.042 U	NR	NR	NR
Chrysene	None	NR	NR	<0.0021 U	NR	NR	NR	<0.0022 U	NR	NR	NR
Di-n-octylphthalate	None	NR	NR	<0.01 U	NR	NR	NR	<0.01 U	NR	NR	NR
Dibenz(a,h)anthracene	None	NR	NR	<0.0026 U	NR	NR	NR	<0.0026 U	NR	NR	NR
Dibenzofuran	None	NR	NR	<0.0032 U	NR	NR	NR	<0.0032 U	NR	NR	NR
Fluoranthene	None	NR	NR	<0.0013 U	NR	NR	NR	**0.0068 J***	NR	NR	NR
Fluorene	None	NR	NR	<0.0019 U	NR	NR	NR	<0.0019 U	NR	NR	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	<0.0025 U	NR	NR	NR	<0.0025 U	NR	NR	NR

Table 4-3. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL6sb-001**	**LL6sb-002**	**LL6sb-003**	**LL6sb-004**	**LL6sb-005**	**LL6sb-006**	**LL6sb-006**	**LL6sb-007**	**LL6sb-008**	**LL6sb-009**
Sample ID		**LL6sb-001-0001-SO**	**LL6sb-002-0001-SO**	**LL6sb-003-0001-SO**	**LL6sb-004-0001-SO**	**LL6sb-005-0001-SO**	**LL6sb-006-0001-FD**	**LL6sb-006-0001-SO**	**LL6sb-007-0001-SO**	**LL6sb-008-0001-SO**	**LL6sb-009-0001-SO**
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**	**11/20/03**
Depth (ft)		**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**
Parameters Analyzed		**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**TAL Metals**	**TAL Metals**	**VOCs**	**RVAAP Full-suite analytes**	**TAL Metals**	**TAL Metals**	**TAL Metals**
Analyte	**Background Criteria**										
Naphthalene	None	NR	NR	<0.002 U	NR	NR	NR	<0.002 U	NR	NR	NR
Phenanthrene	None	NR	NR	<0.0012 U	NR	NR	NR	<0.0012 U	NR	NR	NR
Pyrene	None	NR	NR	<0.0023 U	NR	NR	NR	**0.005 J***	NR	NR	NR
VOCs (mg/kg)											
Acetone	None	NR	NR	<0.0055 U	NR	NR	<0.005 U	<0.005 U	NR	NR	NR
Methylene chloride	None	NR	NR	<0.0035 U	NR	NR	<0.0022 U	<0.0022 U	NR	NR	NR

Table 4-3. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate	**Background Criteria**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL6sb-010**	**LL6sb-011**	**LL6sb-012**	**LL6sb-012**	**LL6sb-013**	**LL6sb-014**	**LL6sb-015**	**LL6sb-015**	**LL6sb-016**	**LL6sb-017**
Sample ID		**LL6sb-010-0001-SO**	**LL6sb-011-0001-SO**	**LL6sb-012-0001-FD**	**LL6sb-012-0001-SO**	**LL6sb-013-0001-SO**	**LL6sb-014-0001-SO**	**LL6sb-015-0001-FD**	**LL6sb-015-0001-SO**	**LL6sb-016-0001-SO**	**LL6sb-017-0001-SO**
Date		**12/02/03**	**12/03/03**	**11/25/03**	**11/25/03**	**11/21/03**	**11/25/03**	**11/25/03**	**11/25/03**	**11/21/03**	**11/19/03**
Depth (ft)		**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**
Parameters Analyzed		**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals**	**TAL Metals**
Analyte											
						Metals (mg/kg)					
Aluminum	19500	13000	13000	**21000 ***	19000	14000	9300	13000	7800	14000	11000
Antimony	0.96	<0.49 U	<0.52 U	<0.52 U	<0.5 U	<0.49 U	<0.47 U	<0.54 U	<0.52 U	<0.47 U	<0.46 U
Arsenic	19.8	13	9.9	11	12	**20 ***	12	18	15	13	5
Barium	124	86	70	81	87	56	62	120	63	90	83
Beryllium	0.88	0.84	0.46 J	0.68	0.63	0.48	0.4 J	0.76	0.37 J	0.81	**0.9 ***
Cadmium	0	<0.085 U	<0.096 U	<0.089 U	<0.093 U	<0.091 U	<0.088 U	**0.12 J***	<0.088 U	<0.09 U	**0.45 ***
Calcium	35500	32000	2500	2100	3000	820	2200	19000	16000	1300	9100
Chromium	27.2	18	17	26	24	19	14	**28 ***	**29 ***	19	13
Cobalt	23.2	11	10	8.6	12	11	9.4	10	8.5	**33 ***	9.9
Copper	32.3	22	15	23	20	19	30	**120 ***	**110 ***	22	16
Iron	35200	26000	23000	32000	30000	28000	22000	29000	34000	28000	17000
Lead	19.1	14	15	13	16	18	17	**250 ***	**130 ***	**20 ***	**47 ***
Magnesium	8790	7600	3300	5300	5100	3100	2600	5600	4700	4000	2700
Manganese	3030	350	360	160	340	200	390	610	530	570	820
Mercury	0.044	0.012 J	0.024	0.036	0.022	0.028	0.023	**0.049 ***	0.03	0.041	**0.29 ***
Nickel	60.7	27	19	32	30	21	21	31	36	31	13
Potassium	3350	2200	1100	2200	2000	1300	960	1800	1700	1500	900
Selenium	1.5	<0.43 U	<0.48 U	<0.45 U	<0.46 U	<0.45 U	<0.44 U	<0.48 U	<0.44 U	0.46 J	<0.49 U
Sodium	145	93 J	<100 U	**1500 ***	**1600 ***	<98 U	**1200 ***	**1700 ***	**970 ***	<97 U	<110 U
Thallium	0.91	<0.21 U	0.28	<1.1 U	<0.22 U	<0.21 U	<1 U	<0.23 U	<0.23 U	<0.2 U	<0.2 U
Vanadium	37.6	22	22	30	29	23	15	20	14	20	20
Zinc	93.3	66	49	64	60	53	**97 ***	**280 ***	**160 ***	65	69
						Explosives (mg/kg)					
Nitrocellulose	None	NR	NR	NR	NR	NR	**2.1 ***	NR	NR	NR	NR
						SVOCs (mg/kg)					
2-Methylnaphthalene	None	NR	NR	NR	NR	NR	<0.0017 U	NR	NR	NR	NR
Acenaphthene	None	NR	NR	NR	NR	NR	<0.0016 U	NR	NR	NR	NR
Anthracene	None	NR	NR	NR	NR	NR	<0.00098 U	NR	NR	NR	NR
Benz(a)anthracene	None	NR	NR	NR	NR	NR	<0.0013 U	NR	NR	NR	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	<0.0025 U	NR	NR	NR	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	<0.0024 U	NR	NR	NR	NR
Benzo(ghi)perylene	None	NR	NR	NR	NR	NR	<0.0022 U	NR	NR	NR	NR
Benzo(k)fluoranthene	None	NR	NR	NR	NR	NR	<0.0032 U	NR	NR	NR	NR
Bis(2-ethylhexyl)phthalate	None	NR	NR	NR	NR	NR	<0.011 U	NR	NR	NR	NR
Carbazole	None	NR	NR	NR	NR	NR	<0.04 U	NR	NR	NR	NR
Chrysene	None	NR	NR	NR	NR	NR	<0.0021 U	NR	NR	NR	NR
Di-n-octylphthalate	None	NR	NR	NR	NR	NR	<0.0099 U	NR	NR	NR	NR
Dibenz(a,h)anthracene	None	NR	NR	NR	NR	NR	<0.0025 U	NR	NR	NR	NR
Dibenzofuran	None	NR	NR	NR	NR	NR	<0.0031 U	NR	NR	NR	NR
Fluoranthene	None	NR	NR	NR	NR	NR	<0.0013 U	NR	NR	NR	NR
Fluorene	None	NR	NR	NR	NR	NR	<0.0018 U	NR	NR	NR	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	NR	NR	<0.0024 U	NR	NR	NR	NR

Table 4-3. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		FPA	FPA	FPA	FPA	FPA	FPA	FPA	FPA	FPA	FPA
Station		LL6sb-010	LL6sb-011	LL6sb-012	LL6sb-012	LL6sb-013	LL6sb-014	LL6sb-015	LL6sb-015	LL6sb-016	LL6sb-017
Sample ID		LL6sb-010-0001-SO	LL6sb-011-0001-SO	LL6sb-012-0001-FD	LL6sb-012-0001-SO	LL6sb-013-0001-SO	LL6sb-014-0001-SO	LL6sb-015-0001-FD	LL6sb-015-0001-SO	LL6sb-016-0001-SO	LL6sb-017-0001-SO
Date		12/02/03	12/03/03	11/25/03	11/25/03	11/21/03	11/25/03	11/25/03	11/25/03	11/21/03	11/19/03
Depth (ft)		1.0-3.0	1.0-3.0	1.0-3.0	1.0-3.0	1.0-3.0	1.0-3.0	1.0-3.0	1.0-3.0	1.0-3.0	1.0-3.0
Parameters Analyzed Analyte	Background Criteria	TAL Metals	TAL Metals	TAL Metals	TAL Metals	TAL Metals	RVAAP Full-suite analytes	TAL Metals, Explosives	TAL Metals, Explosives	TAL Metals	TAL Metals
Naphthalene	None	NR	NR	NR	NR	NR	<0.0019 U	NR	NR	NR	NR
Phenanthrene	None	NR	NR	NR	NR	NR	<0.0011 U	NR	NR	NR	NR
Pyrene	None	NR	NR	NR	NR	NR	<0.0023 U	NR	NR	NR	NR
VOCs (mg/kg)											
Acetone	None	NR	NR	NR	NR	NR	<0.0053 U	NR	NR	NR	NR
Methylene chloride	None	NR	NR	NR	NR	NR	<0.0034 U	NR	NR	NR	NR

Table 4-3. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL6sb-018**	**LL6sb-018**	**LL6sb-019**	**LL6sb-020**	**LL6sb-021**	**LL6sb-023**	**LL6sb-024**	**LL6sb-033**	**LL6sb-033**	**LL6sb-035**
Sample ID		**LL6sb-018-0001-FD**	**LL6sb-018-0001-SO**	**LL6sb-019-0001-SO**	**LL6sb-020-0001-SO**	**LL6sb-021-0001-SO**	**LL6sb-023-0001-SO**	**LL6sb-024-0001-SO**	**LL6sb-033-0001-FD**	**LL6sb-033-0001-SO**	**LL6sb-035-0001-SO**
Date		**12/02/03**	**12/02/03**	**11/19/03**	**12/02/03**	**11/19/03**	**11/19/03**	**11/25/03**	**11/18/03**	**11/18/03**	**11/14/03**
Depth (ft)		**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**6.0-8.0**	**6.0-8.0**	**11.0-13.0**
Parameters Analyzed		**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals**
Analyte	**Background Criteria**										
Metals (mg/kg)											
Aluminum	19500	12000	13000	18000	13000	11000	16000	14000	9200	8400	8300
Antimony	0.96	<0.53 U	<0.5 U	<0.46 U	<0.48 U	<0.49 U	<0.48 U	<0.5 U	<0.43 U	<0.42 U	<0.5 U
Arsenic	19.8	11	13	15	19	2.6	9.7	11	**26 ***	**26 ***	15
Barium	124	79	63	86	110	69	67	92	39	36	49
Beryllium	0.88	0.75	0.61	0.82	**1 ***	0.43 J	0.72	0.63	0.56	0.49	0.35 J
Cadmium	0	<0.091 U	<0.095 U	<0.096 U	<0.086 U	<0.097 U	<0.1 U	<0.09 U	<0.089 U	<0.08 U	<0.083 U
Calcium	35500	830	650	4900	2600	1600	2100	30000	5200	6600	8500
Chromium	27.2	15	16	23	19	12	20	18	14	13	13
Cobalt	23.2	**33 ***	5	10	19	2.3	7.8	9.9	9.9	9.1	8.7
Copper	32.3	9.3	9.7	19	22	5.2	17	20	20	20	20
Iron	35200	24000	25000	30000	27000	10000	25000	22000	25000	24000	22000
Lead	19.1	14	15	19	18	9.2	16	**22 ***	14	10	12
Magnesium	8790	2000	1800	4600	4000	1300	3300	5000	4300	4100	3500
Manganese	3030	1600	260	270	390	45	320	550	290	290	480
Mercury	0.044	0.032	0.024	0.02 J	0.021	0.027	0.037	0.039	<0.005 U	<0.0047 U	0.011 J
Nickel	60.7	13	9.7	25	32	8	20	24	23	22	21
Potassium	3350	830	810	1800	1300	910	1500	2100	1400	1200	1500
Selenium	1.5	<0.45 U	<0.48 U	<0.48 U	<0.43 U	<0.49 U	<0.5 U	0.69 J	1.2	1.4	<0.42 U
Sodium	145	<99 U	<100 U	<100 U	<93 U	<110 U	<110 U	**1400 ***	<97 U	<87 U	**1200 ***
Thallium	0.91	<0.23 U	<0.22 U	<0.2 U	<0.21 U	<0.21 U	<0.21 U	<1.1 U	<0.92 U	<0.91 U	<0.21 U
Vanadium	37.6	26	32	31	22	15	26	21	15	13	14
Zinc	93.3	43	38	59	57	29	50	60	58	54	56
Explosives (mg/kg)											
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	**1.1 ***	NR	NR	NR
SVOCs (mg/kg)											
2-Methylnaphthalene	None	NR	NR	NR	NR	NR	NR	**0.022 J***	NR	NR	NR
Acenaphthene	None	NR	NR	NR	NR	NR	NR	**0.069 ***	NR	NR	NR
Anthracene	None	NR	NR	NR	NR	NR	NR	**0.13 ***	NR	NR	NR
Benz(a)anthracene	None	NR	NR	NR	NR	NR	NR	**0.29 ***	NR	NR	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	NR	**0.2 ***	NR	NR	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	NR	**0.23 ***	NR	NR	NR
Benzo(ghi)perylene	None	NR	NR	NR	NR	NR	NR	**0.083 ***	NR	NR	NR
Benzo(k)fluoranthene	None	NR	NR	NR	NR	NR	NR	**0.16 ***	NR	NR	NR
Bis(2-ethylhexyl)phthalate	None	NR	NR	NR	NR	NR	NR	**0.034 J***	NR	NR	NR
Carbazole	None	NR	NR	NR	NR	NR	NR	**0.14 J***	NR	NR	NR
Chrysene	None	NR	NR	NR	NR	NR	NR	**0.3 ***	NR	NR	NR
Di-n-octylphthalate	None	NR	NR	NR	NR	NR	NR	<0.01 U	NR	NR	NR
Dibenz(a,h)anthracene	None	NR	NR	NR	NR	NR	NR	**0.052 ***	NR	NR	NR
Dibenzofuran	None	NR	NR	NR	NR	NR	NR	**0.045 J***	NR	NR	NR
Fluoranthene	None	NR	NR	NR	NR	NR	NR	**0.76 ***	NR	NR	NR
Fluorene	None	NR	NR	NR	NR	NR	NR	**0.057 ***	NR	NR	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	NR	NR	NR	**0.088 ***	NR	NR	NR

Table 4-3. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		FPA	FPA	FPA	FPA	FPA	FPA	FPA	FPA	FPA	FPA
Station		**LL6sb-018**	**LL6sb-018**	**LL6sb-019**	**LL6sb-020**	**LL6sb-021**	**LL6sb-023**	**LL6sb-024**	**LL6sb-033**	**LL6sb-033**	**LL6sb-035**
Sample ID		**LL6sb-018-0001-FD**	**LL6sb-018-0001-SO**	**LL6sb-019-0001-SO**	**LL6sb-020-0001-SO**	**LL6sb-021-0001-SO**	**LL6sb-023-0001-SO**	**LL6sb-024-0001-SO**	**LL6sb-033-0001-FD**	**LL6sb-033-0001-SO**	**LL6sb-035-0001-SO**
Date		**12/02/03**	**12/02/03**	**11/19/03**	**12/02/03**	**11/19/03**	**11/19/03**	**11/25/03**	**11/18/03**	**11/18/03**	**11/14/03**
Depth (ft)		**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**6.0-8.0**	**6.0-8.0**	**11.0-13.0**
Parameters Analyzed		**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals**
Analyte	**Background Criteria**										
Naphthalene	None	NR	NR	NR	NR	NR	NR	**0.078 ***	NR	NR	NR
Phenanthrene	None	NR	NR	NR	NR	NR	NR	**0.51 ***	NR	NR	NR
Pyrene	None	NR	NR	NR	NR	NR	NR	**0.51 ***	NR	NR	NR
VOCs (mg/kg)											
Acetone	None	NR	NR	NR	NR	NR	NR	<0.0057 U	NR	NR	NR
Methylene chloride	None	NR	NR	NR	NR	NR	NR	<0.0036 U	NR	NR	NR

Table 4-3. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL6sb-018**	**LL6sb-018**	**LL6sb-019**	**LL6sb-020**	**LL6sb-021**	**LL6sb-023**	**LL6sb-024**	**LL6sb-033**	**LL6sb-033**	**LL6sb-035**
Sample ID		**LL6sb-018-0001-FD**	**LL6sb-018-0001-SO**	**LL6sb-019-0001-SO**	**LL6sb-020-0001-SO**	**LL6sb-021-0001-SO**	**LL6sb-023-0001-SO**	**LL6sb-024-0001-SO**	**LL6sb-033-0001-FD**	**LL6sb-033-0001-SO**	**LL6sb-035-0001-SO**
Date		**12/02/03**	**12/02/03**	**11/19/03**	**12/02/03**	**11/19/03**	**11/19/03**	**11/25/03**	**11/18/03**	**11/18/03**	**11/14/03**
Depth (ft)		**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**6.0-8.0**	**6.0-8.0**	**11.0-13.0**
Parameters Analyzed		**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals**
Analyte	**Background Criteria**										
Metals (mg/kg)											
Aluminum	19500	12000	13000	18000	13000	11000	16000	14000	9200	8400	8300
Antimony	0.96	<0.53 U	<0.5 U	<0.46 U	<0.48 U	<0.49 U	<0.48 U	<0.5 U	<0.43 U	<0.42 U	<0.5 U
Arsenic	19.8	11	13	15	19	2.6	9.7	11	**26 ***	**26 ***	15
Barium	124	79	63	86	110	69	67	92	39	36	49
Beryllium	0.88	0.75	0.61	0.82	**1 ***	0.43 J	0.72	0.63	0.56	0.49	0.35 J
Cadmium	0	<0.091 U	<0.095 U	<0.096 U	<0.086 U	<0.097 U	<0.1 U	<0.09 U	<0.089 U	<0.08 U	<0.083 U
Calcium	35500	830	650	4900	2600	1600	2100	30000	5200	6600	8500
Chromium	27.2	15	16	23	19	12	20	18	14	13	13
Cobalt	23.2	**33 ***	5	10	19	2.3	7.8	9.9	9.9	9.1	8.7
Copper	32.3	9.3	9.7	19	22	5.2	17	20	20	20	20
Iron	35200	24000	25000	30000	27000	10000	25000	22000	25000	24000	22000
Lead	19.1	14	15	19	18	9.2	16	**22 ***	14	10	12
Magnesium	8790	2000	1800	4600	4000	1300	3300	5000	4300	4100	3500
Manganese	3030	1600	260	270	390	45	320	550	290	290	480
Mercury	0.044	0.032	0.024	0.02 J	0.021	0.027	0.037	0.039	<0.005 U	<0.0047 U	0.011 J
Nickel	60.7	13	9.7	25	32	8	20	24	23	22	21
Potassium	3350	830	810	1800	1300	910	1500	2100	1400	1200	1500
Selenium	1.5	<0.45 U	<0.48 U	<0.48 U	<0.43 U	<0.49 U	<0.5 U	0.69 J	1.2	1.4	<0.42 U
Sodium	145	<99 U	<100 U	<100 U	<93 U	<110 U	<110 U	**1400 ***	<97 U	<87 U	**1200 ***
Thallium	0.91	<0.23 U	<0.22 U	<0.2 U	<0.21 U	<0.21 U	<0.21 U	<1.1 U	<0.92 U	<0.91 U	<0.21 U
Vanadium	37.6	26	32	31	22	15	26	21	15	13	14
Zinc	93.3	43	38	59	57	29	50	60	58	54	56
Explosives (mg/kg)											
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	**1.1 ***	NR	NR	NR
SVOCs (mg/kg)											
2-Methylnaphthalene	None	NR	NR	NR	NR	NR	NR	**0.022 J***	NR	NR	NR
Acenaphthene	None	NR	NR	NR	NR	NR	NR	**0.069 ***	NR	NR	NR
Anthracene	None	NR	NR	NR	NR	NR	NR	**0.13 ***	NR	NR	NR
Benz(a)anthracene	None	NR	NR	NR	NR	NR	NR	**0.29 ***	NR	NR	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	NR	**0.2 ***	NR	NR	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	NR	**0.23 ***	NR	NR	NR
Benzo(ghi)perylene	None	NR	NR	NR	NR	NR	NR	**0.083 ***	NR	NR	NR
Benzo(k)fluoranthene	None	NR	NR	NR	NR	NR	NR	**0.16 ***	NR	NR	NR
Bis(2-ethylhexyl)phthalate	None	NR	NR	NR	NR	NR	NR	**0.034 J***	NR	NR	NR
Carbazole	None	NR	NR	NR	NR	NR	NR	**0.14 J***	NR	NR	NR
Chrysene	None	NR	NR	NR	NR	NR	NR	**0.3 ***	NR	NR	NR
Di-n-octylphthalate	None	NR	NR	NR	NR	NR	NR	<0.01 U	NR	NR	NR
Dibenz(a,h)anthracene	None	NR	NR	NR	NR	NR	NR	**0.052 ***	NR	NR	NR
Dibenzofuran	None	NR	NR	NR	NR	NR	NR	**0.045 J***	NR	NR	NR
Fluoranthene	None	NR	NR	NR	NR	NR	NR	**0.76 ***	NR	NR	NR
Fluorene	None	NR	NR	NR	NR	NR	NR	**0.057 ***	NR	NR	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	NR	NR	NR	**0.088 ***	NR	NR	NR

Table 4-3. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL6sb-018**	**LL6sb-018**	**LL6sb-019**	**LL6sb-020**	**LL6sb-021**	**LL6sb-023**	**LL6sb-024**	**LL6sb-033**	**LL6sb-033**	**LL6sb-035**
Sample ID		**LL6sb-018-0001-FD**	**LL6sb-018-0001-SO**	**LL6sb-019-0001-SO**	**LL6sb-020-0001-SO**	**LL6sb-021-0001-SO**	**LL6sb-023-0001-SO**	**LL6sb-024-0001-SO**	**LL6sb-033-0001-FD**	**LL6sb-033-0001-SO**	**LL6sb-035-0001-SO**
Date		**12/02/03**	**12/02/03**	**11/19/03**	**12/02/03**	**11/19/03**	**11/19/03**	**11/25/03**	**11/18/03**	**11/18/03**	**11/14/03**
Depth (ft)		**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**6.0-8.0**	**6.0-8.0**	**11.0-13.0**
Parameters Analyzed		**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals**
Analyte	**Background Criteria**										
Naphthalene	None	NR	NR	NR	NR	NR	NR	**0.078 ***	NR	NR	NR
Phenanthrene	None	NR	NR	NR	NR	NR	NR	**0.51 ***	NR	NR	NR
Pyrene	None	NR	NR	NR	NR	NR	NR	**0.51 ***	NR	NR	NR
VOCs (mg/kg)											
Acetone	None	NR	NR	NR	NR	NR	NR	<0.0057 U	NR	NR	NR
Methylene chloride	None	NR	NR	NR	NR	NR	NR	<0.0036 U	NR	NR	NR

Table 4-3. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**NPA**	**NPA**	**NPA**
Station		**LL6sb-038**	**LL6sb-039**	**LL6sb-041**	**LL6sb-042**	**LL6sb-044**	**LL6sb-044**	**LL6sb-045**	**LL6sb-025**	**LL6sb-026**	**LL6sb-027**
Sample ID		**LL6sb-038-0001-SO**	**LL6sb-039-0001-SO**	**LL6sb-041-0001-SO**	**LL6sb-042-0001-SO**	**LL6sb-044-0001-FD**	**LL6sb-044-0001-SO**	**LL6sb-045-0001-SO**	**LL6sb-025-0001-SO**	**LL6sb-026-0001-SO**	**LL6sb-027-0001-SO**
Date		**11/05/03**	**11/05/03**	**10/27/03**	**12/03/03**	**12/02/03**	**12/02/03**	**12/02/03**	**11/14/03**	**11/20/03**	**11/20/03**
Depth (ft)		**8.0-10.0**	**8.0-10.0**	**7.0-7.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**
Parameters Analyzed		**TAL Metals**	**TAL Metals, Explosives**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**
Analyte	**Background Criteria**										
Metals (mg/kg)											
Aluminum	19500	15000	13000	13000	13000	8500	9100	16000	14000	19000	15000
Antimony	0.96	<0.5 U	<0.49 U	<0.5 U	<0.49 U	<0.51 U	<0.5 U	<0.51 U	<0.45 U	<0.47 U	<0.52 U
Arsenic	19.8	13	11	12	15	5.2	4.3	15	6.8	16	10
Barium	124	75	59	74	89	43	47	87	42	70	63
Beryllium	0.88	0.56	0.47 J	0.55	0.53	0.45	0.51	**0.94 ***	0.2 J	0.75	0.76
Cadmium	0	<0.092 U	<0.094 U	<0.085 U	<0.088 U	<0.088 U	<0.083 U	<0.083 U	<0.095 U	<0.091 U	<0.092 U
Calcium	35500	24000	8400	20000	**36000 ***	660	410	3800	300	1300	1300
Chromium	27.2	20	17	19	21	10	11	21	15	24	18
Cobalt	23.2	11	9.9	13	12	3.4	3.7	12	4.3	7.1	9.1
Copper	32.3	20	17	23	21	5	5.6	23	6.3	21	14
Iron	35200	29000	25000	29000	27000	15000	16000	29000	21000	32000	29000
Lead	19.1	10	15	14	12	7.5	8.5	17	13	9.5	12
Magnesium	8790	7200	4200	6300	8500	1400	1500	4600	1900	3700	2400
Manganese	3030	280	400	540	370	210	110	300	120	140	460
Mercury	0.044	0.014 J	0.021	0.018 J	0.011 J	0.013 J	0.013 J	0.017 J	0.025	0.038	0.042
Nickel	60.7	27	22	31	29	7.8	8.4	30	9.2	22	14
Potassium	3350	2900	1800	2200	2500	610	620	1700	760	1500	900
Selenium	1.5	<0.46 U	0.59 J	<0.42 U	0.55 J	<0.44 U	<0.41 U	<0.41 U	<0.48 U	<0.45 U	<0.46 U
Sodium	145	**1500 ***	**1400 ***	<92 U	**150 ***	<96 U	<90 U	100 J	**1300 ***	<99 U	<100 U
Thallium	0.91	<0.22 U	<1.1 U	<0.21 U	0.22 J	<0.22 U	<0.21 U	<0.22 U	<0.2 U	<1 U	<1.1 U
Vanadium	37.6	24	22	21	23	17	18	24	27	30	31
Zinc	93.3	60	76	69	58	29	31	61	40	57	48
Explosives (mg/kg)											
Nitrocellulose	None	NR	NR	NR	NR	**2.8 J***	**0.85 J***	NR	NR	NR	NR
SVOCs (mg/kg)											
2-Methylnaphthalene	None	NR	NR	NR	NR	<0.0018 U	<0.0017 U	NR	NR	NR	NR
Acenaphthene	None	NR	NR	NR	NR	<0.0017 U	<0.0016 U	NR	NR	NR	NR
Anthracene	None	NR	NR	NR	NR	<0.001 U	<0.001 U	NR	NR	NR	NR
Benz(a)anthracene	None	NR	NR	NR	NR	<0.0013 U	<0.0013 U	NR	NR	NR	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	<0.0026 U	<0.0026 U	NR	NR	NR	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	<0.0025 U	<0.0024 U	NR	NR	NR	NR
Benzo(ghi)perylene	None	NR	NR	NR	NR	<0.0023 U	<0.0022 U	NR	NR	NR	NR
Benzo(k)fluoranthene	None	NR	NR	NR	NR	<0.0033 U	<0.0033 U	NR	NR	NR	NR
Bis(2-ethylhexyl)phthalate	None	NR	NR	NR	NR	**0.06 J***	**0.16 J***	NR	NR	NR	NR
Carbazole	None	NR	NR	NR	NR	<0.042 U	<0.041 U	NR	NR	NR	NR
Chrysene	None	NR	NR	NR	NR	<0.0021 U	<0.0021 U	NR	NR	NR	NR
Di-n-octylphthalate	None	NR	NR	NR	NR	<0.01 U	<0.01 U	NR	NR	NR	NR
Dibenz(a,h)anthracene	None	NR	NR	NR	NR	<0.0026 U	<0.0026 U	NR	NR	NR	NR
Dibenzofuran	None	NR	NR	NR	NR	<0.0032 U	<0.0031 U	NR	NR	NR	NR
Fluoranthene	None	NR	NR	NR	NR	<0.0013 U	<0.0013 U	NR	NR	NR	NR
Fluorene	None	NR	NR	NR	NR	<0.0019 U	<0.0019 U	NR	NR	NR	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	NR	<0.0025 U	<0.0024 U	NR	NR	NR	NR

Table 4-3. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		FPA	FPA	FPA	FPA	FPA	FPA	FPA	NPA	NPA	NPA
Station		**LL6sb-038**	**LL6sb-039**	**LL6sb-041**	**LL6sb-042**	**LL6sb-044**	**LL6sb-044**	**LL6sb-045**	**LL6sb-025**	**LL6sb-026**	**LL6sb-027**
Sample ID		**LL6sb-038-0001-SO**	**LL6sb-039-0001-SO**	**LL6sb-041-0001-SO**	**LL6sb-042-0001-SO**	**LL6sb-044-0001-FD**	**LL6sb-044-0001-SO**	**LL6sb-045-0001-SO**	**LL6sb-025-0001-SO**	**LL6sb-026-0001-SO**	**LL6sb-027-0001-SO**
Date		**11/05/03**	**11/05/03**	**10/27/03**	**12/03/03**	**12/02/03**	**12/02/03**	**12/02/03**	**11/14/03**	**11/20/03**	**11/20/03**
Depth (ft)		**8.0-10.0**	**8.0-10.0**	**7.0-7.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**	**1.0-3.0**
Parameters Analyzed											
Analyte	**Background Criteria**	**TAL Metals**	**TAL Metals, Explosives**	**TAL Metals**	**TAL Metals**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**
Naphthalene	None	NR	NR	NR	NR	<0.002 U	<0.002 U	NR	NR	NR	NR
Phenanthrene	None	NR	NR	NR	NR	<0.0012 U	<0.0012 U	NR	NR	NR	NR
Pyrene	None	NR	NR	NR	NR	<0.0024 U	<0.0023 U	NR	NR	NR	NR
VOCs (mg/kg)											
Acetone	None	NR	NR	NR	NR	<0.002 U	<0.002 U	NR	NR	NR	NR
Methylene chloride	None	NR	NR	NR	NR	<0.0012 U	<0.0012 U	NR	NR	NR	NR

Table 4-3. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL6sb-028**	**LL6sb-030**	**LL6sb-031**	**LL6sb-036**	**LL6sb-037**	**LL6sb-040**	**LL6sb-049**	**LL6sb-050**	**LL6sb-051**	**LL6sb-055**	**LL6sb-056**
Sample ID		**LL6sb-028-0001-SO**	**LL6sb-030-0001-SO**	**LL6sb-031-0001-SO**	**LL6sb-036-0001-SO**	**LL6sb-037-0001-SO**	**LL6sb-040-0001-SO**	**LL6sb-049-0001-SO**	**LL6sb-050-0001-SO**	**LL6sb-051-0001-SO**	**LL6sb-055-0001-SO**	**LL6sb-056-0001-SO**
Date		**11/18/03**	**11/18/03**	**11/18/03**	**11/18/03**	**11/14/03**	**11/05/03**	**11/04/03**	**11/04/03**	**11/04/03**	**11/04/03**	**11/18/03**
Depth (ft)		**1.0-3.0**	**1.0-3.0**	**6.0-8.0**	**6.0-8.0**	**12.0-14.0**	**4.0-6.0**	**4.0-6.0**	**6.0-8.0**	**6.0-8.0**	**3.0-5.0**	**1.0-3.0**
Parameters Analyzed		**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**Misc., SVOCs, VOCs**	**Misc., SVOCs, VOCs**	**Misc., SVOCs, VOCs**	**Misc., SVOCs, VOCs**	**TAL Metals**
Analyte	**Background Criteria**	**LL6sb-028**	**LL6sb-030**	**LL6sb-031**	**LL6sb-036**	**LL6sb-037**	**LL6sb-040**	**LL6sb-049**	**LL6sb-050**	**LL6sb-051**	**LL6sb-055**	**LL6sb-056**
Metals (mg/kg)												
Aluminum	19500	19000	19000	15000	9400	6900	5900	NR	NR	NR	NR	16000
Antimony	0.96	<0.5 U	<0.53 U	<0.51 U	<0.41 U	0.58 J	<0.48 U	NR	NR	NR	NR	<0.49 U
Arsenic	19.8	16	11	10	15	16	13	NR	NR	NR	NR	13
Barium	124	**160 ***	83	86	29	25	20	NR	NR	NR	NR	63
Beryllium	0.88	**0.93 ***	0.76	**0.9 ***	0.54	0.29 J	0.19 J	NR	NR	NR	NR	0.6
Cadmium	0	<0.09 U	<0.1 U	<0.09 U	<0.084 U	<0.087 U	<0.085 U	NR	NR	NR	NR	<0.091 U
Calcium	35500	2100	1300	**39000 ***	8000	6900	270	NR	NR	NR	NR	3400
Chromium	27.2	24	25	21	14	10	8.2	NR	NR	NR	NR	19
Cobalt	23.2	9.6	6.6	11	9.2	7.6	3.5	NR	NR	NR	NR	5.5
Copper	32.3	21	18	21	19	16	5.9	NR	NR	NR	NR	15
Iron	35200	28000	**45000 ***	27000	23000	20000	11000	NR	NR	NR	NR	26000
Lead	19.1	18	17	13	11	12	7.8	NR	NR	NR	NR	14
Magnesium	8790	4800	2700	**9200 ***	4700	4700	1500	NR	NR	NR	NR	2600
Manganese	3030	340	440	380	220	220	79	NR	NR	NR	NR	150
Mercury	0.044	0.016 J	0.026	0.0064 J	<0.0049 U	0.0081 J	0.016 J	NR	NR	NR	NR	0.022
Nickel	60.7	32	15	30	21	18	9.1	NR	NR	NR	NR	14
Potassium	3350	1700	1500	3200	1600	1400	640	NR	NR	NR	NR	1300
Selenium	1.5	1.5	**2.5 ***	1.4	1	<0.43 U	0.67 J	NR	NR	NR	NR	1.5
Sodium	145	<98 U	<110 U	140	<91 U	**1000 ***	**740 ***	NR	NR	NR	NR	<98 U
Thallium	0.91	<1.1 U	<1.1 U	<0.22 U	<0.18 U	<0.19 U	<1 U	NR	NR	NR	NR	<1.1 U
Vanadium	37.6	27	31	25	15	11	11	NR	NR	NR	NR	27
Zinc	93.3	59	49	55	52	53	22	NR	NR	NR	NR	45
Explosives (mg/kg)												
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)												
2-Methylnaphthalene	None	NR	NR	NR	NR	NR	NR	<0.0017 U	<0.0017 U	<0.0017 U	<0.0017 U	NR
Acenaphthene	None	NR	NR	NR	NR	NR	NR	<0.0016 U	<0.0016 U	<0.0016 U	<0.0016 U	NR
Anthracene	None	NR	NR	NR	NR	NR	NR	<0.00097 U	<0.001 U	<0.001 U	<0.00097 U	NR
Benz(a)anthracene	None	NR	NR	NR	NR	NR	NR	<0.0012 U	<0.0013 U	<0.0013 U	<0.0012 U	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	NR	<0.0025 U	<0.0026 U	<0.0026 U	<0.0025 U	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	NR	<0.0024 U	<0.0024 U	<0.0024 U	<0.0024 U	NR
Benzo(ghi)perylene	None	NR	NR	NR	NR	NR	NR	<0.0021 U	<0.0022 U	<0.0022 U	<0.0022 U	NR
Benzo(k)fluoranthene	None	NR	NR	NR	NR	NR	NR	<0.0032 U	<0.0033 U	<0.0033 U	<0.0032 U	NR
Bis(2-ethylhexyl)phthalate	None	NR	NR	NR	NR	NR	NR	<0.011 U	<0.011 U	<0.011 U	<0.011 U	NR
Carbazole	None	NR	NR	NR	NR	NR	NR	<0.039 U	<0.041 U	<0.041 U	<0.04 U	NR
Chrysene	None	NR	NR	NR	NR	NR	NR	<0.002 U	<0.0021 U	<0.0021 U	<0.002 U	NR
Di-n-octylphthalate	None	NR	NR	NR	NR	NR	NR	**0.02 J***	<0.01 U	<0.01 U	<0.0099 U	NR
Dibenz(a,h)anthracene	None	NR	NR	NR	NR	NR	NR	<0.0025 U	<0.0026 U	<0.0026 U	<0.0025 U	NR
Dibenzofuran	None	NR	NR	NR	NR	NR	NR	<0.003 U	<0.0031 U	<0.0031 U	<0.0031 U	NR
Fluoranthene	None	NR	NR	NR	NR	NR	NR	<0.0012 U	<0.0013 U	<0.0013 U	<0.0012 U	NR
Fluorene	None	NR	NR	NR	NR	NR	NR	<0.0018 U	<0.0019 U	<0.0019 U	<0.0018 U	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	NR	NR	NR	<0.0024 U	<0.0024 U	<0.0024 U	<0.0024 U	NR

Table 4-3. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL6sb-028**	**LL6sb-030**	**LL6sb-031**	**LL6sb-036**	**LL6sb-037**	**LL6sb-040**	**LL6sb-049**	**LL6sb-050**	**LL6sb-051**	**LL6sb-055**	**LL6sb-056**
Sample ID		**LL6sb-028-0001-SO**	**LL6sb-030-0001-SO**	**LL6sb-031-0001-SO**	**LL6sb-036-0001-SO**	**LL6sb-037-0001-SO**	**LL6sb-040-0001-SO**	**LL6sb-049-0001-SO**	**LL6sb-050-0001-SO**	**LL6sb-051-0001-SO**	**LL6sb-055-0001-SO**	**LL6sb-056-0001-SO**
Date		**11/18/03**	**11/18/03**	**11/18/03**	**11/18/03**	**11/14/03**	**11/05/03**	**11/04/03**	**11/04/03**	**11/04/03**	**11/04/03**	**11/18/03**
Depth (ft)		**1.0-3.0**	**1.0-3.0**	**6.0-8.0**	**6.0-8.0**	**12.0-14.0**	**4.0-6.0**	**4.0-6.0**	**6.0-8.0**	**6.0-8.0**	**3.0-5.0**	**1.0-3.0**
Parameters Analyzed		**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**Misc., SVOCs, VOCs**	**Misc., SVOCs, VOCs**	**Misc., SVOCs, VOCs**	**Misc., SVOCs, VOCs**	**TAL Metals**
Analyte	**Background Criteria**	**LL6sb-028**	**LL6sb-030**	**LL6sb-031**	**LL6sb-036**	**LL6sb-037**	**LL6sb-040**	**LL6sb-049**	**LL6sb-050**	**LL6sb-051**	**LL6sb-055**	**LL6sb-056**
Naphthalene	None	NR	NR	NR	NR	NR	NR	<0.0019 U	<0.002 U	<0.002 U	<0.0019 U	NR
Phenanthrene	None	NR	NR	NR	NR	NR	NR	<0.0011 U	<0.0012 U	<0.0012 U	<0.0011 U	NR
Pyrene	None	NR	NR	NR	NR	NR	NR	<0.0023 U	<0.0023 U	<0.0023 U	<0.0023 U	NR
VOCs (mg/kg)												
Acetone	None	NR	NR	NR	NR	NR	NR	<0.0047 U	<0.0048 U	<0.0048 U	<0.0048 U	NR
Methylene chloride	None	NR	NR	NR	NR	NR	NR	<0.0021 U	<0.0021 U	<0.0021 U	<0.0021 U	NR

FPA = Former Production Area.
ft = Feet.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg – Milligrams per kilogram.
NPA= Non-production Area.
NR = Not reported/not analyzed.
RI = Remedial Investigation
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
TAL = Target analyte list.
U = Not detected.
UJ = Not detected, reporting limit estimated.
VOC = Volatile organic compound.
*** = Result exceeds background criteria or no background criteria was available.**
< = Less than.

Table 4-4. Analytes Detected in Phase I RI Surface Water Samples

Aggregate		**Drainage Ditches**	**Drainage Ditches**	**Drainage Ditches**	**Drainage Ditches**	**Drainage Ditches**	**Former Test Pond**	**Former Test Pond**
Station		**LL6sw-002**	**LL6sw-002**	**LL6sw-003**	**LL6sw-004**	**LL6sw-005**	**LL6sw-001**	**LL6sw-001**
Sample ID		**LL6sw-002-0001-FD**	**LL6sw-002-0001-SW**	**LL6sw-003-0001-SW**	**LL6sw-004-0001-SW**	**LL6sw-005-0001-SW**	**LL6sw-001-0001-FD**	**LL6sw-001-0001-SW**
Date		**12/01/03**	**12/01/03**	**12/01/03**	**12/01/03**	**12/01/03**	**03/14/02**	**03/14/02**
Parameters Analyzed		**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**
Analyte	**Background Criteria**							
Metals (mg/L)								
Aluminum	3.37	0.24	0.71	0.58	**16 ***	**8.3 ***	0.0972 J	0.107 J
Arsenic	0.0032	0.0016 J	0.0016 J	<0.00073 U	**0.026 ***	**0.0082 ***	<0.006 U	<0.006 U
Barium	0.0475	0.047	**0.049 ***	0.019	**0.23 ***	**0.079 ***	0.0154	0.0152
Beryllium	0	<0.00017 U	<0.00017 U	<0.00017 U	**0.0008 J***	**0.00031 J***	<0.004 U	<0.004 U
Cadmium	0	<0.00044 U	<0.00044 U	<0.00044 U	**0.0011 J***	<0.00044 U	<0.002 U	<0.002 U
Calcium	41.4	**67 ***	**72 ***	11	**55 ***	**47 ***	29.5	29.4
Chromium	0	**0.0016 J***	**0.0023 J***	<0.0015 U	**0.023 ***	**0.0098 J***	<0.01 U	<0.01 U
Cobalt	0	**0.0011 J***	**0.0011 J***	<0.001 U	**0.022 ***	**0.0036 J***	<0.005 U	<0.005 U
Copper	0.0079	0.0036 J	0.0042 J	0.0043 J	**0.031 ***	**0.015 ***	<0.01 U	<0.01 U
Iron	2.56	1.2	1.6	1	**38 ***	**12 ***	1.21	1.24
Lead	0	<0.00078 U	**0.0083 ***	**0.00096 J***	**0.083 ***	**0.026 ***	<0.002 U	<0.002 U
Magnesium	10.8	7.7	8.1	2.1	8.8	6.9	5.44	5.4
Manganese	0.391	**2.5 ***	**2.2 ***	0.062	**11 ***	0.23	0.0866	0.0884
Mercury	0	<0.00005 U	<0.00005 U	<0.00005 U	**0.00012 J***	**0.00007 J***	<0.0002 U	<0.0002 U
Nickel	0	<0.0019 U	<0.0019 U	<0.0019 U	**0.025 ***	**0.012 ***	<0.01 U	<0.01 U
Potassium	3.17	2.8	2.8	2.1	**4.6 ***	**5.5 ***	2.52	2.53
Selenium	0	<0.005 U	<0.005 U	<0.005 U	**0.0072 ***	<0.005 U	<0.01 U	<0.01 U
Sodium	21.3	0.66 J	0.53 J	0.65 J	3.2	2.9	0.78 J	0.795 J
Vanadium	0	<0.0021 U	<0.0021 U	<0.0021 U	**0.028 ***	**0.014 ***	<0.005 U	<0.005 U
Zinc	0.042	0.013	0.015	0.021	**0.43 ***	**0.059 ***	0.01 J	0.0047 J
Explosives (mg/L)								
Nitrocellulose	None	**0.1 J***	<0.5 U	NR	NR	NR	NR	NR
SVOCs (mg/L)								
4-Methylphenol	None	**0.00036 J***	**0.00026 J***	NR	NR	NR	NR	NR
VOCs (mg/L)								
Acetone	None	**0.0082 ***	**0.0022 ***	NR	NR	NR	NR	NR

ID = Identification.
J = Estimated value less than reporting limits.
mg/L = Milligrams per liter
NR = Not reported/not analyzed.
RI = Remedial Investigation
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
TAL = Target analyte list.
U = Not detected.
VOC = Volatile organic compound.
*** = Result exceeds background criteria or no background criteria was available.**
< = Less than.

Table 4-5. Analytes Detected in Phase I RI Sediment Samples

Aggregate		**Drainage Ditches**	**Drainage Ditches**	**Drainage Ditches**	**Former Test Pond**
Station		**LL6sd-002**	**LL6sd-003**	**LL6sd-004**	**LL6sd-001**
Sample ID		**LL6sd-002-0001-SD**	**LL6sd-003-0001-SD**	**LL6sd-004-0001-SD**	**LL6sd-001-0001-SD**
Date		**12/01/03**	**12/01/03**	**12/01/03**	**03/14/02**
Depth (ft)		**0.0-0.5**	**0.0-0.5**	**0.0-0.5**	**0.0-1.0**
Parameters Analyzed		**TAL Metals**	**RVAAP Full-suite analytes**	**TAL Metals**	**TAL Metals, Explosives**
Analyte	**Background Criteria**				
Metals (mg/kg)					
Aluminum	13900	9600	4500	13000	**16200 ***
Antimony	0	<0.63 U	<0.45 U	<0.73 U	**0.6 ***
Arsenic	19.5	8.7	9	**37 ***	11.6
Barium	123	73	57	95	91.3
Beryllium	0.38	**0.41 J***	**0.62 ***	**0.69 ***	**0.71 ***
Cadmium	0	<0.14 U	**0.1 J***	**1.1 ***	<0.34 U
Calcium	5510	4700	620	3800	4110
Chromium	18.1	14	9.1	**21 ***	**23.2 ***
Cobalt	9.1	6.3	**15 ***	**9.7 ***	**10.2 ***
Copper	27.6	21	13	**57 ***	**68.4 ***
Iron	28200	20000	21000	23000	27500
Lead	27.4	**36 ***	16	**85 ***	**156 ***
Magnesium	2760	2000	670	2500	**3880 ***
Manganese	1950	380	770	450	315
Mercury	0.059	0.052	0.02 J	**0.094 ***	0.02 J
Nickel	17.7	14	12	**20 ***	**28.4 ***
Potassium	1950	1000	400	1200	1820
Selenium	1.7	<0.68 U	0.72 J	1.3 J	<1.7 U
Sodium	112	<150 U	<88 U	<150 U	**243 ***
Vanadium	26.1	17	13	23	**27.2 ***
Zinc	532	68	130	450	72.1
Explosives (mg/kg)					
Nitrocellulose	None	NR	NR	NR	NR
SVOCs (mg/kg)					
Benz(a)anthracene	None	NR	**2.2 J***	NR	NR
Benzo(a)pyrene	None	NR	**0.0052 J***	NR	NR
Benzo(b)fluoranthene	None	NR	**0.0062 J***	NR	NR
Chrysene	None	NR	**0.0058 J***	NR	NR
Fluoranthene	None	NR	**0.0081 J***	NR	NR
Indeno(1,2,3-cd)pyrene	None	NR	**0.014 J***	NR	NR
Pyrene	None	NR	**0.0043 J***	NR	NR

ft = Feet.
ID = Identification.
mg/kg = Milligrams per kilogram.
J = Estimated value less than reporting limits.
NR = Not reported/not analyzed.
RI = Remedial Investigation
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
TAL = Target analyte list.
U = Not detected.
*** = Result exceeds background criteria or no background criteria was available.**
< = Less than.

Table 4-6. Human Health Chemicals of Potential Concern per the Phase I RI Report

Surface and Subsurface Soil	Sediment	Surface Water	Groundwater
Aluminum Arsenic Manganese Vanadium Benzo(a)pyrene	Aluminum Arsenic Vanadium	Aluminum Arsenic Chromium Lead Manganese Vanadium	Antimony Arsenic Bis(2-ethylhexyl)phthalate 4-Nitroaniline

Adapted from Table 6-7: *Report for the Phase I Remedial Investigation for Load Line 6 at the Ravenna Army Ammunition Plant* (MKM 2007).
RI = Remedial Investigation.

Table 4-7. Summary of Ecological Risk Calculation Results per the Phase I RI

Terrestrial Plants and Soil Invertebrates	Benthic Invertebrates	Aquatic Organisms	Terrestrial Wildlife-Insectivores/ Herbivores	Terrestrial Wildlife-Carnivores
No COPCs retained.	*No COPCs retained.*	Aluminum Copper Iron Lead Zinc	*No COPCs retained.*	*No COPCs retained.*

Adapted from the *Report for the Phase I Remedial Investigation for Load Line 6 at the Ravenna Army Ammunition Plant* (MKM 2007).
COPC = Chemical of potential concern.
RI = Remedial Investigation.

Table 4-8. Chemicals Detected at Concentrations Above Screening Criteria in Previous Investigations

Surface Soil	Subsurface Soil	Sediment	Surface Water	Groundwater
Aluminum Arsenic Cadmium Chromium Cobalt Copper Manganese Benzo(a)pyrene Dibenz(a,h)anthracene	Aluminum Arsenic Chromium Cobalt Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene	Aluminum Arsenic Chromium	Aluminum Arsenic Lead Manganese	Antimony Arsenic 4-Nitrobenzenamine Bis(2-ethylhexyl) phthalate

Adapted from the *Report for the Phase I Remedial Investigation of RVAAP-33 Load Line 6* (MKM 2007).

Table 4-9. PBA08 RI Surface Soil Samples and Rationales

PBA08 RI Station	Targeted Area	Purpose	Analyses Performed				
			Metals	**Explosives**	**VOCs**	**Pesticides/ PCBs**	**SVOC**
LL6ss-073	Building 2F-36	Characterize an area not previously investigated. 1941-1945 – Change House. Analyzed for RVAAP full-suite analytes.	Y	Y	Y	Y	Y
LL6ss-074	Building 2F-32	Characterize an area not previously investigated. 1941-1945 – Fuze Assembly	Y	Y	N	N	PAH
LL6ss-076	Building 2F-19	Characterize an area not previously investigated, southeast of Building 2F-19 (1941-1945 – Booster Pellet Storage) across the perimeter road, within NPA.	Y	Y	N	N	PAH
LL6ss-078	Building 2F-31	Characterize an area not previously investigated, outside of the perimeter road southwest of Building 2F-31 (1941-1945 – Delay Loading), within NPA.	Y	Y	N	N	PAH
		QA/QC	Y	Y	N	N	PAH
		QA/QC	Y	Y	N	N	PAH
LL6ss-079	Building 2F-13	Characterize an area not previously investigated at Building 2F-13 (1941-1945 –Change House).	Y	Y	N	N	PAH

NPA = Non-production Area.
PAH = Polycyclic aromatic hydrocarbon.
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.
PCB = Polychlorinated biphenyl.
QA = Quality assurance.
QC = Quality control.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.

Table 4-10. Analytes Detected in PBA08 RI Discrete Surface Soil Samples

Aggregate		**Former Production Area**	**Former Production Area**	**Former Production Area**	**Former Production Area**	**Former Production Area**	**Former Production Area**	**Former Production Area**	**Former Production Area**	**Former Production Area**
Station		**LL6sb-069**	**LL6sb-070**	**LL6sb-071**	**LL6ss-073**	**LL6ss-074**	**LL6ss-076**	**LL6ss-078**	**LL6ss-078**	**LL6ss-079**
Sample ID		**LL6sb-069-5219-SO**	**LL6sb-070-5223-SO**	**LL6sb-071-5227-SO**	**LL6ss-073-5237-SO**	**LL6ss-074-5238-SO**	**LL6ss-076-5239-SO**	**LL6ss-078-6059-FD**	**LL6ss-078-5240-SO**	**LL6ss-079-5241-SO**
Date		**02/25/10**	**03/01/10**	**03/01/10**	**02/22/10**	**02/22/10**	**02/22/10**	**02/22/10**	**02/22/10**	**02/22/10**
Depth (ft)		**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**	**0.0-1.0**
Parameters Analyzed [a]	**Background Criteria** [b]	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**
Analyte										
Metals (mg/kg)										
Aluminum	17700	15100	13400	11700	2620	13600	16900	9660	12800	9330
Antimony	0.96	0.11 J	0.085 J	0.13 J	0.11 J	0.14 J	0.11 J	0.13 J	0.12 J	0.099 J
Arsenic	15.4	11.7	12.1 J	12.1 J	5.2	12.8	12.7	10.8	12.8	9.4
Barium	88.4	**142 ***	57.9	71.1	42.5	**117 ***	**153 ***	55.5	**103 ***	75.3
Beryllium	0.88	**0.9 ***	0.59	0.55	0.77	**0.94 ***	**1.3 ***	0.57	0.68	0.53
Cadmium	0	<0.1 UJ	**0.053 J***	**0.2 J***	<0.2 UJ	<0.26 U	<0.069 UJ	<0.15 UJ	<0.31 U	<0.17 UJ
Calcium	15800	4050 J	2090 J	14400 J	3860 J	3960 J	3400 J	1820 J	2630 J	7240 J
Chromium	17.4	**22.8 ***	14.8 J	15.9 J	10.8	**21.2 ***	**22.8 ***	13.9	16.6	14.2
Cobalt	10.4	**14.3 ***	7.6	**11.2 ***	7.6	**15.4 ***	**23.9 ***	10.3	**16.3 ***	9.2
Copper	17.7	**24.4 ***	7	17.5	6.8	**29.3 ***	**25.8 ***	14	15.7	15
Iron	23100	**30300 ***	**25400 ***	**25900 ***	**40200 ***	**30200 ***	**33900 ***	**23800 ***	**26100 ***	21000
Lead	26.1	12.2	14.2	20.1	12.6	23.8	17.2	20.7	18	13.1
Magnesium	3030	**5200 ***	1910 J	**4690 J***	787 J	**4960 J***	**5140 J***	2400 J	**3170 J***	**3250 J***
Manganese	1450	340	407	548	930	358	363	538	**1820 ***	408
Mercury	0.036	0.025 J	<0.03 UJ	<0.022 UJ	<0.12 U	0.029 J	0.027 J	**0.041 J***	**0.042 J***	**0.05 J***
Nickel	21.1	**46.6 ***	10	**23.7 ***	15	**37.8 ***	**37.1 ***	17.7	**26.2 ***	21.1
Potassium	927	**1760 J***	723	**1190 ***	430	**1650 ***	**1460 ***	748	**1060 ***	**1030 ***
Selenium	1.4	1.3	1.2	1.1	0.82	**1.5 ***	**1.8 ***	0.91	1.1	0.8
Silver	0	<0.034 UJ	**0.034 J***	**0.029 J***	<0.025 UJ	<0.037 UJ	<0.033 UJ	<0.029 UJ	<0.036 UJ	<0.026 UJ
Sodium	123	64.9 J	<44.1 UJ	<56.1 UJ	26.6 J	54 J	46.1 J	34.7 J	43.4 J	44.9 J
Thallium	0	**0.21 J***	**0.17 J***	**0.17 J***	**0.15 J***	**0.22 J***	**0.24 J***	**0.14 J***	**0.19 J***	**0.16 J***
Vanadium	31.1	25.3	30.6 J	19.8 J	12	23.8	27.1	20.1	22.1	16.7
Zinc	61.8	**65.6 ***	39.1	58	**64.7 ***	**74.9 ***	**64.8 ***	51.3	**63.8 ***	50.5
SVOCs (mg/kg)										
Acenaphthene	None	<0.062 U	<0.0083 U	<0.0087 U	<0.061 U	<0.0088 U	<0.0084 U	**0.01 ***	<0.0083 U	<0.0079 U
Anthracene	None	<0.062 U	<0.0083 U	<0.0087 U	<0.061 U	<0.0088 U	<0.0084 U	**0.031 ***	**0.017 ***	<0.0079 U
Benz(a)anthracene	None	<0.062 U	<0.0083 U	**0.013 ***	**0.031 J***	**0.014 ***	<0.0084 U	**0.096 ***	**0.059 ***	**0.012 ***
Benzo(a)pyrene	None	<0.062 U	<0.0083 U	**0.013 ***	**0.026 J***	**0.012 ***	<0.0084 U	**0.088 ***	**0.054 ***	**0.012 ***
Benzo(b)fluoranthene	None	<0.062 U	<0.0083 U	**0.018 ***	**0.044 J***	**0.018 ***	<0.0084 U	**0.13 ***	**0.078 ***	**0.018 ***
Benzo(ghi)perylene	None	<0.062 U	<0.0083 U	**0.0099 ***	**0.019 J***	<0.0088 U	<0.0084 U	**0.056 ***	**0.032 ***	**0.0079 ***
Benzo(k)fluoranthene	None	<0.062 U	<0.0083 U	<0.0087 U	**0.014 J***	<0.0088 U	<0.0084 U	**0.041 ***	**0.028 ***	<0.0079 U
Chrysene	None	<0.062 U	<0.0083 U	**0.011 ***	**0.035 J***	**0.013 ***	<0.0084 U	**0.099 ***	**0.062 ***	**0.014 ***
Dibenz(a,h)anthracene	None	<0.062 U	<0.0083 U	<0.0087 U	<0.061 U	<0.0088 U	<0.0084 U	**0.013 ***	<0.0083 U	<0.0079 U
Fluoranthene	None	<0.062 U	<0.0083 U	**0.02 ***	**0.076 ***	**0.029 ***	<0.0084 U	**0.28 ***	**0.16 ***	**0.028 ***
Indeno(1,2,3-cd)pyrene	None	<0.062 U	<0.0083 U	<0.0087 U	**0.015 J***	<0.0088 U	<0.0084 U	**0.05 ***	**0.03 ***	<0.0079 U
Phenanthrene	None	<0.062 U	<0.0083 U	**0.0093 ***	**0.027 J***	**0.012 ***	<0.0084 U	**0.12 ***	**0.069 ***	**0.012 ***
Pyrene	None	<0.062 U	<0.0083 U	**0.017 ***	**0.051 J***	**0.021 ***	<0.0084 U	**0.19 ***	**0.12 ***	**0.021 ***
VOCs (mg/kg)										
Methylene chloride	None	<0.0062 UJ	NR	NR	**0.002 J***	NR	NR	NR	NR	NR
Toluene	None	<0.0062 UJ	NR	NR	**0.00035 J***	NR	NR	NR	NR	NR

Table 4-10. Analytes Detected in PBA08 RI Discrete Surface Soil Samples (continued)

Aggregate		**Non-Production Area**	**Non-Production Area**	**Non-Production Area**
Station		**LL6sb-068**	**LL6sb-083**	**LL6sd-081**
Sample ID		**LL6sb-068-5215-SO**	**LL6sb-083-5233-SO**	**LL6sd-081-5243-SD**
Date		**03/01/10**	**02/25/10**	**02/18/10**
Depth (ft)		**0.0-1.0**	**0.0-1.0**	**0.0-0.5**
Parameters Analyzed [a]		**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives**
Analyte	**Background Criteria** [b]			
Metals (mg/kg)				
Aluminum	17700	6000	11900	16300
Antimony	0.96	0.097 J	<0.68 R	0.48 J
Arsenic	15.4	7.2 J	10.1	**31.1 ***
Barium	88.4	43.3	47.3	**109 ***
Beryllium	0.88	0.39	0.45	**1.1 J***
Cadmium	0	**0.13 J***	<0.058 UJ	**2.4 ***
Calcium	15800	2010 J	293 J	5160 J
Chromium	17.4	8.9 J	13.5	**26.7 ***
Cobalt	10.4	5.8	**12.4 ***	**10.9 J***
Copper	17.7	9.7	5.9	**85.4 ***
Iron	23100	17400	**26000 ***	**27200 ***
Lead	26.1	16.9	14.2	**117 J***
Magnesium	3030	1540 J	1360	**3160 ***
Manganese	1450	373	558	447
Mercury	0.036	<0.019 UJ	<0.14 U	**0.14 J***
Nickel	21.1	11.6	8.4	**26.8 ***
Potassium	927	613	475 J	**1400 ***
Selenium	1.4	0.87	0.85	**2.2 ***
Silver	0	**0.019 J***	<0.035 UJ	**0.3 J***
Sodium	123	<30.1 UJ	28.4 J	72.6 J
Thallium	0	**0.1 J***	**0.14 J***	**0.32 J***
Vanadium	31.1	12 J	25.8	28
Zinc	61.8	41.4	34.6	**641 ***
SVOCs (mg/kg)				
Acenaphthene	None	<0.008 U	<0.009 U	NR
Anthracene	None	**0.015 ***	<0.009 U	NR
Benz(a)anthracene	None	**0.072 ***	<0.009 U	NR
Benzo(a)pyrene	None	**0.055 ***	<0.009 U	NR
Benzo(b)fluoranthene	None	**0.078 ***	<0.009 U	NR
Benzo(ghi)perylene	None	**0.038 ***	<0.009 U	NR
Benzo(k)fluoranthene	None	**0.041 ***	<0.009 U	NR
Chrysene	None	**0.074 ***	<0.009 U	NR
Dibenz(a,h)anthracene	None	<0.008 U	<0.009 U	NR
Fluoranthene	None	**0.14 ***	<0.009 U	NR
Indeno(1,2,3-cd)pyrene	None	**0.029 ***	<0.009 U	NR
Phenanthrene	None	**0.054 ***	<0.009 U	NR
Pyrene	None	**0.12 ***	<0.009 U	NR
VOCs (mg/kg)				
Methylene chloride	None	NR	NR	NR
Toluene	None	NR	NR	NR

[a] Only detected SRCs are presented in the table.

[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

ID = Identification.
ft = Feet.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
NR = Not reported/not analyzed.
RVAAP = Ravenna Army Ammunition Plant.
SRC = Site-related contaminant.
SVOC = Semi-volatile organic compound.
TAL = Target analyte list.
U= Not detected.
UJ = Not detected, reporting limit estimated.
VOC = Volatile organic compound.
*** = Result exceeds background criteria or no background criteria was available.**
< = Less than.

Table 4-11. Chromium Speciation Samples Under PBA08 RI

PBA08 RI Location	Rationale for Sample Selection
LL6ss-075	Discrete sample collected to assess chromium speciation. Previous chromium result represents elevated chromium concentration (LL6ss-004 at 21 mg/kg) (Building 2F-34, Primer Storage).
LL6ss-077	Discrete sample collected to assess chromium speciation. Previous chromium result represents elevated chromium concentration (LL6ss-029 at 25 mg/kg) (south of Shaped Charge Test Chamber).
LL6ss-080	Discrete sample collected to assess chromium speciation. Previous chromium result represents near background chromium concentration (LL6ss-012 at 18 mg/kg) (Building 2F-15, Paint Storage).

mg/kg = Milligrams per kilogram.
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.

Table 4-12. PBA08 RI Subsurface Soil Rationale and Analyses

PBA08 RI Location	Comments/Rationale	Sample Type	Depth ft (bgs)	Analyses Performed				
				Metals	Explosives	VOCs	Pesticides/ PCBs	SVOC
LL6sb-068	Define vertical extent of previously identified manganese contamination in LL6ss-032 (north of Suspected Test Range)	Discrete	0-1	Y	Y	N	N	PAH
		Discrete	1-4	Y	Y	N	N	PAH
		Discrete	4-7	Y	Y	N	N	PAH
		NS	7-13	Y	Y	N	N	PAH
LL6sb-069	Delineated vertical extent of previously identified PAH contamination in sample LL6sb-024 (Building 2F-12, Fuze Testing from 1941-1945) and arsenic contamination in nearby ditch sample LL6sd-012. Analyzed for RVAAP full-suite analytes.	Discrete	0-1	Y	Y	Y	Y	Y
		Discrete	1-4	Y	Y	Y	Y	Y
		Discrete	4-7	Y	Y	Y	Y	Y
		Discrete[a]	7-13	Y	Y	Y	Y	Y
LL6sb-070	Delineated vertical extent of previously identified arsenic contamination in LL6sb-013 (Building 2F-9, Primer Dry House from 1941-1945)	Discrete	0-1	Y	Y	N	N	PAH
		Discrete	1-4	Y	Y	N	N	PAH
		Discrete	4-7	Y	Y	N	N	PAH
		NS	7-13	N	N	N	N	N
LL6sb-071	Delineated vertical extent of previously identified metals contamination in LLss-010, LL6ss-033, and LL6ss-033 (west side of 2F-11, Fuze Assembly from 1941-1945)	Discrete	0-1	Y	Y	N	N	PAH
		Discrete	1-4	Y	Y	N	N	PAH
		Discrete	4-7	Y	Y	N	N	PAH
		NS	7-13	Y	Y	N	N	PAH
	QA/QC	Discrete	1-4	Y	Y	N	N	PAH
		Discrete	1-4	Y	Y	N	N	PAH
		Discrete	4-7	Y	Y	N	N	PAH
		Discrete	4-7	Y	Y	N	N	PAH
LL6sb-072	Geotechnical (west side of 2F-11, Fuze Assembly from 1941-1945)	Discrete	4-5	N	N	N	N	N
		Discrete	9-10.5	N	N	N	N	N

Table 4-12. PBA08 RI Subsurface Soil Rationale and Analyses (continued)

PBA08 RI Location	Comments/Rationale	Sample Type	Depth ft (bgs)	Analyses Performed Metals	Explosives	VOCs	Pesticides/ PCBs	SVOC
LL6sb-083	Delineated vertical extent of previously identified metals contamination in LL6ss-029 (south of Shaped Charge Test Chamber, outside perimeter fence). Boring terminated at 5.5 ft bgs due to bedrock refusal.	Discrete	0-1	Y	Y	N	N	PAH
		Discrete	1-4	Y	Y	N	N	PAH
		Discrete	4-5.5	Y	Y	N	N	PAH
		NS	7-13	N	N	N	N	N

[a] One sample (10%) from 7-13 ft bgs was submitted for laboratory analysis to characterize subsurface soil to 13 ft bgs.
bgs = Below ground surface.
NS = Sample not collected due to refusal.
PAH = Polycyclic aromatic hydrocarbon.
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.
PCB = Polychlorinated biphenyl.
ft = Feet.
QA = Quality assurance.
QC = Quality control.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.

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Table 4-13. Analytes Detected in PBA08 RI Subsurface Soil Samples

Aggregate		**Former Production Area**	**Former Production Area**	**Former Production Area**	**Former Production Area**	**Former Production Area**	**Former Production Area**	**Former Production Area**	**Former Production Area**	**Former Production Area**
Station		**LL6sb-069**	**LL6sb-069**	**LL6sb-069**	**LL6sb-070**	**LL6sb-070**	**LL6sb-071**	**LL6sb-071**	**LL6sb-071**	**LL6sb-071**
Sample ID		**LL6sb-069-5220-SO**	**LL6sb-069-5221-SO**	**LL6sb-069-5222-SO**	**LL6sb-070-5224-SO**	**LL6sb-070-5225-SO**	**LL6sb-071-6068-FD**	**LL6sb-071-5228-SO**	**LL6sb-071-6069-FD**	**LL6sb-071-5229-SO**
Date		**02/25/10**	**02/25/10**	**02/25/10**	**03/01/10**	**03/01/10**	**03/01/10**	**03/01/10**	**03/01/10**	**03/01/10**
Depth (ft)		**1.0-4.0**	**4.0-7.0**	**7.0-13.0**	**1.0-4.0**	**4.0-7.0**	**1.0-4.0**	**1.0-4.0**	**4.0-7.0**	**4.0-7.0**
Parameters Analyzed[a]	**Background Criteria**[b]	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**
Analyte										
					Metals (mg/kg)					
Aluminum	19500	14300	5480	6470	13700	6950	12600	14700	12900	10600
Antimony	0.96	<0.59 R	0.099 J	<0.61 R	0.094 J	<0.61 U	<0.6 UJ	<0.6 UJ	<0.59 UJ	<0.59 U
Arsenic	19.8	10.7	14.1	13.5	11.5 J	15.4	12.8 J	11.1 J	10.1 J	10.2
Barium	124	92	24.6	21.6	99.2	48	68.2	67.9	76.1	75.8
Beryllium	0.88	0.7	0.3	0.32	0.84	0.39	0.59	0.66	0.6	0.6
Cadmium	0	<0.078 UJ	**0.062 J***	<0.042 UJ	**0.039 J***	**0.058 J***	**0.049 J***	**0.058 J***	**0.06 J***	**0.07 J***
Calcium	35500	**36600 J***	6990	7760	1880 J	7950	11500 J	19900 J	**37200 J***	35000
Chromium	27.2	19.8	9.1	10.4	17.7 J	11.4	16.8 J	18.5 J	19.2 J	19.7
Cobalt	23.2	12.2	7.6	8.4	9.6	8.4	10.2	10.5	12.4	10.9
Copper	32.3	18.5	24.6	18.1	19.6	16.8	19.4	18.7	18.5	18.6
Iron	35200	27000	19600	22400	28200	23000	27100	26100	26300	27400
Lead	19.1	10.7	9.3	10.1	11	11.1	13	12	11	11.3
Magnesium	8790	6900	3050	4420	3710 J	4370	4870 J	6030 J	7480 J	7800
Manganese	3030	357	462	338	219	625	266	311	428	362
Mercury	0.044	<0.12 U	<0.11 U	<0.12 U	<0.038 UJ	<0.12 U	<0.12 U	<0.026 UJ	<0.018 UJ	<0.12 U
Nickel	60.7	29.7	19	19.6	25.6	20.6	24.4	24.5	31.4	29.1
Potassium	3350	1970 J	785	977	1010	819	1170	2010	1910	1900
Selenium	1.5	1.1	0.57	0.63 J	**1.8 ***	1	1.2	1	1	1.1
Silver	0	<0.017 UJ	**0.018 J***	<0.018 UJ	**0.019 J***	**0.034 J***	**0.023 J***	**0.018 J***	**0.021 J***	**0.022 J***
Sodium	145	79.5 J	39.2 J	45.7 J	<66.1 UJ	<56.8 UJ	<57.3 UJ	<76.2 UJ	<79.3 UJ	<80.2 UJ
Thallium	0.91	0.19 J	0.13 J	0.11 J	0.15 J	0.14 J	0.16 J	0.17 J	0.2 J	0.2 J
Vanadium	37.6	23	9.9	11.1	21.7 J	12.3	19.8 J	22.3 J	21 J	20.9
Zinc	93.3	52.6	62.8	56.6	54.7	45.9	63.7	58	51.7	53.3
					VOCs (mg/kg)					
Acetone	None	<0.024 U	<0.023 U	**0.011 J***	NR	NR	NR	NR	NR	NR
Toluene	None	<0.0059 U	**0.0004 J***	<0.0061 UJ	NR	NR	NR	NR	NR	NR

Table 4-13. Analytes Detected in PBA08 RI Subsurface Soil Samples (continued)

Aggregate		**Non-Production Area**	**Non-Production Area**	**Non-Production Area**	**Non-Production Area**
Station		**LL6sb-068**	**LL6sb-068**	**LL6sb-083**	**LL6sb-083**
Sample ID		**LL6sb-068-5216-SO**	**LL6sb-068-5217-SO**	**LL6sb-083-5234-SO**	**LL6sb-083-5235-SO**
Date		**03/01/10**	**03/01/10**	**02/25/10**	**02/25/10**
Depth (ft)		**1.0-4.0**	**4.0-7.0**	**1.0-4.0**	**4.0-5.5**
Parameters Analyzed [a]					
Analyte	**Background Criteria [b]**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**
Metals (mg/kg)					
Aluminum	19500	12900	13200	18600	13000
Antimony	0.96	0.077 J	0.083 J	<0.68 R	<0.65 R
Arsenic	19.8	9.9 J	18.9	13.5	14
Barium	124	50.7	96.3	124	78.1
Beryllium	0.88	0.53	**1.3 ***	**0.97 ***	0.68
Cadmium	0	**0.056 J***	**0.064 J***	<0.055 UJ	<0.055 UJ
Calcium	35500	1970 J	2230	2530 J	6100 J
Chromium	27.2	14.9 J	19.7	22.4	18.2
Cobalt	23.2	9.2	11.6	17.5	13.4
Copper	32.3	12.9	20.4	22.2	20.8
Iron	35200	23100	27900	30300	29700
Lead	19.1	13	12.3	14.4	14.1
Magnesium	8790	2920 J	4100	4980	4590
Manganese	3030	383	346	458	595
Mercury	0.044	<0.039 UJ	<0.026 UJ	<0.14 U	0.021 J
Nickel	60.7	17.5	34.7	36.7	30.6
Potassium	3350	867	1590	1840 J	1430 J
Selenium	1.5	0.98	**2.4 ***	**1.6 ***	1.4
Silver	0	**0.027 J***	**0.02 J***	<0.03 UJ	<0.023 UJ
Sodium	145	<39.2 UJ	<90.6 UJ	86.4 J	67.5 J
Thallium	0.91	0.17 J	0.19 J	0.2 J	0.16 J
Vanadium	37.6	21.5 J	22.3	25.1	21.8
Zinc	93.3	49.6	61.5	68.6	55.6
VOCs (mg/kg)					
Acetone	None	NR	NR	NR	NR
Toluene	None	NR	NR	NR	NR

[a] Only detected SRCs are presented in the table.
[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).
ft = Feet.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
NR = Not reported/not analyzed.
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.
R = Rejected result.
RVAAP = Ravenna Army Ammunition Plant.
SRC = Site-related contaminant.
SVOC = Semi-volatile organic compound.
TAL = Target analyte list.
U = Non-detectable concentration.
UJ = Not detected, reporting limit estimated.
VOC = Volatile organic compound.
*** = Result exceeds background criteria or no background criteria was available.**
< = less than

Table 4-14. PBA08 RI Surface Water and Sediment Samples and Rationales

PBA08 RI Location	Targeted Area	Comments/Rationale	Sample Type	Depth ft (bgs)	Analyses Performed				
					Metals	**Explosives**	**VOCs**	**Pesticides/ PCBs**	**SVOC**
LL6sw-081	Drainage ditch North of AOC	Characterize current conditions and potential exit pathways in northern ditch (East of Building 1101, Fire Station No. 3) draining the AOC. Previously identified metals contamination in LL6sd-004 and LL6sw-004. The associated sediment sample was reclassified as surface soil since no perennial water is present at the location (i.e., transient drainage).	Discrete	N/A	Y	Y	N	N	PAH
LL6sd-081			Composite	0.0 - 0.5	Y	Y	N	N	PAH
LL6sw-082	Drainage Ditch South of AOC	Characterize current conditions and potential exit pathways in stream exiting the AOC to the south.	Discrete	N/A	Y	Y	N	N	PAH
LL6sd-082			Composite	0.0 - 0.5	Y	Y	Y	Y	Y
		QA/QC.	Composite	0.0 - 0.5	Y	Y	Y	Y	Y
		QA/QC.	Composite	0.0 - 0.5	Y	Y	Y	Y	Y
LL6sw-084	Shaped Charge Former Test Pond	Characterize pond previously used for underwater explosive testing.	Discrete	N/A	Y	Y	N	N	PAH
LL6sd-084			Composite	0.0 - 0.5	Y	Y	N	N	PAH
LL6sw-096	Shaped Charge Former Test Pond	Characterize pond previously used for underwater explosive testing	Discrete	N/A	Y	Y	Y	Y	Y
LL6sd-096			Composite	0.0 - 0.5	Y	Y	Y	Y	Y
FWSsw-101	Off-AOC	Characterize current conditions and potential exit pathways from the Fuze and Booster Hill area and provide data for nature and extent (south of Load Line 6).	Discrete	N/A	Y	Y	Y	Y	Y
FWSsd-101			Composite	0.0 - 0.5	Y	Y	Y	Y	Y
FWSsw-103	Off-AOC	Characterize current conditions and potential exit pathways from the Fuze and Booster Hill area and provide data for nature and extent (southeast of Load Line 6).	Discrete	N/A	Y	Y	Y	Y	Y
FWSsd-103			Composite	0.0 - 0.5	Y	Y	Y	Y	Y

AOC = Area of concern.
bgs = Below ground surface.
ft = Feet.
N/A = Not applicable.
PAH = Polycyclic aromatic hydrocarbon.
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.
PCB = Polychlorinated biphenyl.
QA = Quality assurance.
QC = Quality control.
SVOC= Semi-volatile organic compound.
VOC = Volatile organic compound.

Table 4-15. Analytes Detected in PBA08 RI Surface Water Samples

Aggregate		**Drainage Ditches**	**Drainage Ditches**	**Former Test Pond**	**Off AOC**	**Off AOC**
Sample location		**LL6sw-081**	**LL6sw-082**	**LL6sw-084**	**FWSsw-101**	**FWSsw-103**
Sample ID		**LL6sw-081-5242-SW**	**LL6sw-082-5244-SW**	**LL6sw-084-5794-SW**	**FWSsw-101-5008-SW**	**FWSsw-103-5012-SW**
Date		**03/02/10**	**02/17/10**	**04/01/10**	**02/25/10**	**02/18/10**
Parameters Analyzed [a]	**Background Criteria [b]**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**
Analyte						
Metals (mg/L)						
Aluminum	3.37	1.18	**6.04 ***	0.201	0.348	0.186 J
Antimony	0	<0.005 U	**0.00026 J***	**0.00029 J***	<0.005 U	<0.005 U
Arsenic	0.0032	0.00093 J	0.0032 J	0.00081 J	<0.005 U	<0.005 U
Barium	0.0475	0.0221	**0.0667 ***	0.0099 J	0.0224	0.024
Beryllium	0	<0.001 U	**0.00042 J***	<0.001 U	<0.001 U	<0.001 U
Cadmium	0	**0.00014 J***	**0.0004 J***	<0.002 U	**0.00003 J***	<0.002 U
Calcium	41.4	**49.2 ***	13.2	20.4	15.6	38.5
Chromium	0	**0.0028 J***	**0.007 ***	<0.005 U	<0.005 U	<0.005 U
Cobalt	0	**0.00026 J***	**0.0072 ***	**0.00009 J***	**0.00014 J***	**0.00011 J***
Copper	0.0079	0.0032 J	**0.0123 ***	0.0024 J	0.0014 J	<0.005 U
Iron	2.56	1.14	**8.42 ***	1.04	0.48	0.195
Lead	0	**0.00094 J***	**0.0107 ***	**0.00028 J***	**0.00028 J***	<0.003 U
Magnesium	10.8	5.7	3.33	3.8	4.02	**12.8 ***
Manganese	0.391	0.0287	**0.566 ***	0.133	0.033	0.0733
Nickel	0	**0.0014 J***	**0.0111 ***	<0.01 U	**0.0016 J***	**0.00063 J***
Potassium	3.17	1.39	2.66	2.76	1.12	1.04
Selenium	0	**0.00036 J***	**0.00061 J***	<0.005 U	**0.00028 J***	**0.00022 J***
Sodium	21.3	1.43	1.23	0.582 J	1.93	4.28
Vanadium	0	**0.002 J***	**0.0107 ***	<0.01 U	<0.01 U	<0.01 U
Zinc	0.042	**0.0782 ***	**0.0954 ***	<0.04 U	<0.04 U	<0.04 U
Explosives (mg/L)						
HMX	None	<0.00015 U	**0.00008 J***	**0.00006 J***	**0.00009 J***	**0.00028 ***
Nitrocellulose	None	<0.5 U	**0.24 J***	<0.5 U	<0.5 U	<0.5 U
RDX	None	<0.00025 U	<0.00026 U	<0.00024 U	<0.00025 U	**0.00053 ***
Pesticides (mg/L)						
beta-BHC	None	<0.00005 U	<0.00005 U	**0.00004 J***	<0.00005 U	<0.00005 U
gamma-Chlordane	None	<0.00005 U	<0.00005 U	<0.0001 U	**0.00005 J***	<0.00005 U

[a] Only detected SRCs are presented in the table.
[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).
AOC = Area of concern
Beta-BHC = Beta-hexachlorocyclohexane.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane.
ID = Identification.
J = Estimated value less than reporting limits.
mg/L = Milligrams per liter.
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RVAAP = Ravenna Army Ammunition Plant.
*** = Result exceeds background criteria or no background criteria was available.**

Table 4-16. Analytes Detected in PBA08 RI Sediment Samples

Aggregate		**Drainage Ditches**	**Drainage Ditches**	**Former Test Pond**	**Off AOC**	**Off AOC**
Sample location		**LL6sd-082**	**LL6sd-082**	**LL6sd-084**	**FWSsd-101**	**FWSsd-103**
Sample ID		**LL6sd-082-6063-FD**	**LL6sd-082-5245-SD**	**LL6sd-084-5795-SD**	**FWSsd-101-5009-SD**	**FWSsd-103-5013-SD**
Date		**02/17/10**	**02/17/10**	**04/01/10**	**02/25/10**	**02/18/10**
Depth (ft)		**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**
Parameters Analyzed[a]	**Background Criteria**[b]	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**
Analyte						
Metals (mg/kg)						
Aluminum	13900	5210	7610	13300 J	4150	8670
Antimony	0	**0.13 J***	**0.091 J***	**1.7 J***	<0.69 R	<0.61 UJ
Arsenic	19.5	3.4	9.6	8.9	2.6	15.4
Barium	123	62.9	57.4	70.8	40.6	56.4
Beryllium	0.38	**0.54 ***	**0.55 ***	**0.65 J***	**0.4 ***	**0.52 J***
Cadmium	0	**0.69 ***	<0.19 UJ	**0.88 J***	<0.097 UJ	**0.078 J***
Calcium	5510	934	852	3710	782 J	1190 J
Chromium	18.1	9.7	12.4	18 J	5.7	13.1
Cobalt	9.1	8.9	**12.8 ***	**11.7 ***	3.3	**10.2 J***
Copper	27.6	18.9	15	**91.7 J***	4.4	15
Iron	28200	11600	28100	23300	6220	24400
Lead	27.4	26.7	14.8	**55.2 ***	6.2	11 J
Magnesium	2760	929	2140	**2970 ***	695	2610
Manganese	1950	460	776	327	171	892
Mercury	0.059	**0.064 J***	0.039 J	<0.89 U	<0.14 U	<0.12 U
Nickel	17.7	10.3	**19 ***	**22.8 ***	7.9	**22.1 ***
Potassium	1950	489	881	1670	318 J	1260
Selenium	1.7	0.68 J	0.97	1.4 J	1.1	0.78
Silver	0	<0.054 UJ	<0.015 UJ	**0.21 J***	<0.026 UJ	**0.042 J***
Sodium	112	36.7 J	32.1 J	**148 J***	23.7 J	50.6 J
Thallium	0.89	<0.33 U	0.095 J	<1.8 U	<0.28 U	0.13 J
Vanadium	26.1	12.8	13.9	22.9	8.3	14.1
Zinc	532	106	72.9	93.1	30.7	51.5
Explosives (mg/kg)						
Tetryl	None	<0.24 U	<0.24 U	**0.031 J***	<0.25 U	<0.25 U
SVOCs (mg/kg)						
Fluoranthene	None	**0.015 J***	<0.07 U	NR	<0.069 U	<0.061 U
VOCs (mg/kg)						
Toluene	None	**0.00054 J***	<0.007 U	NR	<0.0069 UJ	**0.00041 J***

[a] Only detected SRCs are presented in the table.
[b] Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (USACE 2001b).
AOC = Area of concern.
ft = Feet.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
NR = Not reported/not analyzed.
RVAAP = Ravenna Army Ammunition Plant.
SVOC= Semi-volatile organic compound.
TAL = Target analyte list.
U = Not detected.
UJ = Not detected, reporting limit estimated.
VOC = Volatile organic compound.
* = Result exceeds background criteria or no background criteria was available.
< = Less than

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Table 4-17. Changes from the PBA08 RI Sample and Analysis Plan

Location	Affected Sample	Date Sampled	Change/Rationale
LL6sw-081	LL6SW-081-5242-SW	3/2/2010	Location had no water when originally sampled on 2/18/2010, but after significant snow melt and rainfall, a sufficient volume of water accumulated to sample.
LL6sw-084	LL6SW-084-5794-SW	4/1/2010	Location was added in order to characterize a pond previously used for underwater explosives testing.
LL6sd-084	LL6SD-084-5795-SD	4/1/2010	
LL6sw-096	LL6sw-096-5871-SW	08/09/2012	Sample was collected to provide further analysis of constituents in the Former Test Pond.
LL6sd-096	LL6sd-096-5870-SD	08/09/2012	Sample was collected to provide further analysis of constituents in the Former Test Pond.

PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.

Table 4-18. Analytes Detected in 2011/2012 Former Test Pond Surface Water Sample

Aggregate	**Background Criteria [b]**	**Former Test Pond**	**Former Test Pond**
Sample location		**FTFsw-001**	**LL6sw-096**
Sample ID		**FTFsw-001-0001-SW**	**LL6sw-096-5871-SW**
Date		**05/05/11**	**08/09/12**
Parameters Analyzed [a]		**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**
Analyte			
Metals (mg/L)			
Aluminum	3.37	0.639	<0.06 U
Antimony	0	<0.032 U	**0.00045 J***
Arsenic	0.0032	NR	0.0012 J
Barium	0.0475	0.0155	0.013
Calcium	41.4	NR	26
Chromium	0	**0.0013 J***	<0.0015 U
Cobalt	0	**0.0108 ***	<0.004 U
Copper	0.0079	1.67	0.17
Iron	2.56	**0.0028 J***	<0.0005 U
Lead	0	NR	5
Magnesium	10.8	NR	0.034
Manganese	0.391	NR	1.5
Potassium	3.17	NR	**0.00032 J***
Selenium	0	NR	0.52 J
Sodium	21.3	**0.0425 ***	NR
Strontium	None	NR	**0.00035 J***
Thallium	0	0.0062 J	<0.02 U
Zinc	0.042	**0.0013 J***	<0.0015 U
SVOCs (mg/L)			
Bis(2-ethylhexyl)phthalate	None	<0.0031 U	**0.0009 J***
Di-n-butyl phthalate	None	**0.00075 J***	<0.00076 UJ
Pesticides (mg/L)			
4,4'-DDT	None	**0.00002 J***	<0.00003 U
VOCs (mg/L)			
2-Butanone	None	<0.01 U	**0.00072 J***

[a] Only detected SRCs are presented in the table.

[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

AOC = Area of concern

Beta-BHC = Beta-hexachlorocyclohexane.

DDT = Dichlorodiphenyltrichloroethane

HMX = Octahydro-1,3,5,7-tetranitroi-1,3,5,7-tetrazocane.

ID = Identification.

J = Estimated value less than reporting limits.

mg/L = Milligrams per liter.

PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.

RVAAP = Ravenna Army Ammunition Plant.

*** = Result exceeds background criteria or no background criteria was available.**

Table 4-19. Analytes Detected in 2011/2012 Former Test Pond Sediment Sample

Aggregate		**Former Test Pond**	**Former Test Pond**	**Former Test Pond**
Sample location		**FTFsd-002-SD**	**FTFsd-003-SD**	**LL6sd-096**
Sample ID		**FTFsd-002-SD**	**FTFsd-003-SD**	**LL6sd-096-5870-SD**
Date		**08/08/11**	**08/08/11**	**08/09/12**
Parameters Analyzed [a]	**Background Criteria** [b]			
Analyte		**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**
Metals (mg/kg)				
Aluminum	13900	**14700 ***	12600	12000
Antimony	0	**0.72 J***	**0.98 J***	**0.37 ***
Arsenic	19.5	NR	NR	3.5
Barium	123	65.6	60.9	53
Beryllium	0.38	NR	NR	**0.51 ***
Cadmium	0	**0.21 ***	**0.16 ***	**0.075 J***
Calcium	5510	1620	1750	1300
Chromium	18.1	18	15.2	15
Cobalt	9.1	NR	NR	5.9
Copper	27.6	**50 ***	**34.3 ***	25
Iron	28200	23700	18100	18000
Lead	27.4	24.3	**48.2 ***	27
Magnesium	2760	2720	2160	2100
Manganese	1950	232	217	160
Mercury	0.059	0.033	0.029	<0.045 U
Nickel	17.7	NR	NR	13
Potassium	1950	NR	NR	930
Selenium	1.7	NR	NR	0.87
Silver	0	NR	NR	**0.037 J***
Sodium	112	NR	NR	24 J
Strontium		**8.7 ***	**8 ***	NR
Thallium	0.89	NR	NR	0.15 J
Vanadium	26.1	NR	NR	**27 ***
Zinc	532	47.2	39.8	37
SVOCs (mg/kg)				
Fluoranthene	None	NR	NR	**0.0098 J***
VOCs (mg/kg)				
2-Butanone	None	NR	NR	**0.0053 J***
Methylene chloride	None	NR	NR	**0.0023 J***

[a] Only detected SRCs are presented in the table.

[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

AOC = Area of concern
ID = Identification.
J = Estimated value less than reporting limits.
mg/L = Milligrams per liter.
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.
RVAAP = Ravenna Army Ammunition Plant.
*** = Result exceeds background criteria or no background criteria was available.**

Table 4-20. Analytes Detected in 2011 ISM Surface Soil at Load Line 6 Former Test Pond

Aggregate	**Background Criteria** [b]	**Former Test Pond**	**Former Test Pond**
Sample location		**FTFss-004(I)**	**FTFss-004(I)**
Sample ID		**FTFss-005(I)-0001-SS**	**FTFss-004(I)-0001-SS**
Date		**08/12/11**	**08/12/11**
Parameters Analyzed [a]			
Analyte		**0.0 - 0.5**	**0.0 - 0.5**
Metals (mg/kg)			
Aluminum	17700	10300	9630
Antimony	0.96	**1.5 ***	**1.5 ***
Barium	88.4	78.9	87.6
Cadmium	0	**0.22 ***	**0.25 ***
Calcium	15800	3920	1860
Chromium	17.4	**156 ***	**147 J***
Copper	17.7	**58.5 ***	**56.7 J***
Iron	23100	17300	17900 J
Lead	26.1	20.5	20.4
Magnesium	3030	2150	1680
Manganese	1450	827	1300 J
Mercury	0.036	0.034	0.033
Strontium		**11.7 ***	**7.9 ***
Zinc	61.8	50.4	50.4 J

[a] Only detected SRCs are presented in the table.

[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

AOC = Area of concern

ID = Identification.

J = Estimated value less than reporting limits.

mg/L = Milligrams per liter.

RVAAP = Ravenna Army Ammunition Plant.

*** = Result exceeds background criteria or no background criteria was available.**

Table 4-21. RVAAP Background Concentrations

Chemical	Surface Soil (mg/kg)	Subsurface soil (mg/kg)	Sediment (mg/kg)	Surface Water (mg/L)	Groundwater-Unconsolidated (mg/L)		Groundwater-Bedrock (mg/L)	
					Filtered	Unfiltered	Filtered	Unfiltered
Aluminum	17700	19500	13900	3.37	NA	48	NA	9.41
Antimony	0.96	0.96	0	0	0	0.0043	0	0
Arsenic	15.4	19.8	19.5	0.0032	0.0117	0.215	0	0.0191
Barium	88.4	124	123	0.0475	0.0821	0.327	0.256	0.241
Beryllium	0.88	0.88	0.38	0	0	0	0	0
Cadmium	0	0	0	0	0	0	0	0
Calcium	15800	35500	5510	41.4	115	194	53.1	48.2
Chromium	17.4	27.2	18.1	0	0.0073	0.0852	0	0.0195
Cobalt	10.4	23.2	9.1	0	0	0.0463	0	0
Copper	17.7	32.3	27.6	0.0079	0	0.289	0	0.017
Cyanide	0	0	0	0	0	0	0	0
Iron	23100	35200	28200	2.56	0.279	195	1.43	21.5
Lead	26.1	19.1	27.4	0	0	0.183	0	0.023
Magnesium	3030	8790	2760	10.8	43.3	58.4	15	13.7
Manganese	1450	3030	1950	0.391	1.02	2.86	1.34	1.26
Mercury	0.036	0.044	0.059	0	0	0.00025	0	0
Nickel	21.1	60.7	17.7	0	0	0.117	0.0834	0.0853
Potassium	927	3350	1950	3.17	2.89	7.48	5.77	6.06
Selenium	1.4	1.5	1.7	0	0	0.0057	0	0
Silver	0	0	0	0	0	0	0	0
Sodium	123	145	112	21.3	45.7	44.7	51.4	49.7
Thallium	0	0.91	0.89	0	0	0.0024	0	0
Vanadium	31.1	37.6	26.1	0	0	0.0981	0	0.0155
Zinc	61.8	93.3	532	0.042	0.0609	0.888	0.0523	0.193

mg/kg = Milligrams per kilogram.
mg/L = Milligrams per liter.
NA = Not available. Aluminum results were rejected in validation.

Table 4-22. Recommended Dietary Allowances/Reference Daily Intake Values

Essential Human Nutrient	USDA RDA/RDI[a] Value
Calcium	1000 mg/d
Chloride[b]	3400 mg/d
Iodine	150 µg/d
Iron	8 mg/d
Magnesium	400 mg/d
Potassium[b]	4700 mg/d
Phosphorous	700 mg/d
Sodium[b]	2300 mg/d

[a] Dietary reference intakes vary by gender and age, values present are for life stage group: Males 19-30 years.
[b] Adequate Intake Value.
mg/d = Milligrams per day.
RDA= Recommended dietary allowance.
RDI= Reference daily intake.
µg/d = Micrograms per day.
USDA = U.S. Department of Agriculture.
Source = Values were obtained from http://fnic.nal.usda.gov charts.

Table 4-23. SRC Screening Summary for Former Production Area Surface Soil

Analyte	CAS Number	Freq of Detect	Minimum Detect (mg/kg)	Maximum Detect (mg/kg)	Average Result (mg/kg)	Background Criteria[a] (mg/kg)	SRC? (yes/no)	SRC Justification
Metals								
Aluminum	7429-90-5	44/44	1990	17000	11300	17700	No	Below background
Antimony	7440-36-0	9/44	0.085	0.3	0.226	0.96	No	Below background
Arsenic	**7440-38-2**	**44/44**	**3.2**	**41**	**11.7**	**15.4**	**Yes**	**Exceeds background**
Barium	**7440-39-3**	**44/44**	**30**	**153**	**75.1**	**88.4**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**44/44**	**0.2**	**1.3**	**0.592**	**0.88**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**14/44**	**0.053**	**6.8**	**0.336**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	44/44	890	184000	15800	15800	No	Essential nutrient
Chromium	**7440-47-3**	**44/44**	**5.8**	**23**	**15.7**	**17.4**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**44/44**	**3.6**	**23.9**	**9.27**	**10.4**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**44/44**	**6.8**	**627**	**34.9**	**17.7**	**Yes**	**Exceeds background**
Iron	7439-89-6	44/44	9940	40200	23300	23100	No	Essential nutrient
Lead	**7439-92-1**	**44/44**	**8.1**	**180**	**33.5**	**26.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	44/44	787	7600	3160	3030	No	Essential nutrient
Manganese	**7439-96-5**	**44/44**	**120**	**1820**	**453**	**1450**	**Yes**	**Exceeds background**
Mercury	**7439-97-6**	**40/44**	**0.013**	**0.6**	**0.0548**	**0.036**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**44/44**	**10**	**46.6**	**20.4**	**21.1**	**Yes**	**Exceeds background**
Potassium	7440-09-7	44/44	430	2800	1220	927	No	Essential nutrient
Selenium	**7782-49-2**	**20/44**	**0.45**	**1.8**	**0.556**	**1.4**	**Yes**	**Exceeds background**
Silver	7440-22-4	2/44	0.029	0.034	0.155	0	No	<5% Detected
Sodium	7440-23-5	22/44	26.6	1400	342	123	No	Essential nutrient
Thallium	**7440-28-0**	**9/44**	**0.15**	**0.33**	**0.2**	**0**	**Yes**	**Exceeds background**
Vanadium	7440-62-2	44/44	5.6	30.6	19.8	31.1	No	Below background
Zinc	**7440-66-6**	**44/44**	**39**	**200**	**74.7**	**61.8**	**Yes**	**Exceeds background**
Explosives and Propellants								
HMX	**2691-41-0**	**1/17**	**0.19**	**0.19**	**0.104**	**None**	**Yes**	**Detected organic**
Nitrocellulose	**9004-70-0**	**6/8**	**0.72**	**10.1**	**3.13**	**None**	**Yes**	**Detected organic**

Table 4-23. SRC Screening Summary for Former Production Area Surface Soil (continued)

Analyte	CAS Number	Freq of Detect	Minimum Detect (mg/kg)	Maximum Detect (mg/kg)	Average Result (mg/kg)	Background Criteria[a] (mg/kg)	SRC? (yes/no)	SRC Justification
				SVOCs				
2-Methylnaphthalene	**91-57-6**	**1/8**	**0.0099**	**0.0099**	**0.0524**	**None**	**Yes**	**Detected organic**
Acenaphthene	**83-32-9**	**1/14**	**0.0046**	**0.0046**	**0.00683**	**None**	**Yes**	**Detected organic**
Anthracene	**120-12-7**	**2/14**	**0.0092**	**0.017**	**0.00796**	**None**	**Yes**	**Detected organic**
Benz(a)anthracene	**56-55-3**	**10/14**	**0.0049**	**0.059**	**0.0187**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**9/14**	**0.0037**	**0.054**	**0.0176**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**10/14**	**0.004**	**0.078**	**0.0229**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**8/14**	**0.0065**	**0.032**	**0.0129**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**6/14**	**0.0042**	**0.033**	**0.0125**	**None**	**Yes**	**Detected organic**
Bis(2-ethylhexyl)phthalate	**117-81-7**	**3/8**	**0.027**	**0.11**	**0.0757**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**10/14**	**0.0047**	**0.062**	**0.02**	**None**	**Yes**	**Detected organic**
Dibenz(a,h)anthracene	**53-70-3**	**2/14**	**0.013**	**0.028**	**0.00951**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**10/14**	**0.0072**	**0.16**	**0.0393**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**5/14**	**0.015**	**0.03**	**0.0119**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**9/14**	**0.0077**	**0.069**	**0.018**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**10/14**	**0.0058**	**0.12**	**0.0296**	**None**	**Yes**	**Detected organic**
				Pesticides and PCBs				
4,4'-DDE	**72-55-9**	**1/8**	**0.0024**	**0.0024**	**0.000935**	**None**	**Yes**	**Detected organic**
PCB-1254	**11097-69-1**	**1/8**	**0.033**	**0.033**	**0.00996**	**None**	**Yes**	**Detected organic**
PCB-1260	**11096-82-5**	**1/8**	**0.0096**	**0.0096**	**0.00678**	**None**	**Yes**	**Detected organic**
				VOCs				
Methylene chloride	**75-09-2**	**1/8**	**0.002**	**0.002**	**0.00174**	**None**	**Yes**	**Detected organic**
Toluene	**108-88-3**	**1/8**	**0.00035**	**0.00035**	**0.000913**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (USACE 2001b).
CAS = Chemical Abstract Service.
DDE = Dichlorodiphenyldichloroethylene.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
mg/kg = Milligrams per kilogram.
PCB = Polychlorinated biphenyl.
SRC = Site-related contaminant.
SVOC= Semi-volatile organic compound.
VOC = Volatile organic compound.
Bold indicates analyte identified as an SRC.

Table 4-24. SRC Screening Summary for Non-Production Area Surface Soil

Analyte	CAS Number	Freq of Detect	Minimum Detect (mg/kg)	Maximum Detect (mg/kg)	Average Result (mg/kg)	Background Criteria[a] (mg/kg)	SRC? (yes/no)	SRC Justification
Metals								
Aluminum	**7429-90-5**	**15/15**	**3300**	**18000**	**12600**	**17700**	**Yes**	**Exceeds background**
Antimony	7440-36-0	3/14	0.097	0.62	0.284	0.96	No	Below background
Arsenic	**7440-38-2**	**15/15**	**2.2**	**31.1**	**11.2**	**15.4**	**Yes**	**Exceeds background**
Barium	**7440-39-3**	**15/15**	**43.3**	**180**	**78.4**	**88.4**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**15/15**	**0.36**	**2.1**	**0.716**	**0.88**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**3/15**	**0.13**	**2.4**	**0.217**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	15/15	140	57000	8810	15800	No	Essential nutrient
Chromium	**7440-47-3**	**15/15**	**5.7**	**26.7**	**15.7**	**17.4**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**15/15**	**3.6**	**12.4**	**8.29**	**10.4**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**15/15**	**5.9**	**85.4**	**17.4**	**17.7**	**Yes**	**Exceeds background**
Iron	7439-89-6	15/15	10000	35000	22400	23100	No	Essential nutrient
Lead	**7439-92-1**	**15/15**	**9.9**	**117**	**23.1**	**26.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	15/15	910	8800	2820	3030	No	Essential nutrient
Manganese	**7439-96-5**	**15/15**	**170**	**1800**	**630**	**1450**	**Yes**	**Exceeds background**
Mercury	**7439-97-6**	**13/15**	**0.0081**	**0.14**	**0.0366**	**0.036**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**15/15**	**8.4**	**27**	**15.6**	**21.1**	**Yes**	**Exceeds background**
Potassium	7440-09-7	15/15	475	1700	1090	927	No	Essential nutrient
Selenium	**7782-49-2**	**11/15**	**0.65**	**2.2**	**1.01**	**1.4**	**Yes**	**Exceeds background**
Silver	**7440-22-4**	**2/15**	**0.019**	**0.3**	**0.168**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	6/15	28.4	1400	321	123	No	Essential nutrient
Thallium	**7440-28-0**	**3/15**	**0.1**	**0.32**	**0.33**	**0**	**Yes**	**Exceeds background**
Vanadium	7440-62-2	15/15	6.7	30	21.6	31.1	No	Below background
Zinc	**7440-66-6**	**15/15**	**33**	**641**	**93.1**	**61.8**	**Yes**	**Exceeds background**
SVOCs								
Anthracene	**120-12-7**	**1/2**	**0.015**	**0.015**	**0.00975**		**Yes**	**Detected organic**
Benz(a)anthracene	**56-55-3**	**1/2**	**0.072**	**0.072**	**0.0383**		**Yes**	**Detected organic**

Table 4-24. SRC Screening Summary for Non-Production Area Surface Soil (continued)

Analyte	CAS Number	Freq of Detect	Minimum Detect (mg/kg)	Maximum Detect (mg/kg)	Average Result (mg/kg)	Background Criteria[a] (mg/kg)	SRC? (yes/no)	SRC Justification
SVOCs, continued								
Benzo(a)pyrene	**50-32-8**	**1/2**	**0.055**	**0.055**	**0.0298**		**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**1/2**	**0.078**	**0.078**	**0.0413**		**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**1/2**	**0.038**	**0.038**	**0.0213**		**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**1/2**	**0.041**	**0.041**	**0.0228**		**Yes**	**Detected organic**
Chrysene	**218-01-9**	**1/2**	**0.074**	**0.074**	**0.0393**		**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**1/2**	**0.14**	**0.14**	**0.0723**		**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**1/2**	**0.029**	**0.029**	**0.0168**		**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**1/2**	**0.054**	**0.054**	**0.0293**		**Yes**	**Detected organic**
Pyrene	**129-00-0**	**1/2**	**0.12**	**0.12**	**0.0623**		**Yes**	**Detected organic**

[a] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).
CAS = Chemical Abstract Service.
mg/kg = Milligrams per kilogram.
SRC = Site-related contaminant.
SVOC = Semi-volatile organic compound.
Bold indicates analyte identified as an SRC.

Table 4-25. SRC Screening Summary for Former Production Area Subsurface Soil

Analyte	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC? (yes/no)	SRC Justification
Metals (mg/kg)								
Aluminum	7429-90-5	38/38	5480	19000	12200	19500	No	Below background
Antimony	7440-36-0	2/36	0.094	0.099	0.242	0.96	No	Below background
Arsenic	**7440-38-2**	**38/38**	**2.6**	**26**	**13.1**	**19.8**	**Yes**	**Exceeds background**
Barium[b]	7440-39-3	38/38	21.6	110	70.8	124	No	Below background
Beryllium	**7440-41-7**	**38/38**	**0.21**	**1.1**	**0.601**	**0.88**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**7/38**	**0.039**	**0.67**	**0.0729**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	38/38	410	36600	9570	35500	No	Essential nutrient
Chromium	**7440-47-3**	**38/38**	**9.1**	**29**	**17.2**	**27.2**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**38/38**	**2.3**	**33**	**10.3**	**23.2**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**38/38**	**5.2**	**110**	**20.9**	**32.3**	**Yes**	**Exceeds background**
Iron	7439-89-6	38/38	10000	34000	24600	35200	No	Essential nutrient
Lead	**7439-92-1**	**38/38**	**8.5**	**150**	**21.7**	**19.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	38/38	1300	8500	4190	8790	No	Essential nutrient
Manganese[b]	7439-96-5	38/38	45	820	395	3030	No	Below background
Mercury	**7439-97-6**	**30/38**	**0.011**	**0.29**	**0.0342**	**0.044**	**Yes**	**Exceeds background**
Nickel[b]	7440-02-0	38/38	8	36	22.9	60.7	No	Below background
Potassium	7440-09-7	38/38	580	2900	1460	3350	No	Essential nutrient
Selenium	**7782-49-2**	**16/38**	**0.46**	**1.8**	**0.479**	**1.5**	**Yes**	**Exceeds background**
Silver	**7440-22-4**	**5/38**	**0.018**	**0.034**	**0.146**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	16/38	39.2	1800	411	145	No	Essential nutrient
Thallium[b]	7440-28-0	10/38	0.11	0.31	0.183	0.91	No	Below background
Vanadium	7440-62-2	38/38	9.9	32	20.5	37.6	No	Below background
Zinc	**7440-66-6**	**38/38**	**29**	**190**	**62.8**	**93.3**	**Yes**	**Exceeds background**
Explosives and Propellants (mg/kg)								
Nitrocellulose	**9004-70-0**	**5/8**	**0.85**	**2.1**	**1.88**	**None**	**Yes**	**Detected organic**
SVOCs (mg/kg)								
2-Methylnaphthalene	**91-57-6**	**1/8**	**0.022**	**0.022**	**0.0757**	**None**	**Yes**	**Detected organic**
Acenaphthene	**83-32-9**	**1/12**	**0.069**	**0.069**	**0.0147**	**None**	**Yes**	**Detected organic**
Anthracene	**120-12-7**	**1/12**	**0.13**	**0.13**	**0.0197**	**None**	**Yes**	**Detected organic**
Benz(a)anthracene	**56-55-3**	**1/12**	**0.29**	**0.29**	**0.0331**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**1/12**	**0.2**	**0.2**	**0.0258**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**1/12**	**0.23**	**0.23**	**0.0282**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**1/12**	**0.083**	**0.083**	**0.016**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**1/12**	**0.16**	**0.16**	**0.0226**	**None**	**Yes**	**Detected organic**

Table 4-25. SRC Screening Summary for Former Production Area Subsurface Soil (continued)

Analyte	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC? (yes/no)	SRC Justification
Bis(2-ethylhexyl)phthalate	**117-81-7**	**4/8**	**0.016**	**0.16**	**0.105**	**None**	**Yes**	**Detected organic**
Carbazole	**86-74-8**	**1/8**	**0.14**	**0.14**	**0.0388**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**1/12**	**0.3**	**0.3**	**0.034**	**None**	**Yes**	**Detected organic**
Dibenz(a,h)anthracene	**53-70-3**	**1/12**	**0.052**	**0.052**	**0.0134**	**None**	**Yes**	**Detected organic**
Dibenzofuran	**132-64-9**	**1/8**	**0.045**	**0.045**	**0.0789**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**2/12**	**0.0068**	**0.76**	**0.0727**	**None**	**Yes**	**Detected organic**
Fluorene	**86-73-7**	**1/12**	**0.057**	**0.057**	**0.0137**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**1/12**	**0.088**	**0.088**	**0.0164**	**None**	**Yes**	**Detected organic**
Naphthalene	**91-20-3**	**1/12**	**0.078**	**0.078**	**0.0155**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**1/12**	**0.51**	**0.51**	**0.0514**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**2/12**	**0.005**	**0.51**	**0.0519**	**None**	**Yes**	**Detected organic**
				VOCs (mg/kg)				
Acetone	**67-64-1**	**1/8**	**0.011**	**0.011**	**0.006**	**None**	**Yes**	**Detected organic**
Toluene	**108-88-3**	**1/8**	**0.0004**	**0.0004**	**0.00121**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (USACE 2001b).
[b] Inorganic analyte was identified as an SRC in corresponding surface soil interval; however, was not an SRC in the subsurface soil interval.
CAS = Chemical Abstract Service.
mg/kg = Milligrams per kilogram.
SRC = Site-related contaminant.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.
Bold indicates analyte identified as an SRC.

Table 4-26. SRC Screening Summary for Non-Production Area Subsurface Soil

Analyte	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC? (yes/no)	SRC Justification
Metals (mg/kg)								
Aluminum[b]	7429-90-5	14/14	5900	19000	14100	19500	No	Below background
Antimony	7440-36-0	3/12	0.077	0.58	0.243	0.96	No	Below background
Arsenic[b]	7440-38-2	14/14	6.8	18.9	13.1	19.8	No	Below background
Barium	**7440-39-3**	**14/14**	**20**	**160**	**70.7**	**124**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**14/14**	**0.19**	**1.3**	**0.671**	**0.88**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**2/14**	**0.056**	**0.064**	**0.0448**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	14/14	270	39000	5480	35500	No	Essential nutrient
Chromium[b]	7440-47-3	14/14	8.2	25	18.1	27.2	No	Below background
Cobalt[b]	7440-48-4	14/14	3.5	17.5	8.94	23.2	No	Below background
Copper[b]	7440-50-8	14/14	5.9	22.2	16.7	32.3	No	Below background
Iron	7439-89-6	14/14	11000	45000	26600	35200	No	Essential nutrient
Lead[b]	7439-92-1	14/14	7.8	18	12.9	19.1	No	Below background
Magnesium	7439-95-4	14/14	1500	9200	3910	8790	No	Essential nutrient
Manganese[b]	7439-96-5	14/14	79	595	309	3030	No	Below background
Mercury[b]	7439-97-6	10/14	0.0064	0.042	0.0232	0.044	No	Below background
Nickel[b]	7440-02-0	14/14	9.1	36.7	21.7	60.7	No	Below background
Potassium	7440-09-7	14/14	640	3200	1440	3350	No	Essential nutrient
Selenium	**7782-49-2**	**10/14**	**0.67**	**2.5**	**1.13**	**1.5**	**Yes**	**Exceeds background**
Silver	**7440-22-4**	**2/14**	**0.02**	**0.027**	**0.131**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	6/14	67.5	1300	264	145	No	Essential nutrient
Thallium[b]	7440-28-0	4/14	0.16	0.2	0.308	0.91	No	Below background
Vanadium	7440-62-2	14/14	11	31	23.3	37.6	No	Below background
Zinc[b]	7440-66-6	14/14	22	68.6	51.1	93.3	No	Below background
SVOCs (mg/kg)								
Di-n-octylphthalate	**117-84-0**	**1/4**	**0.02**	**0.02**	**0.00874**		**Yes**	**Detected organic**

[a] Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (USACE 2001b).
[b] Inorganic analyte was identified as an SRC in corresponding surface soil interval; however, was not an SRC in the subsurface soil interval.
CAS = Chemical Abstract Service.
mg/kg = Milligrams per kilogram.
SRC = Site-related contaminant.
SVOC = Semi-volatile organic compound.
Bold indicates analyte identified as an SRC.

Table 4-27. SRC Screening for Drainage Ditches Discrete Sediment Samples

Analyte	CAS Number	Freq of Detect	Minimum Detect	Max. Detect	Average Result	Background Criteria[a]	SRC? (yes/no)	SRC Justification
Metals (mg/kg)								
Aluminum	7429-90-5	2/2	7610	9600	8610	13900	No	Below background
Antimony	**7440-36-0**	**1/2**	**0.091**	**0.091**	**0.203**	**0**	**Yes**	**Exceeds background**
Arsenic	7440-38-2	2/2	8.7	9.6	9.15	19.5	No	Below background
Barium	7440-39-3	2/2	57.4	73	65.2	123	No	Below background
Beryllium	**7440-41-7**	**2/2**	**0.41**	**0.55**	**0.48**	**0.38**	**Yes**	**Exceeds background**
Calcium	7440-70-2	2/2	852	4700	2780	5510	No	Essential nutrient
Chromium	7440-47-3	2/2	12.4	14	13.2	18.1	No	Below background
Cobalt	**7440-48-4**	**2/2**	**6.3**	**12.8**	**9.55**	**9.1**	**Yes**	**Exceeds background**
Copper	7440-50-8	2/2	15	21	18	27.6	No	Below background
Iron	7439-89-6	2/2	20000	28100	24100	28200	No	Essential nutrient
Lead	**7439-92-1**	**2/2**	**14.8**	**36**	**25.4**	**27.4**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	2/2	2000	2140	2070	2760	No	Essential nutrient
Manganese	7439-96-5	2/2	380	776	578	1950	No	Below background
Mercury	7439-97-6	2/2	0.039	0.052	0.0455	0.059	No	Below background
Nickel	**7440-02-0**	**2/2**	**14**	**19**	**16.5**	**17.7**	**Yes**	**Exceeds background**
Potassium	7440-09-7	2/2	881	1000	941	1950	No	Essential nutrient
Selenium	7782-49-2	1/2	0.97	0.97	0.655	1.7	No	Below background
Sodium	7440-23-5	1/2	32.1	32.1	53.6	112	No	Essential nutrient
Thallium	7440-28-0	1/2	0.095	0.095	0.115	0.89	No	Below background
Vanadium	7440-62-2	2/2	13.9	17	15.5	26.1	No	Below background
Zinc	7440-66-6	2/2	68	72.9	70.5	532	No	Below background

[a] Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (USACE 2001b).

CAS = Chemical Abstract Service.

mg/kg = Milligrams per kilogram.

SRC = Site-related contaminant.

Bold indicates analyte identified as an SRC.

Table 4-28. SRC Screening for Former Test Pond Discrete Sediment Samples

Analyte	CAS Number	Freq of Detect	Minimum Detect	Max. Detect	Average Result	Background Criteria[a]	SRC? (yes/no)	SRC Justification
				Metals (mg/kg)				
Aluminum	7429-90-5	1/1	13300	13300	13300	13900	No	Below background
Antimony	**7440-36-0**	**1/1**	**1.7**	**1.7**	**1.7**	**0**	**Yes**	**Exceeds background**
Arsenic	7440-38-2	1/1	8.9	8.9	8.9	19.5	No	Below background
Barium	7440-39-3	1/1	70.8	70.8	70.8	123	No	Below background
Beryllium	**7440-41-7**	**1/1**	**0.65**	**0.65**	**0.65**	**0.38**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**1/1**	**0.88**	**0.88**	**0.88**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	1/1	3710	3710	3710	5510	No	Essential nutrient
Chromium	7440-47-3	1/1	18	18	18	18.1	No	Below background
Cobalt	**7440-48-4**	**1/1**	**11.7**	**11.7**	**11.7**	**9.1**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**1/1**	**91.7**	**91.7**	**91.7**	**27.6**	**Yes**	**Exceeds background**
Iron	7439-89-6	1/1	23300	23300	23300	28200	No	Essential nutrient
Lead	**7439-92-1**	**1/1**	**55.2**	**55.2**	**55.2**	**27.4**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	1/1	2970	2970	2970	2760	No	Essential nutrient
Manganese	7439-96-5	1/1	327	327	327	1950	No	Below background
Nickel	**7440-02-0**	**1/1**	**22.8**	**22.8**	**22.8**	**17.7**	**Yes**	**Exceeds background**
Potassium	7440-09-7	1/1	1670	1670	1670	1950	No	Essential nutrient
Selenium	7782-49-2	1/1	1.4	1.4	1.4	1.7	No	Below background
Silver	**7440-22-4**	**1/1**	**0.21**	**0.21**	**0.21**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	1/1	148	148	148	112	No	Essential nutrient
Vanadium	7440-62-2	1/1	22.9	22.9	22.9	26.1	No	Below background
Zinc	7440-66-6	1/1	93.1	93.1	93.1	532	No	Below background
				Explosives and Propellants (mg/kg)				
Tetryl	**479-45-8**	**1/1**	**0.031**	**0.031**	**0.031**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (USACE 2001b).

CAS = Chemical Abstract Service.

mg/kg = Milligrams per kilogram.

SRC = Site-related contaminant.

Bold indicates analyte identified as an SRC.

Table 4-29. SRC Screening for Drainage Ditches Surface Water

Analyte	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC? (yes/no)	SRC Justification
Metals (mg/L)								
Aluminum	**7429-90-5**	**3/3**	**0.71**	**6.04**	**2.64**	**3.37**	**Yes**	**Exceeds background**
Antimony	**7440-36-0**	**1/3**	**0.00026**	**0.00026**	**0.00129**	**0**	**Yes**	**Exceeds background**
Arsenic	7440-38-2	3/3	0.00093	0.0032	0.00191	0.0032	No	Below background
Barium	**7440-39-3**	**3/3**	**0.0221**	**0.0667**	**0.0459**	**0.0475**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**1/3**	**0.00042**	**0.00042**	**0.000335**	**0**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**2/3**	**0.00014**	**0.0004**	**0.000253**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	3/3	13.2	72	44.8	41.4	No	Essential nutrient
Chromium	**7440-47-3**	**3/3**	**0.0023**	**0.007**	**0.00403**	**0**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**3/3**	**0.00026**	**0.0072**	**0.00285**	**0**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**3/3**	**0.0032**	**0.0123**	**0.00657**	**0.0079**	**Yes**	**Exceeds background**
Iron	7439-89-6	3/3	1.14	8.42	3.72	2.56	No	Essential nutrient
Lead	**7439-92-1**	**3/3**	**0.00094**	**0.0107**	**0.00665**	**0**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	3/3	3.33	8.1	5.71	10.8	No	Essential nutrient
Manganese	**7439-96-5**	**3/3**	**0.0287**	**2.2**	**0.932**	**0.391**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**2/3**	**0.0014**	**0.0111**	**0.00448**	**0**	**Yes**	**Exceeds background**
Potassium	7440-09-7	3/3	1.39	2.8	2.28	3.17	No	Essential nutrient
Selenium	**7782-49-2**	**2/3**	**0.00036**	**0.00061**	**0.00116**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	3/3	0.53	1.43	1.06	21.3	No	Essential nutrient
Vanadium	**7440-62-2**	**2/3**	**0.002**	**0.0107**	**0.00458**	**0**	**Yes**	**Exceeds background**
Zinc	**7440-66-6**	**3/3**	**0.015**	**0.0954**	**0.0629**	**0.042**	**Yes**	**Exceeds background**
Explosives and Propellants (mg/L)								
HMX	**2691-41-0**	**1/3**	**0.00008**	**0.00008**	**0.0000917**	**None**	**Yes**	**Exceeds background**
Nitrocellulose	**9004-70-0**	**1/3**	**0.24**	**0.24**	**0.247**	**None**	**Yes**	**Exceeds background**
SVOCs (mg/L)								
4-Methylphenol	**106-44-5**	**1/1**	**0.00026**	**0.00026**	**0.00026**	**None**	**Yes**	**Exceeds background**
VOCs (mg/L)								
Acetone	**67-64-1**	**1/3**	**0.0022**	**0.0022**	**0.00407**	**None**	**Yes**	**Exceeds background**

[a] Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (USACE 2001b).

CAS = Chemical Abstract Service.

HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.

mg/L = Milligrams per liter.

SRC = Site-related Contaminant.

SVOC = Semi-volatile organic compound.

VOC = Volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4-30. SRC Screening for Former Test Pond Surface Water

Analyte	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC? (yes/no)	SRC Justification
Metals (mg/L)								
Aluminum	7429-90-5	1/1	0.201	0.201	0.201	3.37	No	Below background
Antimony	**7440-36-0**	**1/1**	**0.00029**	**0.00029**	**0.00029**	**0**	**Yes**	**Exceeds background**
Arsenic	7440-38-2	1/1	0.00081	0.00081	0.00081	0.0032	No	Below background
Barium	7440-39-3	1/1	0.0099	0.0099	0.0099	0.0475	No	Below background
Calcium	7440-70-2	1/1	20.4	20.4	20.4	41.4	No	Essential nutrient
Cobalt	**7440-48-4**	**1/1**	**0.00009**	**0.00009**	**0.00009**	**0**	**Yes**	**Exceeds background**
Copper	7440-50-8	1/1	0.0024	0.0024	0.0024	0.0079	No	Below background
Iron	7439-89-6	1/1	1.04	1.04	1.04	2.56	No	Essential nutrient
Lead	**7439-92-1**	**1/1**	**0.00028**	**0.00028**	**0.00028**	**0**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	1/1	3.8	3.8	3.8	10.8	No	Essential nutrient
Manganese	7439-96-5	1/1	0.133	0.133	0.133	0.391	No	Below background
Potassium	7440-09-7	1/1	2.76	2.76	2.76	3.17	No	Essential nutrient
Sodium	7440-23-5	1/1	0.582	0.582	0.582	21.3	No	Essential nutrient
Explosives and Propellants (mg/L)								
HMX	**2691-41-0**	**1/1**	**0.000062**	**0.000062**	**0.000062**	**None**	**Yes**	**Exceeds background**
Pesticides (mg/L)								
beta-BHC	**319-85-7**	**1/1**	**0.000044**	**0.000044**	**0.000044**	**None**	**Yes**	**Exceeds background**

[a] Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (USACE 2001b).

beta-BHC = Beta-hexachlorocyclohexane.
CAS = Chemical Abstract Service.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
mg/L = Milligrams per liter.
SRC = Site-related contaminant.
VOC = Volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4-31. Data Summary and Designated Use for Remedial Investigation

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
Subsurface Soil (>1 ft)										
LL6sb-001-0001-SO	D	12/03/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-002-0001-SO	D	12/03/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-003-0001-SO	D	12/03/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-004-0001-SO	D	11/25/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-005-0001-SO	D	11/19/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-006-0001-FD	D	11/21/03	1.0-3.0	Phase I RI	X	--	--	--	--	Field duplicate.
LL6sb-006-0001-SO	D	11/21/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-007-0001-SO	D	11/14/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-008-0001-SO	D	11/14/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-009-0001-SO	D	11/20/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-010-0001-SO	D	12/02/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-011-0001-SO	D	12/03/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-012-0001-FD	D	11/25/03	1.0-3.0	Phase I RI	X	--	--	--	--	Field duplicate.
LL6sb-012-0001-SO	D	11/25/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-013-0001-SO	D	11/21/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-014-0001-SO	D	11/25/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-015-0001-FD	D	11/25/03	1.0-3.0	Phase I RI	X	--	--	--	--	Field duplicate.
LL6sb-015-0001-SO	D	11/25/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-016-0001-SO	D	11/21/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-017-0001-SO	D	11/19/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-018-0001-FD	D	12/02/03	1.0-3.0	Phase I RI	X	--	--	--	--	Field duplicate.
LL6sb-018-0001-SO	D	12/02/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-019-0001-SO	D	11/19/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-020-0001-SO	D	12/02/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-021-0001-SO	D	11/19/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-023-0001-SO	D	11/19/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-024-0001-SO	D	11/25/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-025-0001-SO	D	11/14/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-026-0001-SO	D	11/20/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-027-0001-SO	D	11/20/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-028-0001-SO	D	11/18/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-030-0001-SO	D	11/18/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-031-0001-SO	D	11/18/03	6.0-8.0	Phase I RI	--	X	X	X	--	
LL6sb-032-0001-SO	D	11/13/03	14.0-15.0	Phase I RI	--	X	X	--	--	Sample below the exposure depth of all receptors.

Table 4-31. Data Summary and Designated Use for Remedial Investigation (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
LL6sb-033-0001-FD	D	11/18/03	6.0-8.0	Phase I RI	X	--	--	--	--	Field duplicate.
LL6sb-033-0001-SO	D	11/18/03	6.0-8.0	Phase I RI	--	X	X	X	--	
LL6sb-034-0001-SO	D	11/14/03	15.0-17.0	Phase I RI	--	X	X	--	--	Sample below the exposure depth of all receptors.
LL6sb-035-0001-SO	D	11/14/03	11.0-13.0	Phase I RI	--	X	X	X	--	
LL6sb-036-0001-SO	D	11/18/03	6.0-8.0	Phase I RI	--	X	X	X	--	
LL6sb-037-0001-SO	D	11/14/03	12.0-14.0	Phase I RI	--	X	X	X	--	
LL6sb-038-0001-SO	D	11/05/03	8.0-10.0	Phase I RI	--	X	X	X	--	
LL6sb-039-0001-SO	D	11/05/03	8.0-10.0	Phase I RI	--	X	X	X	--	
LL6sb-040-0001-SO	D	11/05/03	4.0-6.0	Phase I RI	--	X	X	X	--	
LL6sb-041-0001-SO	D	10/27/03	7.0-7.0	Phase I RI	--	X	X	X	--	
LL6sb-042-0001-SO	D	12/03/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-044-0001-FD	D	12/02/03	1.0-3.0	Phase I RI	X	--	--	--	--	Field duplicate.
LL6sb-044-0001-SO	D	12/02/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-045-0001-SO	D	12/02/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-046-0001-SO	D	11/04/03	0.0-13.0	Phase I RI	--	X	--	--	--	Boring drilled for field screening only. Every 2 ft field screened for VOCs.
LL6sb-047-0001-SO	D	11/04/03	0.0-9.1	Phase I RI	--	X	--	--	--	Boring drilled for field screening only. Every 2 ft field screened for VOCs.
LL6sb-048-0001-SO	D	11/04/03	0.0-12.0	Phase I RI	--	X	--	--	--	Boring drilled for field screening only. Every 2 ft field screened for VOCs.
LL6sb-049-0001-SO	D	11/04/03	4.0-6.0	Phase I RI	--	X	X	X	--	Boring drilled to 11 ft bgs and every 2 ft field screened for VOCs. Sample from 4-6 ft bgs sent to analytical laboratory.
LL6sb-050-0001-SO	D	11/04/03	6.0-8.0	Phase I RI	--	X	X	X	--	Boring drilled to 12 ft bgs and every 2 ft field screened for VOCs. Sample from 6-8 ft bgs sent to analytical laboratory.
LL6sb-051-0001-SO	D	11/04/03	6.0-8.0	Phase I RI	--	X	X	X	--	Boring drilled to 9 ft bgs and every 2 ft field screened for VOCs. Sample from 6-8 ft bgs sent to analytical laboratory.
LL6sb-052-0001-SO	D	11/04/03	0.0-8.0	Phase I RI	--	X	--	--	--	Boring drilled for field screening only. Every 2 ft field screened for VOCs.
LL6sb-053-0001-SO	D	11/04/03	0.0-11.1	Phase I RI	--	X	--	--	--	Boring drilled for field screening only. Every 2 ft field screened for VOCs.
LL6sb-054-0001-SO	D	11/04/03	0.0-15.0	Phase I RI	--	X	--	--	--	Boring drilled for field screening only. Every 2 ft field screened for VOCs.

Table 4-31. Data Summary and Designated Use for Remedial Investigation (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
LL6sb-055-0001-SO	D	11/04/03	3.0-5.0	Phase I RI	--	X	X	X	--	
LL6sb-056-0001-SO	D	11/18/03	1.0-3.0	Phase I RI	--	X	X	X	--	
LL6sb-068-5215-SO	D	03/01/10	0.0-1.0	PBA08 RI	--	X	X	X	X	
LL6sb-068-5216-SO	D	03/01/10	1.0-4.0	PBA08 RI	--	X	X	X	--	
LL6sb-068-5217-SO	D	03/01/10	4.0-7.0	PBA08 RI	--	X	X	X	--	
LL6sb-069-5219-SO	D	02/25/10	0.0-1.0	PBA08 RI	--	X	X	X	X	
LL6sb-069-5220-SO	D	02/25/10	1.0-4.0	PBA08 RI	--	X	X	X	--	
LL6sb-069-5221-SO	D	02/25/10	4.0-7.0	PBA08 RI	--	X	X	X	--	
LL6sb-069-5222-SO	D	02/25/10	7.0-13.0	PBA08 RI	--	X	X	X	--	
LL6sb-070-5223-SO	D	03/01/10	0.0-1.0	PBA08 RI	--	X	X	X	X	
LL6sb-070-5224-SO	D	03/01/10	1.0-4.0	PBA08 RI	--	X	X	X	--	
LL6sb-070-5225-SO	D	03/01/10	4.0-7.0	PBA08 RI	--	X	X	X	--	
LL6sb-071-5227-SO	D	03/01/10	0.0-1.0	PBA08 RI	--	X	X	X	X	
LL6sb-071-5228-SO	D	03/01/10	1.0-4.0	PBA08 RI	--	X	X	X	--	
LL6sb-071-5229-SO	D	03/01/10	4.0-7.0	PBA08 RI	--	X	X	X	--	
LL6sb-071-6068-FD	D	03/01/10	1.0-4.0	PBA08 RI	X	--	--	--	--	Field duplicate.
LL6sb-071-6069-FD	D	03/01/10	4.0-7.0	PBA08 RI	X	--	--	--	--	Field duplicate.
LL6sb-083-5233-SO	D	02/25/10	0.0-1.0	PBA08 RI	--	X	X	X	X	
LL6sb-083-5234-SO	D	02/25/10	1.0-4.0	PBA08 RI	--	X	X	X	--	
LL6sb-083-5235-SO	D	02/25/10	4.0-5.5	PBA08 RI	--	X	X	X	--	
Surface Soil (0-1 ft)										
LL6sd-005-0001-FD	D	12/01/03	0.0-0.5	Phase I RI	X	--	--	--	--	Field duplicate.
LL6sd-005-0001-SD	D	12/01/03	0.0-0.5	Phase I RI	--	X	X	X	X	
LL6sd-010-0001-FD	D	12/01/03	0.0-0.5	Phase I RI	X	--	--	--	--	Field duplicate.
LL6sd-010-0001-SD	D	12/01/03	0.0-0.5	Phase I RI	--	X	X	X	X	
LL6sd-011-0001-SD	D	12/02/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6sd-012-0001-SD	D	12/02/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6sd-013-0001-SD	D	12/02/03	0.0-1.5	Phase I RI	--	X	X	X	X	
LL6sd-014-0001-SD	D	12/02/03	0.0-0.5	Phase I RI	--	X	X	X	X	
LL6sd-015-0001-SD	D	12/02/03	0.0-0.5	Phase I RI	--	X	X	X	X	
LL6sd-081-5243-SD	D	02/18/10	0.0-0.5	PBA08 RI	--	X	X	X	X	Reclassified as surface soil since the location was not perennially wet.
LL6ss-001-0001-SO	D	03/12/02	0.0-1.0	Lead Azide Screening	--	X	X	X	X	
LL6ss-001-D12S-FD	D	03/15/02	0.0-1.0	Lead Azide Screening	X	--	--	--	--	Field duplicate.

Table 4-31. Data Summary and Designated Use for Remedial Investigation (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
LL6ss-001-W12S-FD	D	03/15/02	0.0-1.0	Lead Azide Screening	X	--	--	--	--	Field duplicate.
LL6ss-002-0001-SO	D	03/12/02	0.0-1.0	Lead Azide Screening	--	X	X	X	X	
LL6ss-002-D13S-FD	D	03/15/02	0.0-1.0	Lead Azide Screening	X	--	--	--	--	Field duplicate.
LL6ss-002-W13S-FD	D	03/15/02	0.0-1.0	Lead Azide Screening	X	--	--	--	--	Field duplicate.
LL6ss-003-0001-SO	D	03/12/02	0.0-1.0	Lead Azide Screening	--	X	X	X	X	
LL6ss-003-D14S-FD	D	03/15/02	0.0-1.0	Lead Azide Screening	X	--	--	--	--	Field duplicate.
LL6ss-003-W14S-FD	D	03/15/02	0.0-1.0	Lead Azide Screening	X	--	--	--	--	Field duplicate.
LL6ss-004-0001-SO	D	11/25/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-005-0001-SO	D	11/19/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-006-0001-SO	D	11/21/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-007-0001-SO	D	11/14/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-008-0001-SO	D	11/14/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-009-0001-SO	D	11/20/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-010-0001-SO	D	12/02/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-010-0002-SO	D	01/14/04	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-011-0001-SO	D	12/03/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-012-0001-SO	D	11/25/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-013-0001-SO	D	11/21/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-014-0001-SO	D	11/25/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-015-0001-SO	D	11/25/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-016-0001-SO	D	11/21/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-017-0001-SO	D	11/19/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-018-0001-SO	D	12/02/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-019-0001-SO	D	11/19/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-020-0001-FD	D	12/02/03	0.0-1.0	Phase I RI	X	--	--	--	--	Field duplicate.
LL6ss-020-0001-SO	D	12/02/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-021-0001-SO	D	11/19/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-022-0001-SO	D	11/14/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-023-0001-SO	D	11/19/03	0.0-1.0	Phase I RI	--	X	X	X	X	

Table 4-31. Data Summary and Designated Use for Remedial Investigation (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
LL6ss-024-0001-SO	D	11/25/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-025-0001-SO	D	11/14/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-026-0001-SO	D	11/20/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-027-0001-SO	D	11/20/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-028-0001-SO	D	11/18/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-029-0001-FD	D	11/25/03	0.0-1.0	Phase I RI	X	--	--	--	--	Field duplicate.
LL6ss-029-0001-SO	D	11/25/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-030-0001-SO	D	11/18/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-031-0001-SO	D	11/13/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-032-0001-FD	D	11/13/03	0.0-1.0	Phase I RI	X	--	--	--	--	Field duplicate.
LL6ss-032-0001-SO	D	11/13/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-033-0001-SO	D	11/18/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-034-0001-SO	D	11/14/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-035-0001-SO	D	11/13/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-036-0001-SO	D	11/13/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-037-0001-SO	D	11/13/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-038-0001-SO	D	11/05/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-039-0001-SO	D	11/05/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-040-0001-FD	D	11/05/03	0.0-1.0	Phase I RI	X	--	--	--	--	Field duplicate.
LL6ss-040-0001-SO	D	11/05/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-056-0001-SO	D	11/18/03	0.0-1.0	Phase I RI	--	X	X	X	X	
LL6ss-073-5237-SO	D	02/22/10	0.0-1.0	PBA08 RI	--	X	X	X	X	
LL6ss-074-5238-SO	D	02/22/10	0.0-1.0	PBA08 RI	--	X	X	X	X	
LL6ss-075-5246-SO	D	02/22/10	0.0-1.0	PBA08 RI	--	X	--	X	--	Sample collected for chromium speciation analysis only.
LL6ss-076-5239-SO	D	02/22/10	0.0-1.0	PBA08 RI	--	X	X	X	X	
LL6ss-077-5247-SO	D	02/25/10	0.0-1.0	PBA08 RI	--	X	--	X	--	Sample collected for chromium speciation analysis only.
LL6ss-078-5240-SO	D	02/22/10	0.0-1.0	PBA08 RI	--	X	X	X	X	
LL6ss-078-6059-FD	D	02/22/10	0.0-1.0	PBA08 RI	X	--	--	--	--	Field duplicate
LL6ss-079-5241-SO	D	02/22/10	0.0-1.0	PBA08 RI	--	X	X	X	X	
LL6ss-080-5248-SO	D	02/22/10	0.0-1.0	PBA08 RI	--	X	--	X	--	Sample collected for chromium speciation analysis only.
FTFss-004(I)-0001-SS	ISM	08/12/11	0.0-0.5	MMRP RI	--	X	--	--	--	Sample collected during MMRP RI and used in this report for qualitative assessment of Former Test Pond.

Table 4-31. Data Summary and Designated Use for Remedial Investigation (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
331	D	11/01/96	0.0-0.5	1996 RRSE	--	--	--	--	--	Used for initial evaluation of site.
332	D	11/01/96	0.0-0.5	1996 RRSE	--	--	--	--	--	Used for initial evaluation of site.
333	D	11/01/96	0.0-0.5	1996 RRSE	--	--	--	--	--	Used for initial evaluation of site.
334	D	11/01/96	0.0-0.5	1996 RRSE	--	--	--	--	--	Used for initial evaluation of site.
335	D	11/01/96	0.0-0.5	1996 RRSE	--	--	--	--	--	Used for initial evaluation of site.
336	D	11/01/96	0.0-0.5	1996 RRSE	--	--	--	--	--	Used for initial evaluation of site.
337	D	11/01/96	0.0-0.5	1996 RRSE	--	--	--	--	--	Used for initial evaluation of site.
338	D	11/01/96	0.0-0.5	1996 RRSE	--	--	--	--	--	Used for initial evaluation of site.
Sediment										
FWSsd-101-5009-SD	D	02/25/10	0.0-0.5	PBA08 RI	--	X	--	--	--	Collected at potential exit points from the Fuze and Booster Hill area (which includes Load Lines 5 through 11) and near the southern boundary of RVAAP/Camp Ravenna.
FWSsd-103-5013-SD	D	02/18/10	0.0-0.5	PBA08 RI	--	X	--	--	--	Collected at potential exit points from the Fuze and Booster Hill area (which includes Load Lines 5 through 11) and near the southern boundary of RVAAP/Camp Ravenna.
LL6sd-001-0001-SD	D	03/14/02	0.0-1.0	Lead Azide Screening	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
LL6sd-002-0001-SD	D	12/01/03	0.0-0.5	Phase I RI	--	X	X	X	X	
LL6sd-003-0001-SD	D	12/01/03	0.0-0.5	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
LL6sd-004-0001-SD	D	12/01/03	0.0-0.5	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
LL6sd-082-5245-SD	D	02/17/10	0.0-0.5	PBA08 RI	--	X	X	X	X	
LL6sd-082-6063-FD	D	02/17/10	0.0-0.5	PBA08 RI	X	--	--	--	--	Field duplicate.
LL6sd-084-5795-SD	D	04/01/10	0.0-0.5	PBA08 RI	--	X	X	X	X	
LL6sd-096-5870-SD	D	08/09/12	0.0-0.5	PBA08 RI	--	X	--	--	--	
FTFsd-002-SD	D	08/08/11	0.0-0.5	MMRP RI	--	X	--	--	--	Sample collected during MMRP RI and used in this report for qualitative assessment of Former Test Pond.
FTFsd-003-SD	D	08/08/11	0.0-0.5	MMRP RI	--	X	--	--	--	Sample collected during MMRP RI and

Table 4-31. Data Summary and Designated Use for Remedial Investigation (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
										used in this report for qualitative assessment of Former Test Pond.
33B	D	11/01/96	0.0-0.5	1996 RRSE	--	--	--	--	--	Used for initial evaluation of site.
				Surface Water						
FWSsw-101-5008-SW	D	02/25/10	0.0-0.0	PBA08 RI	--	X	--	--	--	Collected at potential exit points from the Fuze and Booster Hill area (which includes Load Lines 5 through 11) and near the southern boundary of RVAAP/Camp Ravenna.
FWSsw-103-5012-SW	D	02/18/10	0.0-0.0	PBA08 RI	--	X	--	--	--	Collected at potential exit points from the Fuze and Booster Hill area (which includes Load Lines 5 through 11) and near the southern boundary of RVAAP/Camp Ravenna.
LL6sw-001-0001-FD	D	03/14/02	0.0-0.5	Lead Azide Screening	X	--	--	--	--	Field duplicate.
LL6sw-001-0001-SW	D	03/14/02	0.0-0.5	Lead Azide Screening	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
LL6sw-002-0001-FD	D	12/01/03	0.0-0.5	Phase I RI	X	--	--	--	--	Field duplicate.
LL6sw-002-0001-SW	D	12/01/03	0.0-0.5	Phase I RI	--	X	X	X	X	
LL6sw-003-0001-SW	D	12/01/03	0.0-0.5	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
LL6sw-004-0001-SW	D	12/01/03	0.0-0.5	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
LL6sw-005-0001-SW	D	12/01/03	0.0-0.5	Phase I RI	--	X	--	--	--	Sample from temporary puddle.
LL6sw-006-0001-SW	D	12/01/03	0.0-0.5	Phase I RI	--	--	--	--	--	Excluded samples from sewers and sumps.
LL6sw-008-0001-SW	D	12/01/03	0.0-0.5	Phase I RI	--	--	--	--	--	Excluded samples from sewers and sumps.
LL6sw-081-5242-SW	D	03/02/10	0.0-0.0	PBA08 RI	--	X	X	X	X	
LL6sw-082-5244-SW	D	02/17/10	0.0-0.0	PBA08 RI	--	X	X	X	X	
LL6sw-084-5794-SW	D	04/01/10	0.0-0.0	PBA08 RI	--	X	X	X	X	
LL6sw-096-5871-SW	D	08/09/12	0.0-0.0	PBA08 RI	--	X	--	--	--	
FTFsw-001	D	05/05/11	0.0-0.0	MMRP RI	--	X	--	--	--	Sample collected during MMRP RI and

Table 4-31. Data Summary and Designated Use for Remedial Investigation (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
										used in this report for qualitative assessment of Former Test Pond.
33W	D	11/01/96	0.0-0.0	1996 RRSE	--	--	--	--	--	Used for initial evaluation of site.

AOC = Area of concern.
D = Discrete.
ERA = Ecological risk assessment.
ft = Feet.
F&T = Fate and transport.
HHRA = Human health risk assessment.
ID = Identification.
MMRP = Military Munitions Response Program.
N&E = Nature and extent
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.
QC = Quality control.
RI = Remedial Investigation.
RRSE = Relative Risk Site Evaluation.

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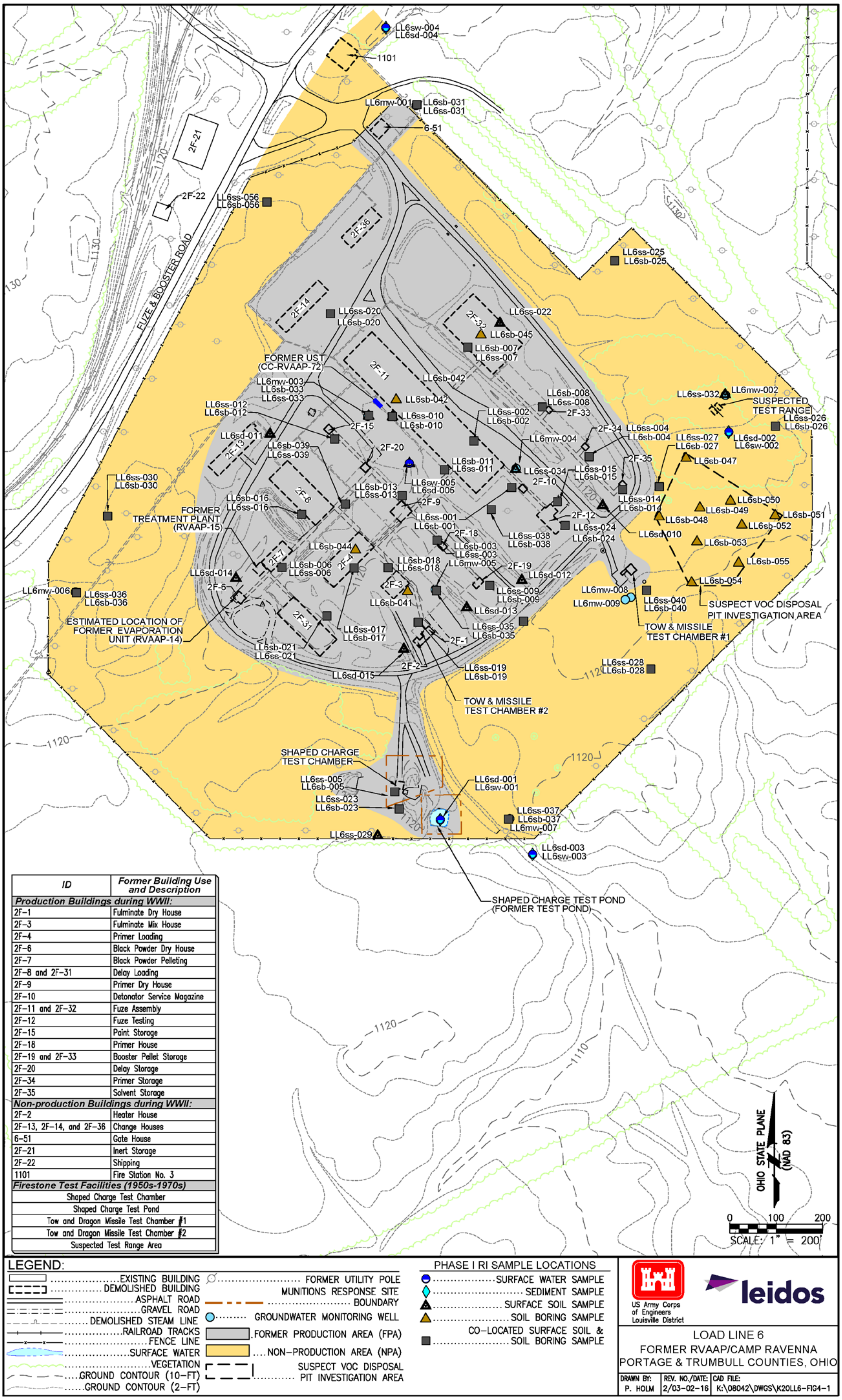

ID	Former Building Use and Description
Production Buildings during WWII:	
2F–1	Fulminate Dry House
2F–3	Fulminate Mix House
2F–4	Primer Loading
2F–6	Black Powder Dry House
2F–7	Black Powder Pelleting
2F–8 and 2F–31	Delay Loading
2F–9	Primer Dry House
2F–10	Detonator Service Magazine
2F–11 and 2F–32	Fuze Assembly
2F–12	Fuze Testing
2F–15	Paint Storage
2F–18	Primer House
2F–19 and 2F–33	Booster Pellet Storage
2F–20	Delay Storage
2F–34	Primer Storage
2F–35	Solvent Storage
Non-production Buildings during WWII:	
2F–2	Heater House
2F–13, 2F–14, and 2F–36	Change Houses
6–51	Gate House
2F–21	Inert Storage
2F–22	Shipping
1101	Fire Station No. 3
Firestone Test Facilities (1950s-1970s)	
Shaped Charge Test Chamber	
Shaped Charge Test Pond	
Tow and Dragon Missile Test Chamber #1	
Tow and Dragon Missile Test Chamber #2	
Suspected Test Range Area	

Figure 4-1. Phase I RI Sample Locations at Load Line 6

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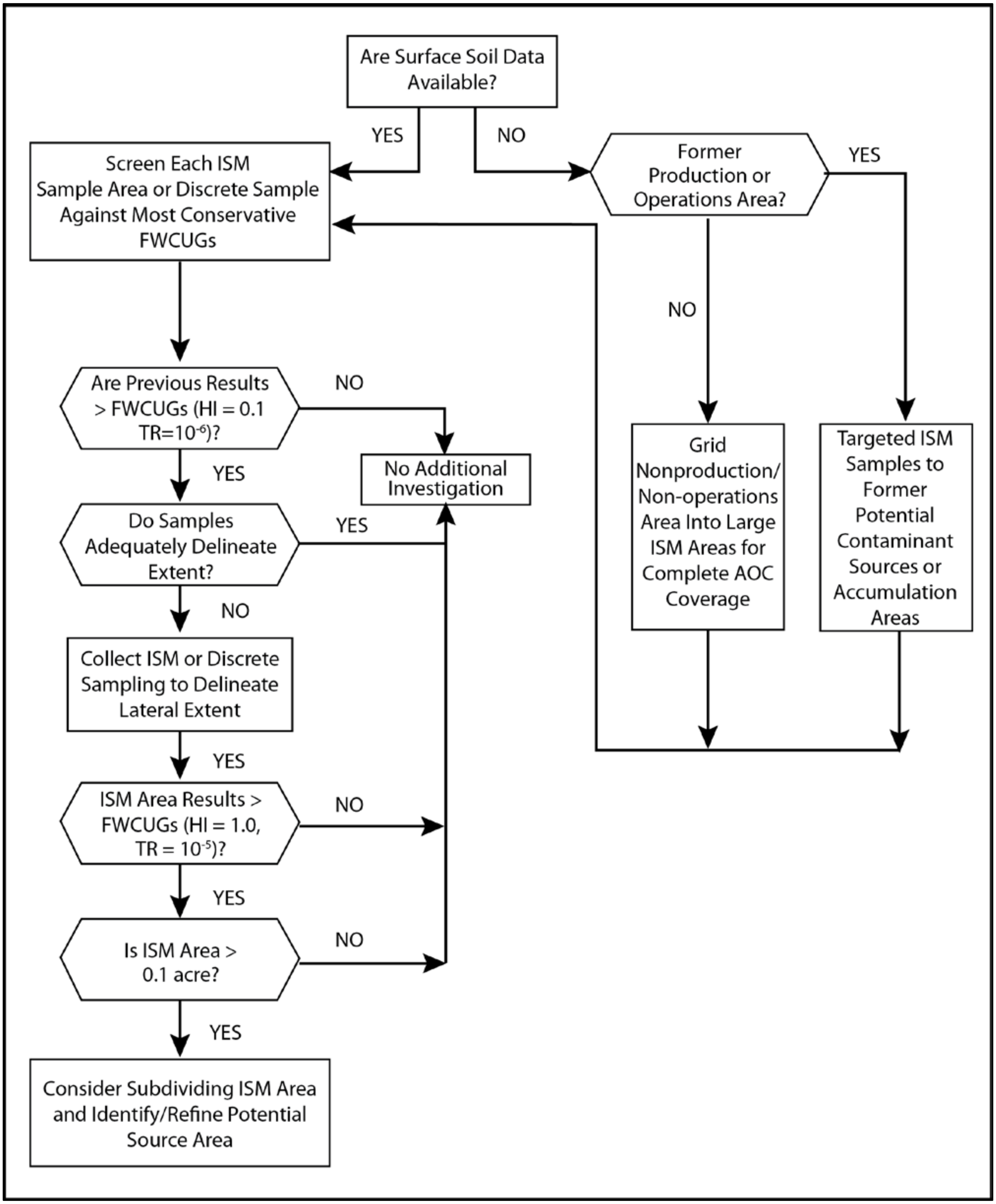


Figure 4-2. PBA08 RI Surface Soil Sampling

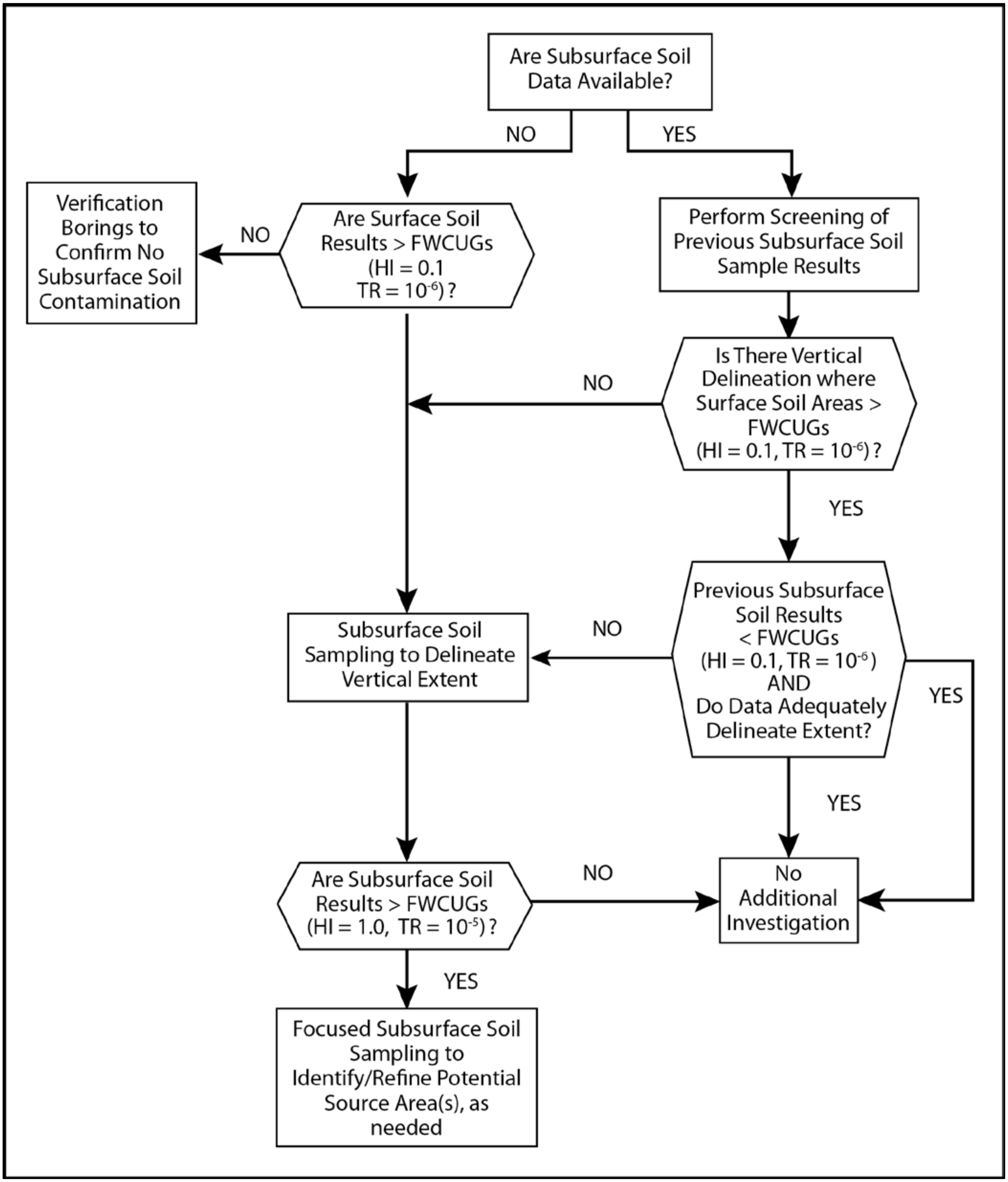
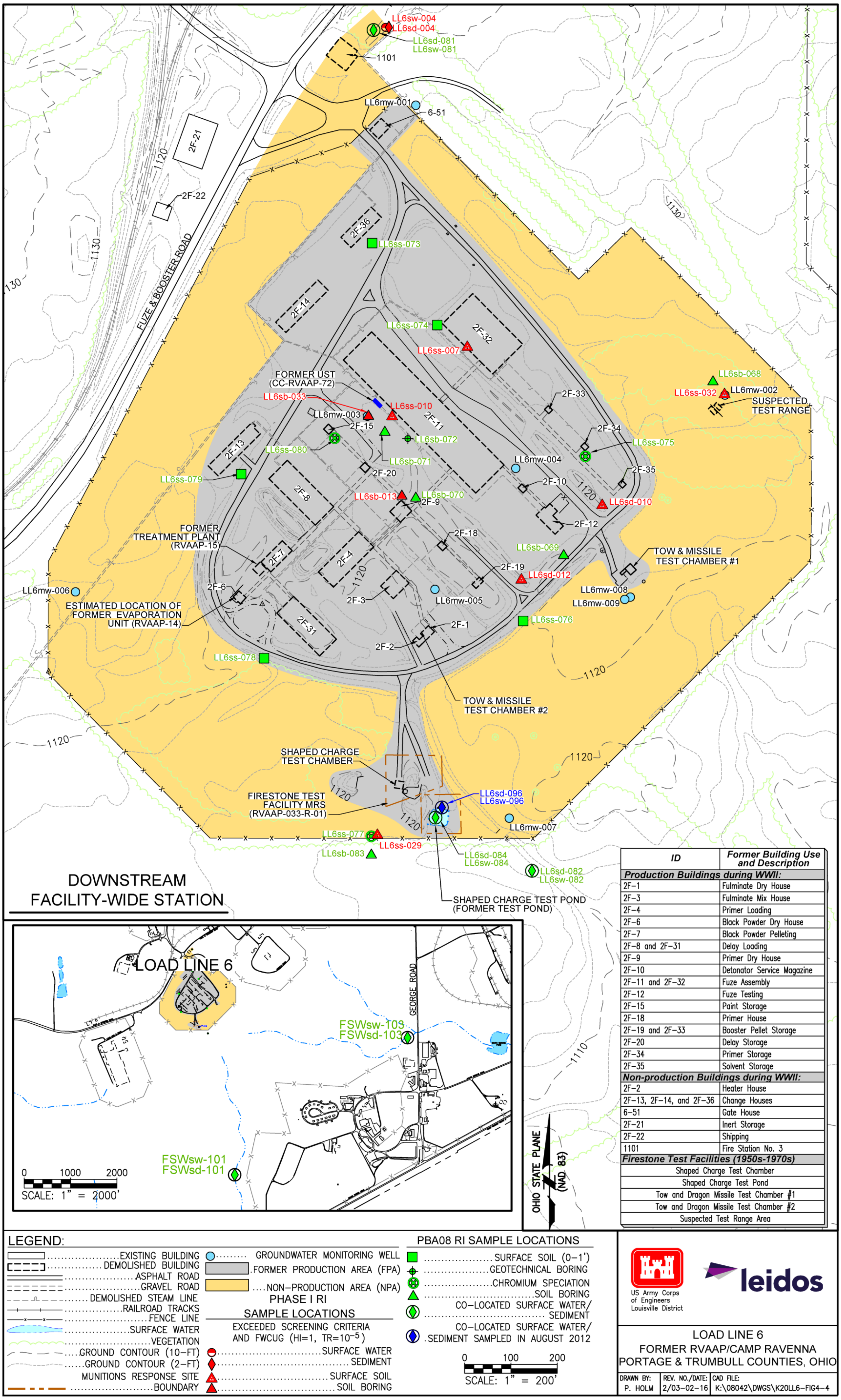


Figure 4-3. PBA08 RI Subsurface Soil Sampling



ID	Former Building Use and Description
Production Buildings during WWII:	
2F-1	Fulminate Dry House
2F-3	Fulminate Mix House
2F-4	Primer Loading
2F-6	Black Powder Dry House
2F-7	Black Powder Pelleting
2F-8 and 2F-31	Delay Loading
2F-9	Primer Dry House
2F-10	Detonator Service Magazine
2F-11 and 2F-32	Fuze Assembly
2F-12	Fuze Testing
2F-15	Paint Storage
2F-18	Primer House
2F-19 and 2F-33	Booster Pellet Storage
2F-20	Delay Storage
2F-34	Primer Storage
2F-35	Solvent Storage
Non-production Buildings during WWII:	
2F-2	Heater House
2F-13, 2F-14, and 2F-36	Change Houses
6-51	Gate House
2F-21	Inert Storage
2F-22	Shipping
1101	Fire Station No. 3
Firestone Test Facilities (1950s-1970s)	
Shaped Charge Test Chamber	
Shaped Charge Test Pond	
Tow and Dragon Missile Test Chamber #1	
Tow and Dragon Missile Test Chamber #2	
Suspected Test Range Area	

Figure 4-4. PBA08 RI Sample Locations at Load Line 6

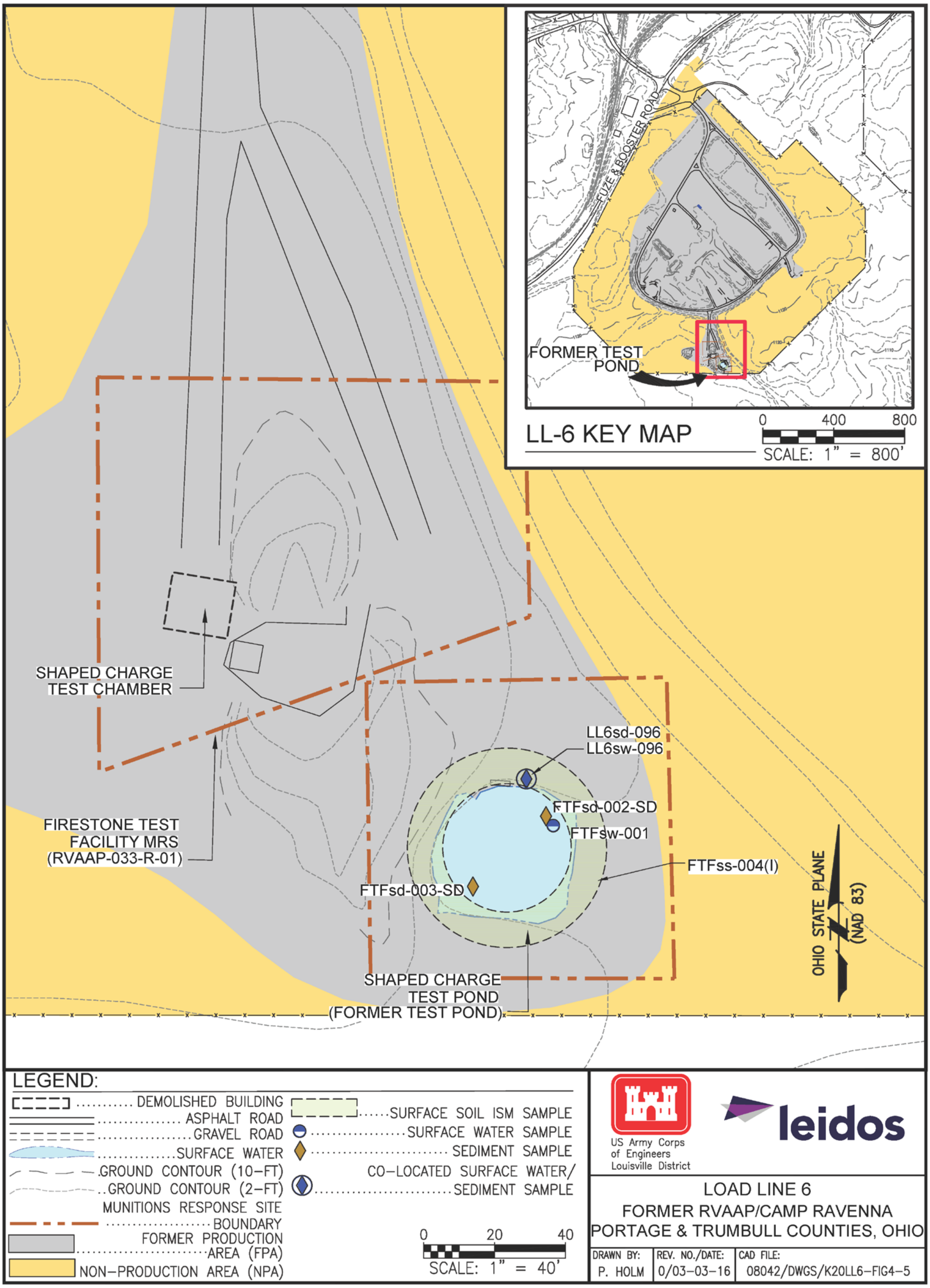


Figure 4-5. 2011/2012 Former Test Pond Sample Locations

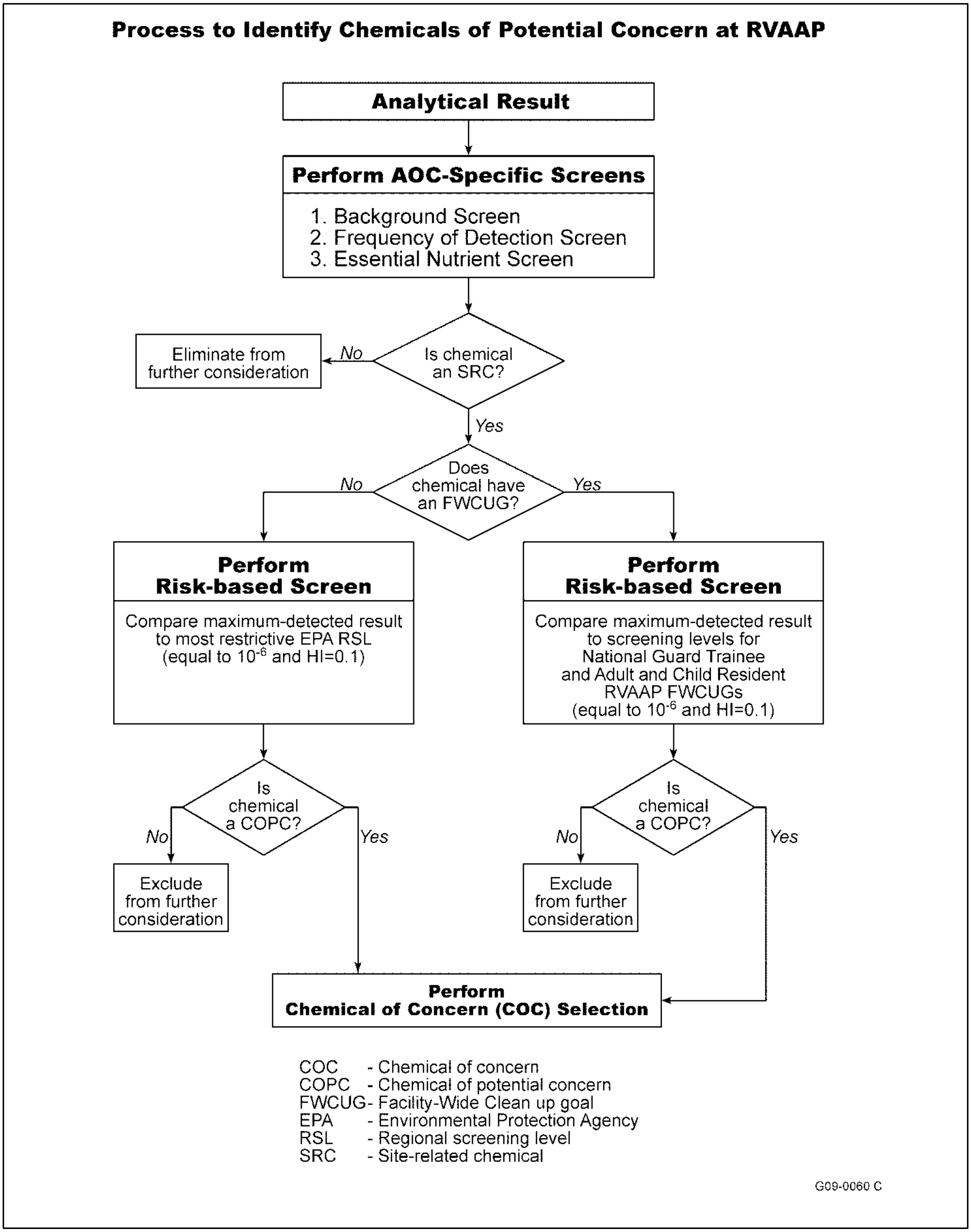


Figure 4-6. Process to Identify RVAAP COPCs in the HHRA (USACE 2010a)

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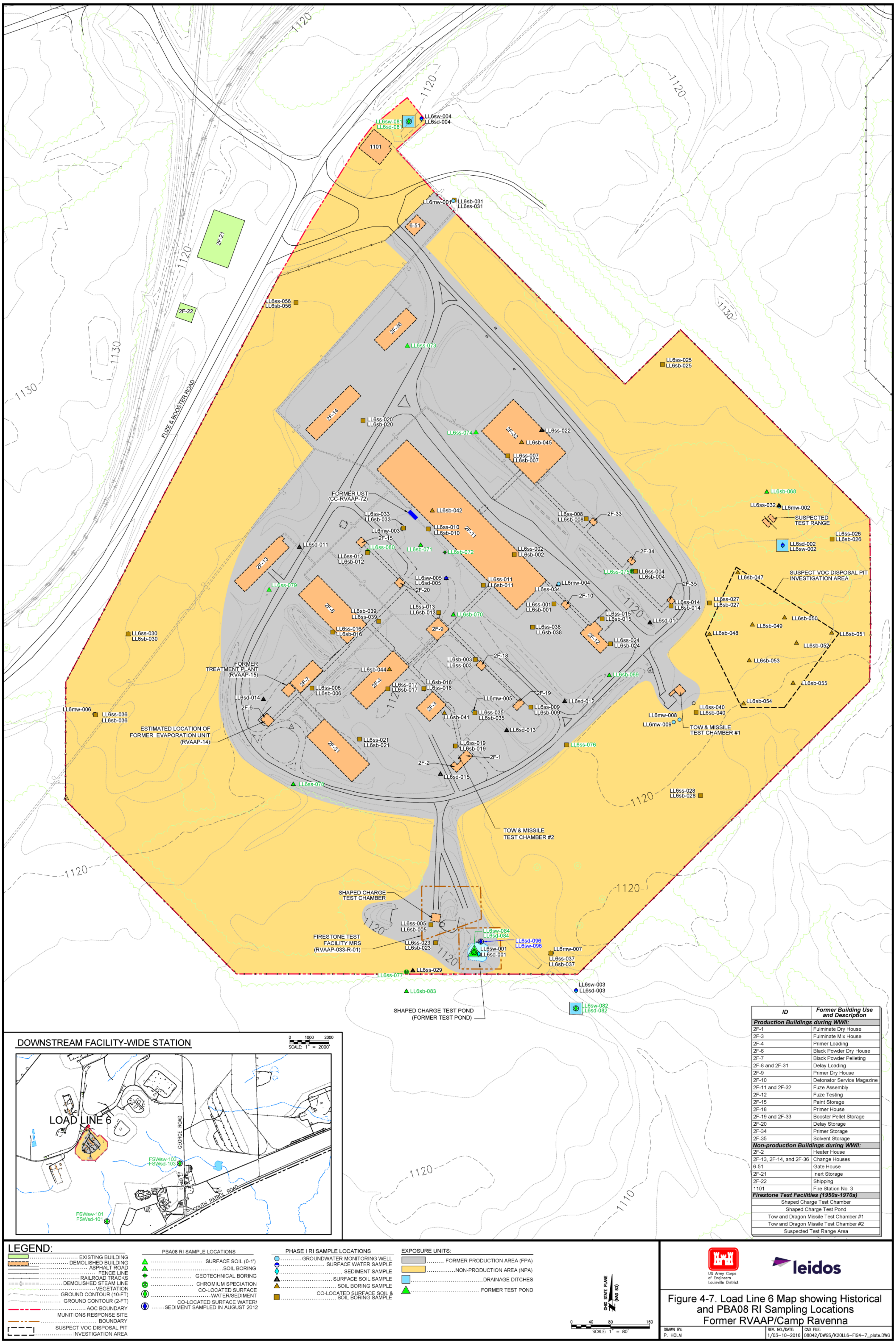

ID	Former Building Use and Description
Production Buildings during WWII:	
2F-1	Fulminate Dry House
2F-3	Fulminate Mix House
2F-4	Primer Loading
2F-6	Black Powder Dry House
2F-7	Black Powder Pelleting
2F-8 and 2F-31	Delay Loading
2F-9	Primer Dry House
2F-10	Detonator Service Magazine
2F-11 and 2F-32	Fuze Assembly
2F-12	Fuze Testing
2F-15	Paint Storage
2F-18	Primer House
2F-19 and 2F-33	Booster Pellet Storage
2F-20	Delay Storage
2F-34	Primer Storage
2F-35	Solvent Storage
Non-production Buildings during WWII:	
2F-2	Heater House
2F-13, 2F-14, and 2F-36	Change Houses
6-51	Gate House
2F-21	Inert Storage
2F-22	Shipping
1101	Fire Station No. 3
Firestone Test Facilities (1950s-1970s)	
Shaped Charge Test Chamber	
Shaped Charge Test Pond	
Tow and Dragon Missile Test Chamber #1	
Tow and Dragon Missile Test Chamber #2	
Suspected Test Range Area	

Figure 4-7. All Load Line 6 RI Sample Locations

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5.0 NATURE AND EXTENT OF CONTAMINATION

This section evaluates the nature and extent of contamination at Load Line 6. This evaluation includes two types of chemicals: 1) SRCs identified as being previously used during operational activities or that potentially were associated with operations, and 2) SRCs that did not appear to have been used during historical operations previously but were analyzed during investigations.

The evaluation discusses the nature and extent of SRCs in environmental media at Load Line 6, with a focus on chemicals previously used during operational activities, using analytical data results obtained during the 2002 lead azide screening, 2003 Phase I RI, and 2010 PBA08 RI. For purposes of this evaluation, references to the Phase I RI include samples collected in 2002 and 2003. Additional samples from the Former Test Pond were collected in 2011 and 2012 and are discussed in this section.

To support the evaluation of nature and extent of contamination, SRC concentrations were compared to SLs corresponding to the lowest FWCUG for the Resident Receptor (Adult and Child) and National Guard Trainee at a target HQ of 0.1 or TR of 1E-06, as presented in the FWCUG Report. If there was no FWCUG for a chemical, the EPA RSL was used as the SL. The following figures (within this section) illustrate the concentrations and distributions of SRCs that exceed SLs. For the inorganic chemicals, the figures are separated between inorganic chemicals that were potentially associated with AOC operations (i.e., antimony, arsenic, barium, cadmium, chromium, lead, and mercury) and inorganic SRCs that had exceedances of the SLs:

- Figure 5-1 – Exposure Units.
- Figure 5-2 – Detected Concentrations of Explosives and Propellants in Soil (Discrete Soil Borings).
- Figure 5-3 – Exceedances of FWCUGs (HQ of 0.1, TR of 1E-06) for Antimony, Arsenic, Barium, Cadmium, Chromium, Lead, and Mercury in Soil (Discrete Soil Borings).
- Figure 5-4 – Exceedances of FWCUGs (HQ of 0.1, TR of 1E-06) for Aluminum, Cobalt, Copper, and Manganese in Soil (Discrete Soil Borings).
- Figure 5-5 – Exceedances of FWCUGs (HQ of 0.1, TR of 1E-06) for PAHs in Soil (Discrete Soil Borings).
- Figure 5-6 – Detected Concentrations of VOCs, Pesticides, and PCBs in Soil (Discrete Soil Borings).
- Figure 5-7 – Detected Concentrations of Explosives and Propellants in Surface Water and Sediment.
- Figure 5-8 – Exceedances of FWCUGs (HQ of 0.1, TR of 1E-06) for Antimony, Arsenic, Barium, Cadmium, Chromium, Cobalt, Lead, Manganese, and Mercury in Surface Water and Sediment.

As discussed in Section 4.0, data from all eligible samples were combined and screened to identify SRCs representing current conditions at Load Line 6. All validated Load Line 6 data from the RIs (2002 lead azide screening, 2003 Phase I RI, 2010 PBA08 RI, and 2011 Former Test Pond samples) are included in Appendix D. Complete laboratory analytical data packages from the PBA08 RI are also included in Appendix D.

Contaminant nature and extent is presented below for each medium and class of analytes.

5.1 EXPOSURE UNITS DATA AGGREGATES

5.1.1 Soil Exposure Units

EUs were established at Load Line 6 as part of the data aggregation prior to the risk assessment evaluations. The EUs take into account how the areas were previously used and the extensiveness of potential contamination within a given area. In establishing EUs at Load Line 6, the area within the perimeter road is assumed to have the maximum exposure for future receptors; therefore, that area was identified as a separate EU (i.e., FPA) from the rest of the AOC (i.e., NPA). The FPA includes the area inside the perimeter road and all former buildings and operational areas. The NPA includes the area outside the production area to the fence line and the area just north of the AOC near former Building 1011 (Fire Station No. 3) at Fuze and Booster Road.

Soil at Load Line 6 is evaluated in the two EUs, as shown in Figure 5-1. The samples included in the soil EUs are located in Tables 5-1 and 5-2 for surface and subsurface soil, respectively.

5.1.2 Sediment and Surface Water Exposure Units

On-site surface water at Load Line 6 is limited to the Former Test Pond (a small pond formerly used for testing of explosives) and intermittently flooded drainage ditches or gullies. Consequently, two sediment and surface water EUs were established for Load Line 6. Sediment and surface water EUs at Load Line 6 are shown in Figure 5-1. The samples included in the surface water and sediment EUs are located in Tables 5-3 and 5-4, respectively.

The Drainage Ditches EU represents sediment and surface water sample locations where surface water is encountered year-round. Two sediment samples and three surface water samples are included in the Drainage Ditches EU data set.

During an underwater tactile investigation performed during the MMRP RI, it was revealed that the Former Test Pond is conical shaped with approximate 50-60 degree side slopes, approximately 35 ft in diameter, with a maximum depth of 14 ft. For the purposes of evaluating nature and extent of contamination, the Former Test Pond EU consists of four sediment samples and three surface water samples to characterize the pond and determine whether releases from the former testing had occurred. The samples collected as part of the MMRP RI (FTFsd-002-SD, FTFsd-003-SD, and FTFsw-001-0001-SW) and those collected in 2012 (LL6sd-096-5870-SD and LL6sw-096-5871-SW) were not used in the SRC screen, fate and transport, HHRA, or ERA.

5.2 SURFACE SOIL DISCRETE SAMPLE RESULTS FOR CHROMIUM SPECIATION

During the 2010 PBA08 RI, surface soil samples were collected from three discrete sample locations and analyzed for hexavalent chromium and total chromium. Two samples were collected from areas previously identified during the Phase I RI as having elevated total chromium concentrations (LL6ss-075 and LL6ss-077), and one sample was collected from an area previously identified as having a total chromium concentration near background concentrations (LL6ss-080). This sampling determined the contribution of hexavalent chromium to total chromium over a range of concentrations in soil at Load Line 6 for use in the HHRA (Section 7.2). Chromium speciation results are shown in Table 5-5. Two of three samples had a total chromium concentration below the facility-wide background concentration of 17.4 mg/kg, and one sample (LL6ss-075) had a total chromium concentration (27.3 mg/kg) exceeding the facility-wide background concentration. All three hexavalent chromium concentrations were non-detect and did not appear to be correlative to total chromium values. A detailed assessment of the speciation results respective to the HHRA is presented in Section 7.2.2.

5.3 CONTAMINANT NATURE AND EXTENT IN FORMER PRODUCTION AREA

Tables 4-23 and 4-25 present the results of the SRC screening for surface and subsurface soil, respectively, in the FPA at Load Line 6. The following subsections discuss the concentration and distribution of surface and subsurface soil results for the FPA.

5.3.1 Explosives and Propellants

Surface Soil

One explosive (HMX) and one propellant (nitrocellulose) were identified as SRCs in surface soil at the Load Lind 6 FPA and as potentially related to previous AOC operations. No other explosives were detected in surface soil in the FPA. The historical process buildings were evaluated for explosives and propellants during both of the investigations comprising of the RI data set. Specifically, the soil samples around the buildings were analyzed during the Phase I RI, and data gaps were assessed during the 2010 PBA08 RI.

Figure 5-2 presents the locations that had detectable concentrations of HMX and nitrocellulose. They are not considered COPCs because all concentrations are below the SL.

Subsurface Soil

Nitrocellulose was detected in five subsurface soil samples collected in the FPA. No other explosives were detected in subsurface soil in the FPA. The nitrocellulose detections occurred in the 1–3 ft bgs sample interval, with the MDC of 2.1 mg/kg at soil boring LL6sb-014, west of the former treatment plant. This MDC is well below the RSL of 19,000,000 mg/kg.

Figure 5-2 presents the locations that had detectable concentrations of nitrocellulose. Nitrocellulose is not considered a subsurface soil COPC because concentrations are below the SLs.

5.3.2 Inorganic Chemicals

Surface Soil

Antimony, arsenic, barium, cadmium, chromium, lead, and mercury were identified as potential inorganic SRCs and as potentially related to previous AOC operations. Of these seven inorganic chemicals, all except antimony had an MDC exceeding their respective background concentrations at the FPA, as summarized below:

- Antimony was not detected above its background concentration (0.96 mg/kg) in the FPA.
- Arsenic was detected above its background concentration (15.4 mg/kg) in three samples, with an MDC of 41 mg/kg observed at sample location LL6ss-007, which is adjacent to former Building 2F-32.
- Barium was detected above its background concentration (88.4 mg/kg) in eight samples, with an MDC of 153 mg/kg observed at sample location LL6ss-076, which was collected from a ditch along on southeast side of the perimeter road.
- Cadmium had one detection above the FWCUG at a TR of 1E-06, HQ of 0.1 (6.41 mg/kg) in 1 of 44 samples, with an MDC of 6.8 mg/kg at sample location LL6sb-002. This sample location is within the footprint of former Building 2F-11.Total chromium was detected above its background concentration (17.4 mg/kg) in 13 samples, with an MDC of 23 mg/kg observed at sample location LL6ss-075, which is adjacent to former Building 2F-34.
- Lead was detected above its background concentration (26.1 mg/kg) in 18 samples, with an MDC of 180 mg/kg observed at sample location LL6ss-034, which is immediately adjacent to the southeast portion of former Building 2F-11. The maximum lead detection was two times that of the next highest concentration, 90 mg/kg at sample location LL6ss-022, also located north of Building 2F-32.
- Mercury was detected above its background concentration (0.036 mg/kg) in 15 samples, with an MDC of 0.6 mg/kg observed at sample location LL6ss-017, which is located immediately adjacent to former Building 2F-4.

Figure 5-3 presents the locations with concentrations that exceeded SLs and background for these seven chemicals. When evaluating these chemicals against their SLs (using the trivalent chromium FWCUG for chromium and the RSL of 400 mg/kg for lead), antimony, barium, chromium, lead, and mercury concentrations were all below their SLs; therefore, these chemicals were not considered COPCs. Arsenic and cadmium are the only inorganic chemicals potentially related to previous AOC use that are considered COPCs in the FPA.

Although not identified as previously used during historical operations, eight other inorganic chemicals were identified as SRCs from the RVAAP screening process, as presented in Table 4-23. Of these eight chemicals, three (cobalt, copper, and manganese) exceeded their respective SLs for the Resident Receptor (Adult and Child) or National Guard Trainee FWCUG at a TR of 1E-06, HQ of 0.1

and background concentrations at the FPA, as presented in Figure 5-4. No apparent spatial trend in the distribution of inorganic chemicals throughout the AOC is evident. Observations regarding the three other individual inorganic SRCs in Load Line 6 surface soil are presented below:

- Cobalt was detected above the background concentration of 10.4 mg/kg in 10 of 44 samples, with an MDC of 23.9 mg/kg at sample location LL6ss-076. This sample location is in the southeastern edge of the FPA across from the road.
- Copper had a single detection above the FWCUG at a TR of 1E-06, HQ of 0.1 (311 mg/kg) in 1 of 44 samples, with an MDC of 627 mg/kg at sample location LL6sb-002. This sample location is within the footprint of former Building 2F-11.
- Manganese had a single detection above the background concentration of 1,450 mg/kg in 1 of 44 samples, with an MDC of 1,820 mg/kg at sample location LL96ss-078. This sample location is in the southern portion of the FPA along the road. The MDC exceeded the National Guard Trainee FWCUG at a TR of 1E-05, HQ of 1 (351 mg/kg), as displayed on Figure 5-4.

Subsurface Soil

Antimony, arsenic, barium, cadmium, chromium, lead, and mercury were identified as potential inorganic contaminants from previous AOC operations. Of these seven inorganic chemicals, all except antimony and barium had an MDC exceeding their respective background concentrations. When further evaluating these seven chemicals against their SLs (using the trivalent chromium FWCUG for chromium and the RSL of 400 mg/kg for lead), only arsenic had exceedances at the FPA, as presented in Figure 5-3.

Arsenic was detected above its background concentration (19.8 mg/kg) in 2 of 38 subsurface samples, with an MDC of 26 mg/kg observed at 6–8 ft bgs at sample location LL6sb-033. This sample location is adjacent to former Building 2F-11. This boring installed in 2003 did not have a deeper sample; therefore, an additional boring (LL6sb-071) was installed in 2010 to fill this data gap. The arsenic concentration in the 4-7 ft bgs sample interval from LL6sb-071 was 10.2 mg/kg, which is well below the subsurface background concentration.

Although not identified as previously used during historical operations, six other inorganic chemicals were identified as SRCs from the RVAAP screening process, as presented in Table 4-25. Of these six chemicals, only cobalt exceeded the SL at a TR of 1E-06, HQ of 0.1 and background concentrations at one location (LL6sb-016) in the FPA, as presented in Figure 5-4. Additionally, copper detected above the SLs in surface soil were not detected above the SLs in subsurface soil.

No apparent spatial trend in the distribution of inorganic chemicals throughout the subsurface soil within the FPA is evident.

5.3.3 Semi-volatile Organic Compounds

Surface and Subsurface Soil

SVOCs do not have background concentrations for comparison with chemical results; consequently, a large number of SVOCs were identified as surface soil SRCs. Of the 15 SVOC SRCs identified, concentrations of 2 PAHs [benzo(a)pyrene and dibenz(a,h)anthracene] exceeded their respective SLs and were identified as COPCs in FPA surface soil.

No surface or subsurface soil samples had PAH concentrations greater than their respective Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Furthermore, no subsurface soil samples had PAH concentrations greater than their respective Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1, with the exception of four PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] that exceeded their respective SLs. These four PAHs were identified as COPCs, with all the exceedances being at one location (LL6sb-024) in the FPA, as presented in Figure 5-5.

5.3.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

One pesticide [4,4’-dichlorodiphenyldichloroethylene (DDE)], two PCBs (PCB-1254 and PCB-1260), and two VOCs (methylene chloride and toluene) were identified as SRCs in surface soil at the FPA, as presented in Table 4-23. Most detections were at low, estimated concentrations below laboratory detection limits, and all were below their respective FWCUG at a TR of 1E-06, HQ of 0.1 and, therefore, were not identified as COPCs. No pesticides or PCBs were detected in subsurface soil above the SLs.

Only two VOCs (acetone and toluene) were identified as SRCs in subsurface soil at only one sample location (LL6sb-069) in the FPA at low, estimated concentrations below laboratory detection limits and the FWCUG at a TR of 1E-06, HQ of 0.1. The only potential source for VOCs in the FPA is the former solvent storage building (2F-35). Soil boring LL6sb-014 was collected to evaluate VOCs in the vicinity of former Building 2F-35, and no VOCs were detected. These detections were sporadic and isolated in distribution and extent and do not exhibit an apparent trend, as presented in Figure 5-6.

5.4 CONTAMINANT NATURE AND EXTENT IN NON-PRODUCTION AREA

Tables 4-24 and 4-26 present the results of the SRC screening for surface and subsurface soil, respectively, in the NPA at Load Line 6. The following subsections discuss the concentrations and distributions of surface and subsurface soil results for the NPA.

5.4.1 Explosives and Propellants

Surface and Subsurface Soil

No explosives or propellants were detected in the surface or subsurface soil samples in the NPA.

5.4.2 Inorganic Chemicals

Surface Soil

Antimony, arsenic, barium, cadmium, chromium, lead, and mercury were identified as potential inorganic SRCs and as potentially related to previous AOC operations at Load Line 6. Of these seven inorganic chemicals, all except antimony had a maximum detection in exceedance of their respective background concentrations at the NPA, as summarized below:

- Antimony was not detected above the background concentration (0.96 mg/kg) in surface soil in the NPA.
- Arsenic was detected above its background concentration (15.4 mg/kg) in one sample, with an MDC of 31.1 mg/kg observed at sample location LL6sd-081, which is located within an area that receives transient runoff sourced from the Fuze and Booster Road and former Building 1101 vicinity. Sample location LL6sd-081 was originally classified as a sediment sample but was reclassified due to the transient nature of surface water at this location, which exists only as standing water following rain events.
- Barium was detected above its background concentration (88.4 mg/kg) in four samples, with an MDC of 180 mg/kg observed at sample location LL6ss-032.
- Cadmium was detected in 3 of 15 samples with an MDC of 2.4 mg/kg at sample location LL6sd-081. No background concentration is available for cadmium, however all three detections were below the FWCUG at a TR of 1E-06, HQ of 0.1 (6.41 mg/kg).Total chromium was detected above its background concentration (17.4 mg/kg) in five samples, with an MDC of 26.7 mg/kg observed at sample location LL6sd-081.
- Lead was detected above its background concentration (26.1 mg/kg) in one sample, with an MDC of 117 mg/kg observed at sample location LL6sd-081.
- Mercury was detected above its background concentration (0.036 mg/kg) in three samples, with an MDC of 0.14 mg/kg observed at sample location LL6sd-081.

Figure 5-3 presents the locations with concentrations that exceeded SLs and background for these seven chemicals. When evaluating these chemicals against their SLs (using the trivalent chromium FWCUG for chromium and the RSL of 400 mg/kg for lead), antimony, barium, cadmium, chromium, lead, and mercury concentrations were all below their SLs; therefore, these chemicals were not considered COPCs. Arsenic is the only inorganic chemical potentially related to previous AOC operations that is considered a COPC in the NPA.

Although not identified as previously used during historical operations, 10 other inorganic chemicals were identified as SRCs from the RVAAP screening process, as presented in Table 4-24. Of these 10 chemicals, 3 (aluminum, cobalt, and manganese) exceeded their respective SLs for the National Guard Trainee or Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1 and background concentrations at the NPA and are identified as COPCs. No apparent spatial trend in the distribution of inorganic chemicals throughout the AOC is evident.

Observations regarding the three other individual inorganic SRCs in Load Line 6 surface soil are presented below:

- Aluminum was detected above the background concentration (17,700 mg/kg) in two samples, with an MDC of 18,000 mg/kg at two locations (LL6sb-032 and LL6sb-029) within the NPA.
- Cobalt was detected above the background concentration (10.4 mg/kg) in three samples, with an MDC of 12.4 mg/kg at sample location LL6sb-083, which is south of the Firestone Test Facility MRS.
- Manganese was detected above the background concentration (1,450 mg/kg) in one sample, with an MDC of 1,800 mg/kg at sample location LL6sb-032, which is adjacent to the suspected test range, which exceeded the NGT FWCUG at a TR of 1E-05, HQ of 1 (351 mg/kg), as displayed on Figure 5-4.

Subsurface Soil

Antimony, arsenic, barium, cadmium, chromium, lead, and mercury were identified as potential inorganic contaminants from previous AOC operations. Of these seven inorganic chemicals, only barium and cadmium had an MDC exceeding their respective background concentrations. However their MDCs were below their respective SLs at a TR of 1E-06, HQ of 0.1 and, therefore, are not subsurface soil COPCs in the NPA, as presented in Figure 5-3.

As shown in Table 4-26, the only other SRCs for NPA subsurface soil are beryllium, selenium, and silver. None of these SRC MDCs exceeded their respective SLs at a TR of 1E-06, HQ of 0.1 and, therefore, are not subsurface soil COPCs in the NPA. Additionally, none of the surface soil SRCs were above the SLs in the subsurface soil.

5.4.3 Semi-volatile Organic Compounds

Surface and Subsurface Soil

SVOCs do not have background concentrations for comparison with chemical results; consequently, a large number of SVOCs were identified as surface soil SRCs, as presented in Table 4-24. Of the 11 SVOC SRCs identified, the concentration of 1 PAH [benzo(a)pyrene] exceeded the SL and was identified as a COPC in NPA surface soil. Only one location (LL6sb-068) in the eastern portion of the NPA, close to the fence line, had a benzo(a)pyrene concentration (0.055 mg/kg) greater than the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1, but below a TR of 1E-05, HQ of 1, as presented in Figure 5-5. Benzo(a)pyrene was not detected in subsurface soil samples collected in the NPA.

All surface and subsurface samples collected in the NPA had PAH concentrations below their respective Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1.

5.4.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

There were no VOCs detected in surface or subsurface soil, nor were any identified as SRCs, as presented in Tables 4-24 and 4-26, respectively. As discussed in Section 4.2.2.1, a Suspect VOC Disposal Pit to the east of the former solvent storage building (Building 2F-35) was assessed during the Phase I RI. Of the 10 borings installed to assess this area, none of the borings had VOCs detected during the field screening. Also, of the four samples sent to the analytical laboratory, none had detections of TPH (DRO and GRO) or VOCs. The only SVOC detected was at LL6sb-049 with an estimated concentration of 0.02J mg/kg of di-n-octylphthalate. Thus, no evidence of contamination is present from the Suspect VOC Disposal Pit. Pesticides and PCBs were not evaluated in the NPA, as historical use of these areas did not indicate potential pesticide or PCB contamination.

5.5 CONTAMINANT NATURE AND EXTENT IN SEDIMENT AND SURFACE WATER

Similar to the soil contaminant nature and extent evaluation, sediment and surface water at Load Line 6 were evaluated by two EUs (Drainage Ditches and Former Test Pond).

For the Drainage Ditches, two sediment and three surface water samples were evaluated, as presented in Tables 5-3 and 5-4. The co-located sediment and surface water samples (LL6sd/sw-082) were analyzed for RVAAP full-suite analytes. Sample location LL6sd/sw-081 was proposed in the Sampling and Analysis Plan for surface water and sediment sampling. However, the sediment sample at this location was reclassified and evaluated as surface soil due the presence of ephemeral water based on field observations. Tables 4-27 and 4-29 present the sediment and surface water SRC screening results, respectively, for the Drainage Ditches.

For the Former Test Pond, one co-located sediment and surface water sample (LL6sd/sw-084) was used for the SRC screening for the Former Test Pond. This sample was collected in April 2010 during the PBA08 RI. The surface water sample was analyzed for RVAAP full-suite analytes, and the sediment sample was analyzed for TAL metals and explosives. Tables 4-28 and 4-30 present the sediment and surface water SRC screening results, respectively, for the Former Test Pond. In addition, two sediment samples (FTFsd-002-SD and FTFsd-003-SD) and one surface water sample (FTFsw-001-0001-SW) were collected in August 2011 during the MMRP RI, and one sediment sample (LL6sd-096-5870-SD) and surface water sample (LL6sw-096-5871-SW) were collected in August 2012. While these samples were not included in the SRC screen for the Former Test Pond EU, the results of these samples are discussed in this nature and extent evaluation.

In addition to the samples collected within the AOC boundaries, surface water and wet sediment samples were collected during the PBA08 RI at potential exit points from the Fuze and Booster Hill area (which includes Load Lines 5 through 11) and near the southern boundary of RVAAP/Camp Ravenna to determine nature and extent. Four surface water and co-located composite wet sediment samples were collected from these areas in order to characterize current conditions and assess potential exit pathways from the area. This report provides an evaluation of two of these samples (FWSsd/sw-101 and FWSsd/sw-103) that are south and southeast of Load Line 6. Sample location FWSsd/sw-101 was collected within the tributary directly south of Load Line 6, and sample location

FWSsd/sw-103 was collected within the channel to the southeast of the AOC which drains to the east. All samples were analyzed for the RVAAP full suite of parameters. The data tables for these samples are included in Appendix D.

5.5.1 Explosives and Propellants

Drainage Ditches

No explosives or propellants were detected in the Drainage Ditches sediment samples.

As shown in Figure 5-7, two explosives were identified as SRCs in surface water samples at the Drainage Ditches. Nitrocellulose was detected at an estimated concentration of 0.24J mg/L in sample location LL6sw-082, collected from the storm water drainage discharge point exiting the south side of Load Line 6. HMX was also detected at sample location LL6sw-082 at a low, estimated concentration of 0.00008 mg/L. Both detections were below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1, and were, therefore, not considered COPCs.

Former Test Pond

One explosive (tetryl) was detected in sediment at sample location LLsd-084 at an estimated concentration of 0.031J mg/kg, collected from the Former Test Pond. This detection was below the RSL at a TR of 1E-06, HQ of 0.1, and is, therefore, not considered a COPC. One explosive (HMX) was detected in surface water at sample location LLsw-084 at an estimated concentration of 0.000062J mg/L collected from the Former Test Pond. This detection was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1, and is, therefore, not considered a COPC. None of the surface water or sediment samples collected in 2011 or 2012 had detections of explosives or propellants.

Downstream of Fuze and Booster Hill

No explosives or propellants were detected in the Downstream of Fuze and Booster Hill sediment samples. HMX was detected in both surface water samples. FWSsw-101 had an HMX concentration of 0.000088J mg/L and FWSsw-103 had an HMX concentration of 0.00028 mg/L. Both detected concentrations were well below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1 of 0.782 mg/L. RDX was detected in the surface water sample from FWSsw-103 at a concentration of 0.00053 mg/L. The detected concentration was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1 of 0.0155 mg/L.

5.5.2 Inorganic Chemicals

Drainage Ditches

As shown in Table 4-27, five inorganic chemicals were identified as SRCs in the Drainage Ditches sediment samples. Only cobalt was detected above its background and screening criteria, at a concentration of 12.8 mg/kg collected at sample location LL6sd-082. This sample location is at a storm water drainage discharge point exiting the south side of Load Line 6, as presented in Figure 5-8. At this same location, the surface water concentration for cobalt exceeded the RSL at a TR of 1E-05, HQ of 1. However, cobalt was not detected above its RSL in the Downstream of Fuze and Booster Hill surface water samples (FWSsw-101 or FWSsw-103).

As shown in Table 4-29, 14 inorganic chemicals were identified as SRCs in the Drainage Ditches surface water samples. However, only cobalt and manganese were detected above their respective SLs in surface water at sample location LL6sw-002 but were not detected above background in sediment at this location, as presented in Figure 5-8. Additionally, the surface water concentration for cobalt (0.0072 mg/L) exceeded the RSL at a TR of 1E-05, HQ of 1 (0.006 mg/L) at sample location LL6sw-082, and the cobalt concentration in sediment (12.8 mg/kg) exceeded the RSL at a TR of 1E-06, HQ of 0.1 at the same location (2.3 mg/kg) but was below the RSL at a TR of 1E-05, HQ of 1 (23 mg/kg).

Former Test Pond

As shown in Table 4-28, eight inorganic chemicals were identified as SRCs in the Former Test Pond using sediment sample LL6sd-084 collected in 2010. Only cobalt was detected above its background and screening criteria at a concentration of 11.7 mg/kg but was less than the RSL (23 mg/kg) at a TR of 1E-05, HQ of 1, as presented in Figure 5-8. In the 2012 sample, cobalt had a reduced concentration in sediment of 5.9 mg/kg. In the 2011 and 2012 samples, aluminum had an MDC of 14,700 mg/kg and was the only inorganic chemical that exceeded its SL; however, this concentration was below the RSL at a TR of 1E-05, HQ of 1 (34,960 mg/L).

As shown in Table 4-30, three inorganic chemicals were identified as SRCs in Former Test Pond surface water sample LL6sw-084 collected in 2010. However, all samples were below their respective SLs; therefore, they are not considered COPCs. In addition, all inorganic chemicals analyzed in the 2011 and 2012 surface water samples were also below the SLs.

Downstream of Fuze and Booster Hill

Cobalt was the only inorganic chemical detected above the SL in sediment at the two sample locations. Cobalt was detected in FWSsw-103 at a concentration of 10.2 mg/kg which exceeded the RSL at a TR of 1E-06, HQ of 0.1 (2.3 mg/kg) but was below the RSL at a TR of 1E-05, HQ of 1 (23 mg/kg). No inorganic chemicals were detected above the SL in surface water at the two sample locations.

5.5.3 Semi-volatile Organic Compounds

Drainage Ditches

No SVOCs were identified as SRCs in the Drainage Ditches sediment samples.

As shown in Table 4-29, one SVOC (4-methylphenol) was identified as an SRC in surface water samples at the Drainage Ditches but was detected below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1, and, therefore, is not considered a COPC.

Former Test Pond

No SVOCs were identified as SRCs in Former Test Pond surface water or sediment samples using the 2010 samples. In the 2011 and 2012 samples, only bis(2-ethylhexyl)phthalate at an estimated concentration of 0.0009 mg/L and di-n-butyl phthalate at an estimated concentration of 0.00075J mg/L were detected in surface water samples, and fluoranthene at an estimated concentration of 0.0098J mg/kg was detected in the sediment samples. These concentrations are below their respective SLs.

Downstream of Fuze and Booster Hill

No SVOCs were detected in Downstream of Fuze and Booster Hill sediment or surface water samples.

5.5.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

Drainage Ditches

No VOCs, pesticides, or PCBs were identified as SRCs in the Drainage Ditches sediment samples.

One VOC (acetone) was identified as an SRC in surface water samples at the Drainage Ditches, as presented in Table 4-29, but was detected below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1, and, therefore, is not considered a COPC. Also, no pesticides or PCBs were identified as SRCs in surface water samples collected within the Load Line 6 Drainage Ditches.

Former Test Pond

No VOCs, pesticides, or PCBs were identified as SRCs in the Former Test Pond sediment sample collected in 2010. In the 2012 sample, two VOCs, 2-butanone and methylene chloride, had detections at estimated concentrations of 0.0053J mg/kg and 0.0023J mg/kg, respectively. These concentrations are below their respective SLs.

One pesticide [beta-hexachlorocyclohexane (BHC)] was identified as an SRC in 2010 surface water sample at the Former Test Pond, as presented in Table 4-30, but was detected below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1, and, therefore, is not considered a COPC. Beta-BHC was not detected in the 2012 surface water sample.

No VOCs or PCBs were identified as SRCs in surface water samples collected within the Former Test Pond using the 2010 surface water sample. 2-Butanone was detected at an estimated concentration of

0.00072J mg/L in the 2012 sample and 4,4'-DDT was detected at an estimated concentration of 0.00002J mg/L in the 2011 sample. Both concentrations were below their SLs.

Downstream of Fuze and Booster Hill

No PCBs were detected in sediment or surface water samples and only low, estimated concentrations of toluene at 0.00041J mg/kg in sediment at FWS-103 and gamma-chlordane at 0.000048J mg/L in surface water at FWS-101 were detected. All other VOCs and pesticides had non-detectable concentrations.

5.6 GEOTECHNICAL SUBSURFACE SOIL SAMPLE

One soil boring was completed at Load Line 6 for the purposes of obtaining geotechnical parameters to perform vadose zone soil leaching and groundwater transport modeling. Two samples were collected from this soil boring from the 4-5 and 9-10.5 ft bgs intervals, directly above the only moist zones observed in the pilot boring as discussed in Appendix A. Soil boring LL6sb-072 was advanced to a depth of 21.25 ft bgs, with weathered shale encountered at the terminal depth, and groundwater encountered 11.5 ft bgs. Table 5-6 summarizes the results of the geotechnical characteristics of Load Line 6 soil. Laboratory analytical data package results are presented in Appendix D.

5.7 SUMMARY OF CONTAMINANT NATURE AND EXTENT

5.7.1 Soil

Data from the 2002 lead azide screening, 2003 Phase I RI, and 2010 PBA08 RI were used to identify SRCs at Load Line 6, and data from samples collected in 2011 and 2012 were used to provide additional assessment of the Former Test Pond. Collectively, this data set effectively characterizes the nature and extent of the contamination at the AOC. To support the evaluation of nature and extent of contamination, SRC concentrations were compared to SLs corresponding to the lowest FWCUG for the Resident Receptor (Adult and Child) and National Guard Trainee at a target HQ of 0.1 or TR of 1E-06, as presented in the FWCUG Report. If there was no FWCUG for a chemical, the EPA RSL was used as the SL. Based on the information provided earlier in this section and the summary below, it can be concluded that the vertical and horizontal extent of contamination is defined, and no further sampling is needed to evaluate Load Line 6.

Locations where explosives were identified as potential contaminants from previous use were thoroughly evaluated, including around former process buildings and across each EU. The maximum concentrations of explosives and propellants were all below their respective SLs and were not considered COPCs. In addition, the 2002 lead azide screening had field tests conducted for TNT and RDX using the Jenkins method. No explosives were detected above SLs in any of the surface soil, sediment, or surface water samples.

As identified in the Phase I RI Report, concentrations of contaminants are generally low. No apparent spatial trend in the distribution of inorganic chemicals throughout the AOC is evident. Inorganic chemicals, specifically arsenic and manganese concentrations, detected across the entire AOC were generally higher in samples taken from the FPA.

Seven inorganic chemicals (antimony, arsenic, barium, cadmium, chromium, lead, and mercury) were identified as potential inorganic SRCs and as potentially related to previous AOC operations. When evaluating these chemicals against their SLs (using the trivalent chromium FWCUG for chromium and the RSL of 400 mg/kg for lead), antimony, barium, chromium, lead, and mercury concentrations were all below their SLs; therefore, these chemicals were not considered COPCs for the FPA or NPA. Arsenic and cadmium are the only inorganic chemicals potentially related to previous AOC operations that are considered COPCs in surface soil at the FPA and NPA.

Arsenic is considered a COPC in surface soil at the FPA and NPA, with an MDC of 41 mg/kg at sample location LL6sb-007. However, subsurface soil was below the SL at this location. Arsenic was detected above its background concentration (19.8 mg/kg) in 2 of 38 subsurface samples, with an MDC of 26 mg/kg observed at 6–8 ft bgs at sample location LL6sb-033, which is adjacent to former Building 2F-11. This boring, installed in 2003, did not have a deeper sample; therefore, an additional boring (LL6sb-071) was installed in 2010 to fill this data gap. The arsenic concentration in the 4-7 ft bgs sample interval from sample location LL6sb-071 was 10.2 mg/kg, which is well below the subsurface background concentration.

Cadmium was not identified as a COPC in the NPA. Cadmium had one detection above the FWCUG at a TR of 1E-06, HQ of 0.1 (6.41 mg/kg) in 1 of 44 samples collected in the FPA, with an MDC of 6.8 mg/kg at sample location LL6sb-002. However, subsurface soil was below the SL at this location and throughout the FPA and NPA.

Manganese had a single detection above the background concentration of 1,450 mg/kg, with an MDC of 1,820 mg/kg at sample location LL96ss-078. This sample location is in the southern portion of the FPA along the road, which exceeded the National Guard Trainee FWCUG at a TR of 1E-05, HQ of 1 (351 mg/kg). Another isolated exceedance at a similar concentration was observed in the NPA at sample location LL6sb-032, the suspected test range. However, manganese was detected below the SL in subsurface soil at this location.

None of the detected concentrations of SVOCs, VOCs, pesticides, or PCBs in surface or subsurface soil were above the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Building 2F-35 was the only building at Load Line 6 whose purpose was solvent storage. The sample associated with former Building 2F-35 (LL6sb-014) had no detectable concentrations of VOCs in soil. A Suspect VOC Disposal Pit to the east of this building was assessed during the Phase I RI. Of the 10 borings installed to assess this area, none of the borings had VOCs detected during the field screening. Also, of the four samples sent to the analytical laboratory, none had detections of TPH (DRO and GRO) or VOCs. The only SVOC detected was at LL6sb-049 with an estimated concentration of 0.02J mg/kg of di-n-octylphthalate. Thus, no evidence of VOC contamination is present from the Suspect VOC Disposal Pit.

5.7.2 Sediment and Surface Water

The Drainage Ditches EU was evaluated with two sediment and three surface water samples. No explosives or propellants were detected in the Drainage Ditches sediment samples. Nitrocellulose and HMX were detected at low, estimated concentrations at sample location LL6sw-082 in the Drainage Ditches surface water. Both concentrations were below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. No sediment or surface water concentrations for metals in the Drainage Ditches samples exceeded the RSL at a TR of 1E-05, HQ of 1 except for the surface water concentration for cobalt at LL6sw-082. No SVOCs were identified as SRCs in the Drainage Ditches sediment samples, and only one SVOC (4-methylphenol) was identified as an SRC in surface water samples at the Drainage Ditches. 4-Methylphenol had a concentration below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1. No VOCs, pesticides, or PCBs were identified as SRCs in the Drainage Ditches sediment samples, and only one VOC (acetone) was identified as an SRC in surface water samples at the Drainage Ditches. The concentration of acetone was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1.

The Former Test Pond was assessed with one co-located sediment and surface water sample (LL6sd/sw-084) collected during the 2010 PBA08 RI, two sediment samples (FTFsd-002-SD and FTFsd-003-SD) and one surface water sample (FTFsw-001-0001-SW) collected in August 2011 during the MMRP RI, and one sediment sample (LL6sd-096-5870-SD) and surface water sample (LL6sw-096-5871-SW) collected in August 2012. One explosive (tetryl) was detected in sediment at sample location LLsd-084 at an estimated concentration of 0.031J mg/kg. This detection was below the RSL at a TR of 1E-06, HQ of 0.1, and is, therefore, not considered a COPC. One explosive (HMX) was detected in surface water at sample location LLsw-084 at an estimated concentration of 0.000062J mg/L collected from the Former Test Pond. This detection was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1, and is, therefore, not considered a COPC. None of the samples collected in 2011 or 2012 had detections of explosives or propellants. No sediment or surface water concentration for metals at the Former Test Pond exceeded the RSL at a TR of 1E-05, HQ of 1.

Surface water and wet sediment samples were collected at potential exit points from the Fuze and Booster Hill area (which includes Load Lines 5 through 11) and near the southern boundary of RVAAP/Camp Ravenna to determine nature and extent. Four surface water and co-located composite wet sediment samples were collected from these areas in order to characterize current conditions and assess potential exit pathways from the area. This report provides an evaluation of two of these samples (FWSsd/sw-101 and FWSsd/sw-103) that are south and southeast of Load Line 6. No explosives or propellants were detected in these sediment samples. HMX was detected in both surface water samples and RDX was detected at FWSsw-103 at concentrations well below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1. No sediment or surface water concentration for metals at FWSsd/sw-101 and FWSsd/sw-103 exceeded the RSL at a TR of 1E-05, HQ of 1. No PCBs were detected in sediment or surface water samples and only low, estimated concentrations of toluene at 0.00041J mg/kg in sediment at FWS-103 and gamma-chlordane at

0.000048J mg/L at FWS-101 were detected. All other SVOCs, VOCs and pesticides had non-detectable concentrations.

Table 5-1. Exposure Unit Data Set for Surface Soil (0-1 ft bgs) Discrete Samples

Location	Sample ID	Date	Depth (ft bgs)
Former Production Area			
LL6ss-001	LL6ss-001-0001-SO	03/12/02	0 - 1
LL6ss-002	LL6ss-002-0001-SO	03/12/02	0 - 1
LL6ss-003	LL6ss-003-0001-SO	03/12/02	0 - 1
LL6ss-004	LL6ss-004-0001-SO	11/25/03	0 - 1
LL6sd-005	LL6sd-005-0001-SD	12/01/03	0 - 0.5
LL6ss-005	LL6ss-005-0001-SO	11/19/03	0 - 1
LL6ss-006	LL6ss-006-0001-SO	11/21/03	0 - 1
LL6ss-007	LL6ss-007-0001-SO	11/14/03	0 - 1
LL6ss-008	LL6ss-008-0001-SO	11/14/03	0 - 1
LL6ss-009	LL6ss-009-0001-SO	11/20/03	0 - 1
LL6sd-010	LL6sd-010-0001-SD	12/01/03	0 - 0.5
LL6ss-010	LL6ss-010-0001-SO	12/02/03	0 - 1
LL6ss-010	LL6ss-010-0002-SO	01/14/04	0 - 1
LL6sd-011	LL6sd-011-0001-SD	12/02/03	0 - 1
LL6ss-011	LL6ss-011-0001-SO	12/03/03	0 - 1
LL6sd-012	LL6sd-012-0001-SD	12/02/03	0 - 1
LL6ss-012	LL6ss-012-0001-SO	11/25/03	0 - 1
LL6sd-013	LL6sd-013-0001-SD	12/02/03	0 - 1.5
LL6ss-013	LL6ss-013-0001-SO	11/21/03	0 - 1
LL6sd-014	LL6sd-014-0001-SD	12/02/03	0 - 0.5
LL6ss-014	LL6ss-014-0001-SO	11/25/03	0 - 1
LL6sd-015	LL6sd-015-0001-SD	12/02/03	0 - 0.5
LL6ss-015	LL6ss-015-0001-SO	11/25/03	0 - 1
LL6ss-016	LL6ss-016-0001-SO	11/21/03	0 - 1
LL6ss-017	LL6ss-017-0001-SO	11/19/03	0 - 1
LL6ss-018	LL6ss-018-0001-SO	12/02/03	0 - 1
LL6ss-019	LL6ss-019-0001-SO	11/19/03	0 - 1
LL6ss-020	LL6ss-020-0001-SO	12/02/03	0 - 1
LL6ss-021	LL6ss-021-0001-SO	11/19/03	0 - 1
LL6ss-022	LL6ss-022-0001-SO	11/14/03	0 - 1
LL6ss-023	LL6ss-023-0001-SO	11/19/03	0 - 1
LL6ss-024	LL6ss-024-0001-SO	11/25/03	0 - 1
LL6ss-033	LL6ss-033-0001-SO	11/18/03	0 - 1
LL6ss-034	LL6ss-034-0001-SO	11/14/03	0 - 1
LL6ss-035	LL6ss-035-0001-SO	11/13/03	0 - 1
LL6ss-038	LL6ss-038-0001-SO	11/05/03	0 - 1
LL6ss-039	LL6ss-039-0001-SO	11/05/03	0 - 1
LL6sb-069	LL6sb-069-5219-SO	02/25/10	0 - 1
LL6sb-070	LL6sb-070-5223-SO	03/01/10	0 - 1
LL6sb-071	LL6sb-071-5227-SO	03/01/10	0 - 1
LL6ss-073	LL6ss-073-5237-SO	02/22/10	0 - 1
LL6ss-074	LL6ss-074-5238-SO	02/22/10	0 - 1
LL6ss-076	LL6ss-076-5239-SO	02/22/10	0 - 1
LL6ss-078	LL6ss-078-5240-SO	02/22/10	0 - 1
LL6ss-079	LL6ss-079-5241-SO	02/22/10	0 - 1
LL6ss-075[a]	LL6ss-075-5246-SO	02/22/10	0 - 1
LL6ss-080[a]	LL6ss-080-5248-SO	02/22/10	0 - 1

Table 5–1. Exposure Unit Data Set for Surface Soil (0-1 ft bgs) Discrete Samples (continued)

Location	Sample ID	Date	Depth (ft bgs)
Non-Production Area			
LL6ss-025	LL6ss-025-0001-SO	11/14/03	0 - 1
LL6ss-026	LL6ss-026-0001-SO	11/20/03	0 - 1
LL6ss-027	LL6ss-027-0001-SO	11/20/03	0 - 1
LL6ss-028	LL6ss-028-0001-SO	11/18/03	0 - 1
LL6ss-029	LL6ss-029-0001-SO	11/25/03	0 - 1
LL6ss-030	LL6ss-030-0001-SO	11/18/03	0 - 1
LL6ss-031	LL6ss-031-0001-SO	11/13/03	0 - 1
LL6ss-032	LL6ss-032-0001-SO	11/13/03	0 - 1
LL6ss-036	LL6ss-036-0001-SO	11/13/03	0 - 1
LL6ss-037	LL6ss-037-0001-SO	11/13/03	0 - 1
LL6ss-040	LL6ss-040-0001-SO	11/05/03	0 - 1
LL6ss-056	LL6ss-056-0001-SO	11/18/03	0 - 1
LL6sb-068	LL6sb-068-5215-SO	03/01/10	0 - 1
LL6sd-081	LL6sd-081-5243-SD	02/18/10	0 - 0.5
LL6sb-083	LL6sb-083-5233-SO	02/25/10	0 - 1
LL6ss-077[a]	LL6ss-077-5247-SO	02/25/10	0 - 1

[a]Chromium speciation samples used to evaluate the presence of hexavalent chromium.
bgs = Below ground surface.
ID = Identifier.

Table 5-2. Exposure Unit Data Set for Subsurface Soil (1-13 ft bgs) Discrete Samples

Location	Sample ID	Date	Depth[a] (ft bgs)		
Former Production Area					
LL6sb-001	LL6sb-001-0001-SO	12/03/03	1	-	3
LL6sb-002	LL6sb-002-0001-SO	12/03/03	1	-	3
LL6sb-003	LL6sb-003-0001-SO	12/03/03	1	-	3
LL6sb-004	LL6sb-004-0001-SO	11/25/03	1	-	3
LL6sb-005	LL6sb-005-0001-SO	11/19/03	1	-	3
LL6sb-006	LL6sb-006-0001-SO	11/21/03	1	-	3
LL6sb-007	LL6sb-007-0001-SO	11/14/03	1	-	3
LL6sb-008	LL6sb-008-0001-SO	11/14/03	1	-	3
LL6sb-009	LL6sb-009-0001-SO	11/20/03	1	-	3
LL6sb-010	LL6sb-010-0001-SO	12/02/03	1	-	3
LL6sb-011	LL6sb-011-0001-SO	12/03/03	1	-	3
LL6sb-012	LL6sb-012-0001-SO	11/25/03	1	-	3
LL6sb-013	LL6sb-013-0001-SO	11/21/03	1	-	3
LL6sb-014	LL6sb-014-0001-SO	11/25/03	1	-	3
LL6sb-015	LL6sb-015-0001-SO	11/25/03	1	-	3
LL6sb-016	LL6sb-016-0001-SO	11/21/03	1	-	3
LL6sb-017	LL6sb-017-0001-SO	11/19/03	1	-	3
LL6sb-018	LL6sb-018-0001-SO	12/02/03	1	-	3
LL6sb-019	LL6sb-019-0001-SO	11/19/03	1	-	3
LL6sb-020	LL6sb-020-0001-SO	12/02/03	1	-	3
LL6sb-021	LL6sb-021-0001-SO	11/19/03	1	-	3
LL6sb-023	LL6sb-023-0001-SO	11/19/03	1	-	3
LL6sb-024	LL6sb-024-0001-SO	11/25/03	1	-	3
LL6sb-042	LL6sb-042-0001-SO	12/03/03	1	-	3
LL6sb-044	LL6sb-044-0001-SO	12/02/03	1	-	3
LL6sb-045	LL6sb-045-0001-SO	12/02/03	1	-	3
LL6sb-069	LL6sb-069-5220-SO	02/25/10	1	-	4

Table 5-2. Exposure Unit Data Set for Subsurface Soil Discrete (1-13 ft bgs) Discrete Samples (continued)

Station	Sample ID	Date	Depth[a] (ft bgs)
LL6sb-070	LL6sb-070-5224-SO	03/01/10	1 - 4
LL6sb-071	LL6sb-071-5228-SO	03/01/10	1 - 4
LL6sb-069	LL6sb-069-5221-SO	02/25/10	4 - 7
LL6sb-070	LL6sb-070-5225-SO	03/01/10	4 - 7
LL6sb-071	LL6sb-071-5229-SO	03/01/10	4 - 7
LL6sb-033	LL6sb-033-0001-SO	11/18/03	6 - 8
LL6sb-041	LL6sb-041-0001-SO	10/27/03	7 - 7
LL6sb-069	LL6sb-069-5222-SO	02/25/10	7 - 13
LL6sb-038	LL6sb-038-0001-SO	11/05/03	8 - 10
LL6sb-039	LL6sb-039-0001-SO	11/05/03	8 - 10
LL6sb-035	LL6sb-035-0001-SO	11/14/03	11 - 13
Non-Production Area			
LL6sb-025	LL6sb-025-0001-SO	11/14/03	1 - 3
LL6sb-026	LL6sb-026-0001-SO	11/20/03	1 - 3
LL6sb-027	LL6sb-027-0001-SO	11/20/03	1 - 3
LL6sb-028	LL6sb-028-0001-SO	11/18/03	1 - 3
LL6sb-030	LL6sb-030-0001-SO	11/18/03	1 - 3
LL6sb-056	LL6sb-056-0001-SO	11/18/03	1 - 3
LL6sb-068	LL6sb-068-5216-SO	03/01/10	1 - 4
LL6sb-083	LL6sb-083-5234-SO	02/25/10	1 - 4
LL6sb-055	LL6sb-055-0001-SO	11/04/03	3 - 5
LL6sb-040	LL6sb-040-0001-SO	11/05/03	4 - 6
LL6sb-049	LL6sb-049-0001-SO	11/04/03	4 - 6
LL6sb-068	LL6sb-068-5217-SO	03/01/10	4 - 7
LL6sb-083	LL6sb-083-5235-SO	02/25/10	4 - 5.5
LL6sb-031	LL6sb-031-0001-SO	11/18/03	6 - 8
LL6sb-036	LL6sb-036-0001-SO	11/18/03	6 - 8
LL6sb-050	LL6sb-050-0001-SO	11/04/03	6 - 8
LL6sb-051	LL6sb-051-0001-SO	11/04/03	6 - 8
LL6sb-037	LL6sb-037-0001-SO	11/14/03	12 - 14

[a] Samples were assigned to depth intervals based on starting depth.
bgs = Below ground surface.
ID = Identifier.

Table 5-3. Exposure Unit Data Set for Surface Water

Location	Sample ID	Date
Drainage Ditches		
LL6sw-002	LL6sw-002-0001-SW	12/01/03
LL6sw-081	LL6sw-081-5242-SW	03/02/10
LL6sw-082	LL6sw-082-5244-SW	02/17/10
Former Test Pond		
LL6sw-084	LL6sw-084-5794-SW	04/01/10
FTFsw-001	FTFSW-001-0001-SW	05/05/11
LL6sd-096	LL6sd-096-5870-SD	08/09/12

ID = Identifier.

Table 5-4. Exposure Unit Data Set for Sediment

Location	Sample ID	Date	Depth (ft bgs)
Drainage Ditches			
LL6sd-002	LL6sd-002-0001-SD	12/01/03	0 - 0.5
LL6sd-082	LL6sd-082-5245-SD	02/17/10	0 - 0.5
Former Test Pond			
LL6sd-084	LL6sd-084-5795-SD	04/01/10	0 - 0.5
FTFsd-002	FTFsd-002-SD	08/08/11	0 - 0.5
FTFsd-003	FTFsd-003-SD	08/08/11	0 - 0.5
LL6sw-096	LL6sw-096-5871-SW	08/09/12	0 - 0.5

bgs = Below ground surface.
ID = Identifier.

Table 5-5. Chromium Speciation Results

Sample Location	Hexavalent Chromium Concentration (mg/kg)	Total Chromium Concentration[a] (mg/kg)	Percent Hexavalent Chromium (%)
Former Production Area			
LL6ss-075	1.1 U	27.3	NA
LL6ss-080	1 U	17.2	NA
Non-Production Area			
LL6ss-077	1.1 U	16	NA

[a] Background concentration for total chromium is 17.4 mg/kg. No background concentration is available for hexavalent chromium.
NA = Not applicable; hexavalent chromium was not detected in sample.
U = Value not detected.

Table 5-6. Summary of Geotechnical Parameters

Sample ID: Parameters	LL6sb-072-5231-SO	LL6sb-072-5232-SO
Depth	4 to 5 ft bgs	9 to 10.5 ft bgs
Porosity	34.2%	9.7%
Density	1.79 g/cm^3	1.87 g/cm^3
Moisture content	15.9%	10%
Total organic carbon	2000 mg/kg	770J mg/kg
Size fraction analysis	3.7% gravel, 15.3% sand, 38.9% silt, 42.1% clay	13.6% gravel, 37% sand, 35.6% silt, 13.8% clay
Permeability (K)	3.1E-07 cm/sec	6.18E-08 cm/sec

bgs = Below ground surface.
cm/sec = Centimeters per second.
ft = Feet.
g/cm^3 = Grams per cubic centimeter.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.

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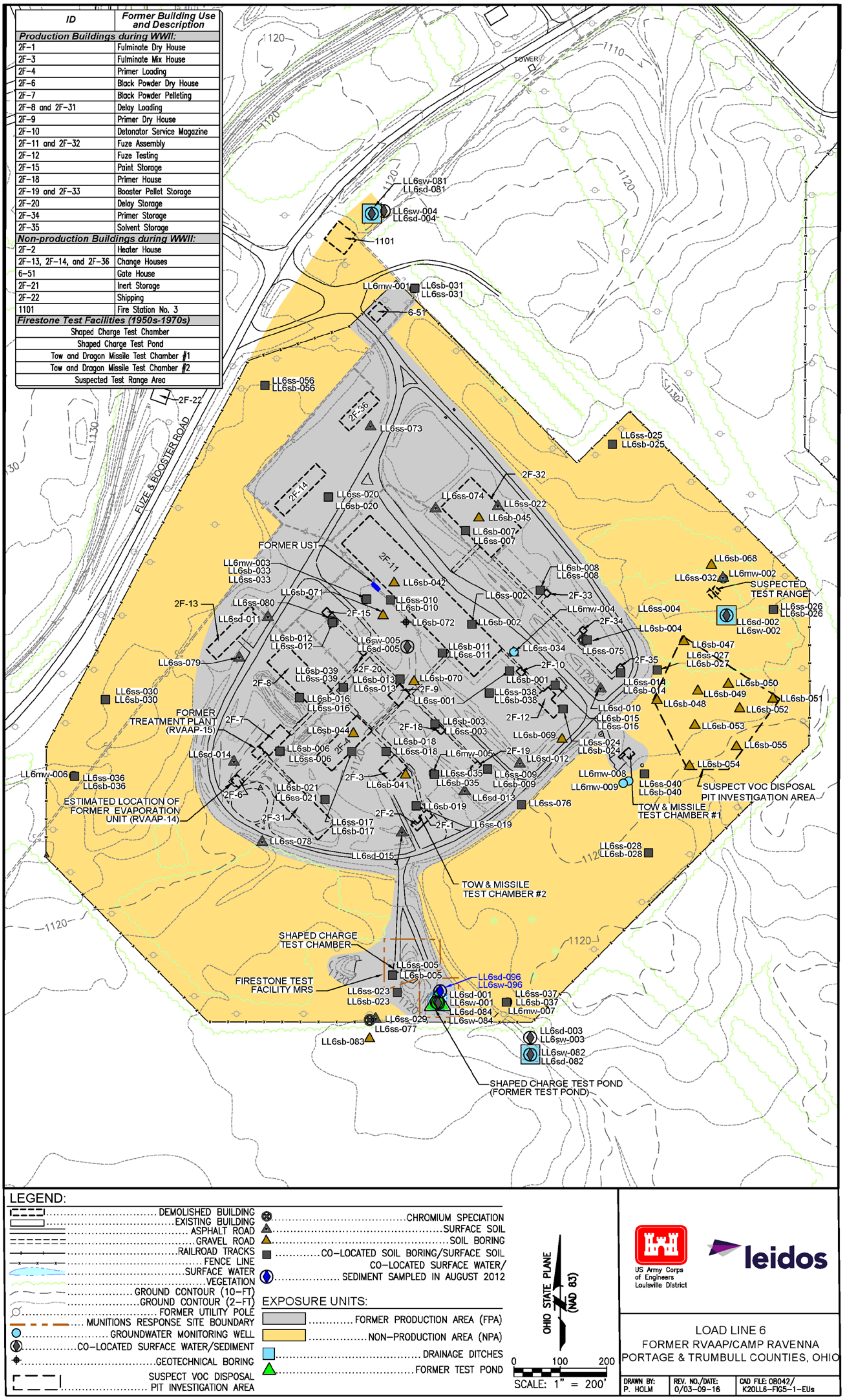
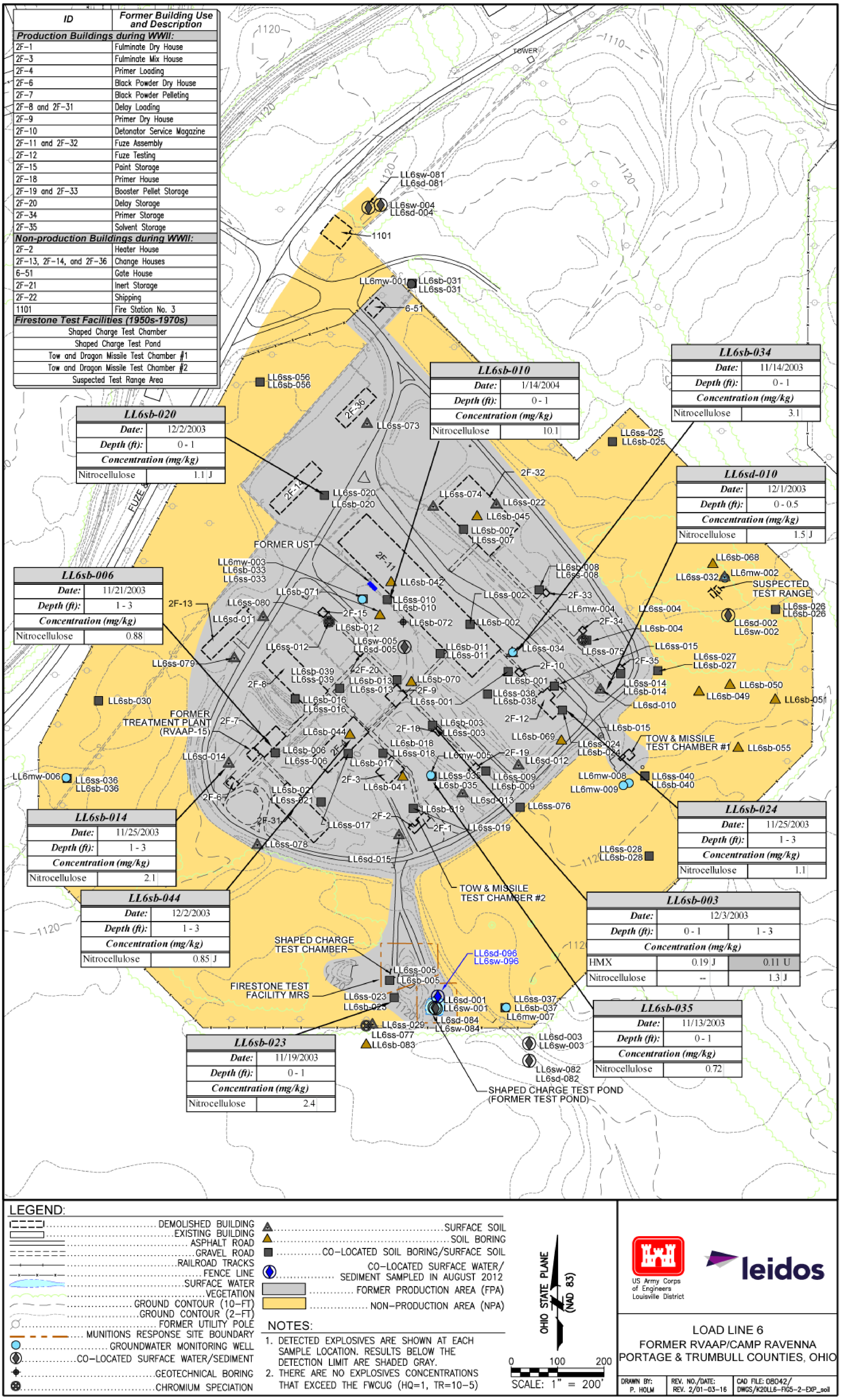


Figure 5-1. Exposure Units



ID	Former Building Use and Description
Production Buildings during WWII:	
2F-1	Fulminate Dry House
2F-3	Fulminate Mix House
2F-4	Primer Loading
2F-6	Black Powder Dry House
2F-7	Black Powder Pelleting
2F-8 and 2F-31	Delay Loading
2F-9	Primer Dry House
2F-10	Detonator Service Magazine
2F-11 and 2F-32	Fuze Assembly
2F-12	Fuze Testing
2F-15	Paint Storage
2F-18	Primer House
2F-19 and 2F-33	Booster Pellet Storage
2F-20	Delay Storage
2F-34	Primer Storage
2F-35	Solvent Storage
Non-production Buildings during WWII:	
2F-2	Heater House
2F-13, 2F-14, and 2F-36	Change Houses
6-51	Gate House
2F-21	Inert Storage
2F-22	Shipping
1101	Fire Station No. 3
Firestone Test Facilities (1950s-1970s)	
	Shaped Charge Test Chamber
	Shaped Charge Test Pond
	Tow and Dragon Missile Test Chamber #1
	Tow and Dragon Missile Test Chamber #2
	Suspected Test Range Area

LL6sb-020	
Date:	12/2/2003
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	1.1 J

LL6sb-010	
Date:	1/14/2004
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	10.1

LL6sb-034	
Date:	11/14/2003
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	3.1

LL6sd-010	
Date:	12/1/2003
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Nitrocellulose	1.5 J

LL6sb-006	
Date:	11/21/2003
Depth (ft):	1 - 3
Concentration (mg/kg)	
Nitrocellulose	0.88

LL6sb-014	
Date:	11/25/2003
Depth (ft):	1 - 3
Concentration (mg/kg)	
Nitrocellulose	2.1

LL6sb-024	
Date:	11/25/2003
Depth (ft):	1 - 3
Concentration (mg/kg)	
Nitrocellulose	1.1

LL6sb-044	
Date:	12/2/2003
Depth (ft):	1 - 3
Concentration (mg/kg)	
Nitrocellulose	0.85 J

LL6sb-003		
Date:	12/3/2003	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
HMX	0.19 J	0.11 U
Nitrocellulose	--	1.3 J

LL6sb-035	
Date:	11/13/2003
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	0.72

LL6sb-023	
Date:	11/19/2003
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	2.4

LEGEND:

⌐ ‑ ‑ ‑	DEMOLISHED BUILDING
▭	EXISTING BUILDING
═	ASPHALT ROAD
= = =	GRAVEL ROAD
┼┼┼	RAILROAD TRACKS
─×─	FENCE LINE
▬	SURFACE WATER
	VEGETATION
─ ─	GROUND CONTOUR (10-FT)
─ ─	GROUND CONTOUR (2-FT)
○	FORMER UTILITY POLE
─ ─	MUNITIONS RESPONSE SITE BOUNDARY
○	GROUNDWATER MONITORING WELL
◈	CO-LOCATED SURFACE WATER/SEDIMENT
✦	GEOTECHNICAL BORING
⊗	CHROMIUM SPECIATION
△	SURFACE SOIL
▲	SOIL BORING
■	CO-LOCATED SOIL BORING/SURFACE SOIL
◈	CO-LOCATED SURFACE WATER/ SEDIMENT SAMPLED IN AUGUST 2012
▨	FORMER PRODUCTION AREA (FPA)
🟨	NON-PRODUCTION AREA (NPA)

NOTES:

1. DETECTED EXPLOSIVES ARE SHOWN AT EACH SAMPLE LOCATION. RESULTS BELOW THE DETECTION LIMIT ARE SHADED GRAY.
2. THERE ARE NO EXPLOSIVES CONCENTRATIONS THAT EXCEED THE FWCUG (HQ=1, TR=10-5)

LOAD LINE 6
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

Figure 5-2. Detected Concentrations of Explosives and Propellants in Soil (Discrete Soil Borings)

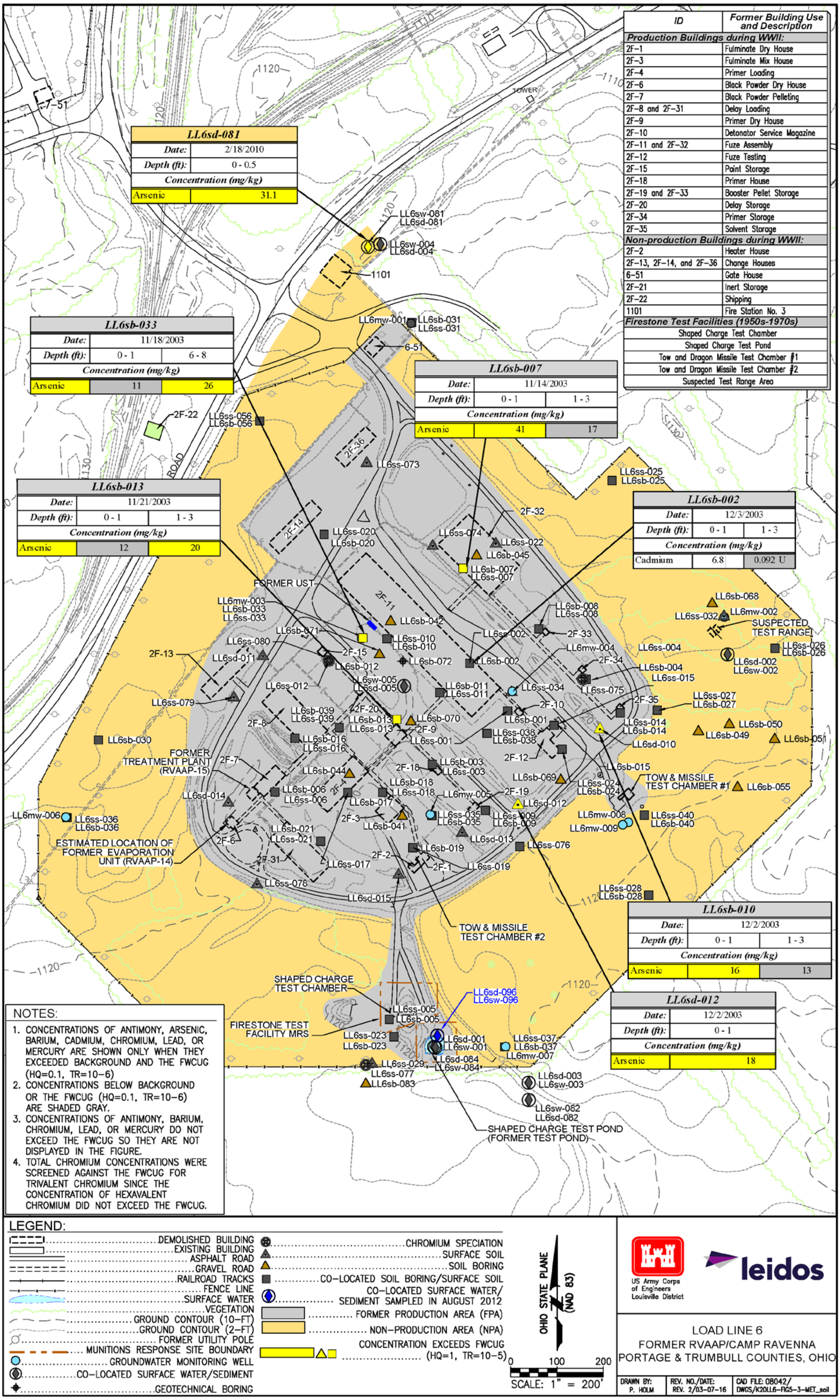
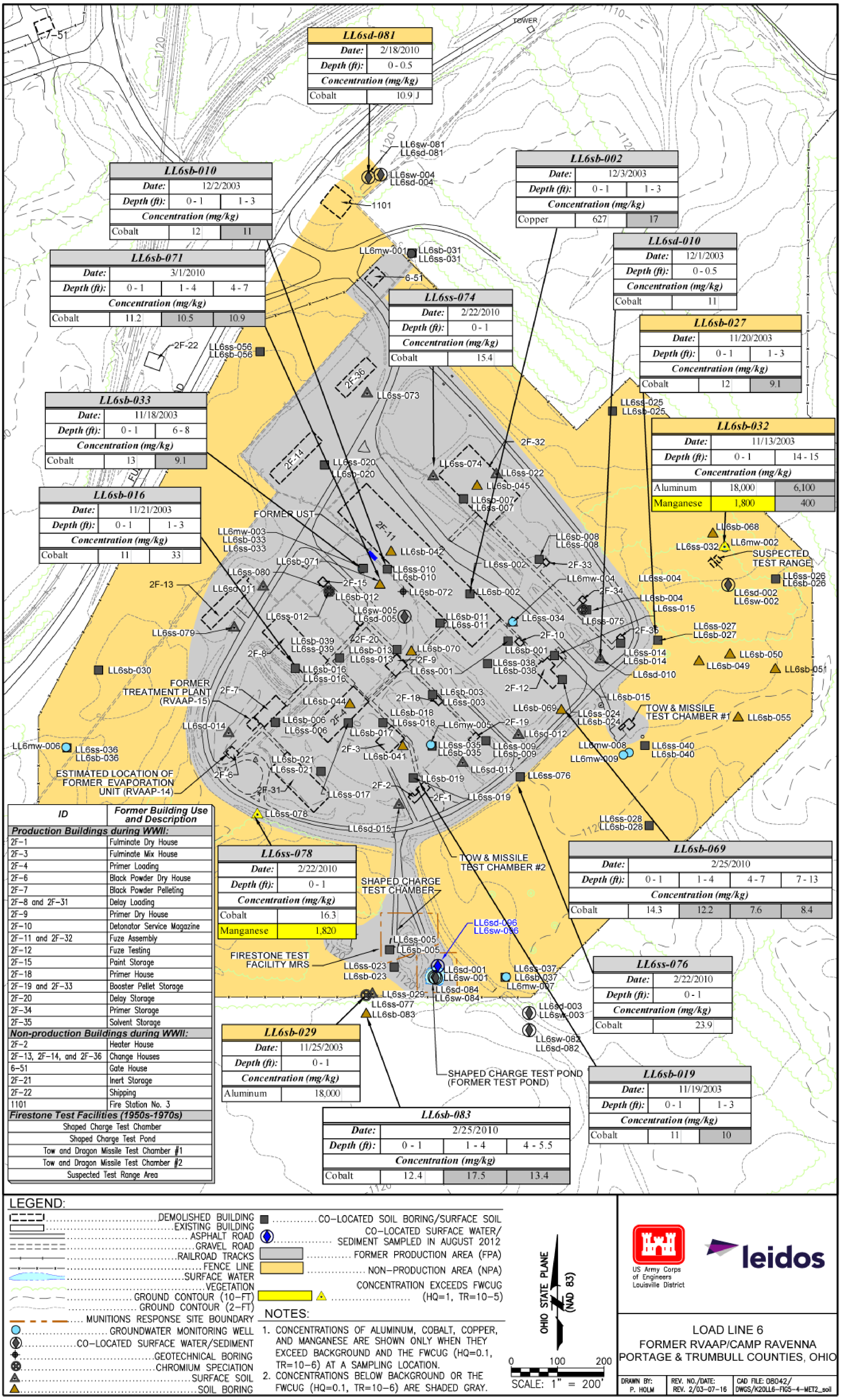


Figure 5-3. Exceedances of FWCUGs (HQ of 0.1, TR of 1E-06) for Antimony, Arsenic, Barium, Cadmium, Chromium, Lead, and Mercury in Soil (Discrete Soil Borings)



LL6sd-081	
Date:	2/18/2010
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Cobalt	10.9 J

LL6sb-010		
Date:	12/2/2003	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Cobalt	12	11

LL6sb-002		
Date:	12/3/2003	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Copper	627	17

LL6sd-010	
Date:	12/1/2003
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Cobalt	11

LL6sb-071			
Date:	3/1/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Cobalt	11.2	10.5	10.9

LL6ss-074	
Date:	2/22/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	15.4

LL6sb-027		
Date:	11/20/2003	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Cobalt	12	9.1

LL6sb-033		
Date:	11/18/2003	
Depth (ft):	0 - 1	6 - 8
Concentration (mg/kg)		
Cobalt	13	9.1

LL6sb-032		
Date:	11/13/2003	
Depth (ft):	0 - 1	14 - 15
Concentration (mg/kg)		
Aluminum	18,000	6,100
Manganese	1,800	400

LL6sb-016		
Date:	11/21/2003	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Cobalt	11	33

ID	Former Building Use and Description
Production Buildings during WWII:	
2F-1	Fulminate Dry House
2F-3	Fulminate Mix House
2F-4	Primer Loading
2F-6	Black Powder Dry House
2F-7	Black Powder Pelleting
2F-8 and 2F-31	Delay Loading
2F-9	Primer Dry House
2F-10	Detonator Service Magazine
2F-11 and 2F-32	Fuze Assembly
2F-12	Fuze Testing
2F-15	Paint Storage
2F-18	Primer House
2F-19 and 2F-33	Booster Pellet Storage
2F-20	Delay Storage
2F-34	Primer Storage
2F-35	Solvent Storage
Non-production Buildings during WWII:	
2F-2	Heater House
2F-13, 2F-14, and 2F-36	Change Houses
6-51	Gate House
2F-21	Inert Storage
2F-22	Shipping
1101	Fire Station No. 3
Firestone Test Facilities (1950s-1970s)	
Shaped Charge Test Chamber	
Shaped Charge Test Pond	
Tow and Dragon Missile Test Chamber #1	
Tow and Dragon Missile Test Chamber #2	
Suspected Test Range Area	

LL6ss-078	
Date:	2/22/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	16.3
Manganese	1,820

LL6sb-069				
Date:	2/25/2010			
Depth (ft):	0 - 1	1 - 4	4 - 7	7 - 13
Concentration (mg/kg)				
Cobalt	14.3	12.2	7.6	8.4

LL6ss-076	
Date:	2/22/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	23.9

LL6sb-029	
Date:	11/25/2003
Depth (ft):	0 - 1
Concentration (mg/kg)	
Aluminum	18,000

LL6sb-019		
Date:	11/19/2003	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Cobalt	11	10

LL6sb-083			
Date:	2/25/2010		
Depth (ft):	0 - 1	1 - 4	4 - 5.5
Concentration (mg/kg)			
Cobalt	12.4	17.5	13.4

LEGEND:

⌐‐‐‐¬	DEMOLISHED BUILDING
▭	EXISTING BUILDING
═	ASPHALT ROAD
╍	GRAVEL ROAD
─┼─	RAILROAD TRACKS
─x─	FENCE LINE
▭	SURFACE WATER
〰	VEGETATION
─ ─	GROUND CONTOUR (10–FT)
‐‐‐	GROUND CONTOUR (2–FT)
▬ ▬	MUNITIONS RESPONSE SITE BOUNDARY
○	GROUNDWATER MONITORING WELL
◈	CO–LOCATED SURFACE WATER/SEDIMENT
✦	GEOTECHNICAL BORING
⊗	CHROMIUM SPECIATION
△	SURFACE SOIL
▲	SOIL BORING
■	CO–LOCATED SOIL BORING/SURFACE SOIL
◈	CO–LOCATED SURFACE WATER/ SEDIMENT SAMPLED IN AUGUST 2012
▨	FORMER PRODUCTION AREA (FPA)
🟨	NON–PRODUCTION AREA (NPA)
🟨 △	CONCENTRATION EXCEEDS FWCUG (HQ=1, TR=10–5)

NOTES:

1. CONCENTRATIONS OF ALUMINUM, COBALT, COPPER, AND MANGANESE ARE SHOWN ONLY WHEN THEY EXCEED BACKGROUND AND THE FWCUG (HQ=0.1, TR=10–6) AT A SAMPLING LOCATION.
2. CONCENTRATIONS BELOW BACKGROUND OR THE FWCUG (HQ=0.1, TR=10–6) ARE SHADED GRAY.

OHIO STATE PLANE (NAD 83)

0 100 200

SCALE: 1" = 200'

US Army Corps of Engineers Louisville District

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LOAD LINE 6
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE: 08042/
P. HOLM	REV. 2/03–07–16	DWGS/K20LL6–FIG5–4–MET2_soil

Figure 5-4. Exceedances of FWCUGs (HQ of 0.1, TR of 1E-06) for Aluminum, Cobalt, Copper, and Manganese in Soil (Discrete Soil Borings)

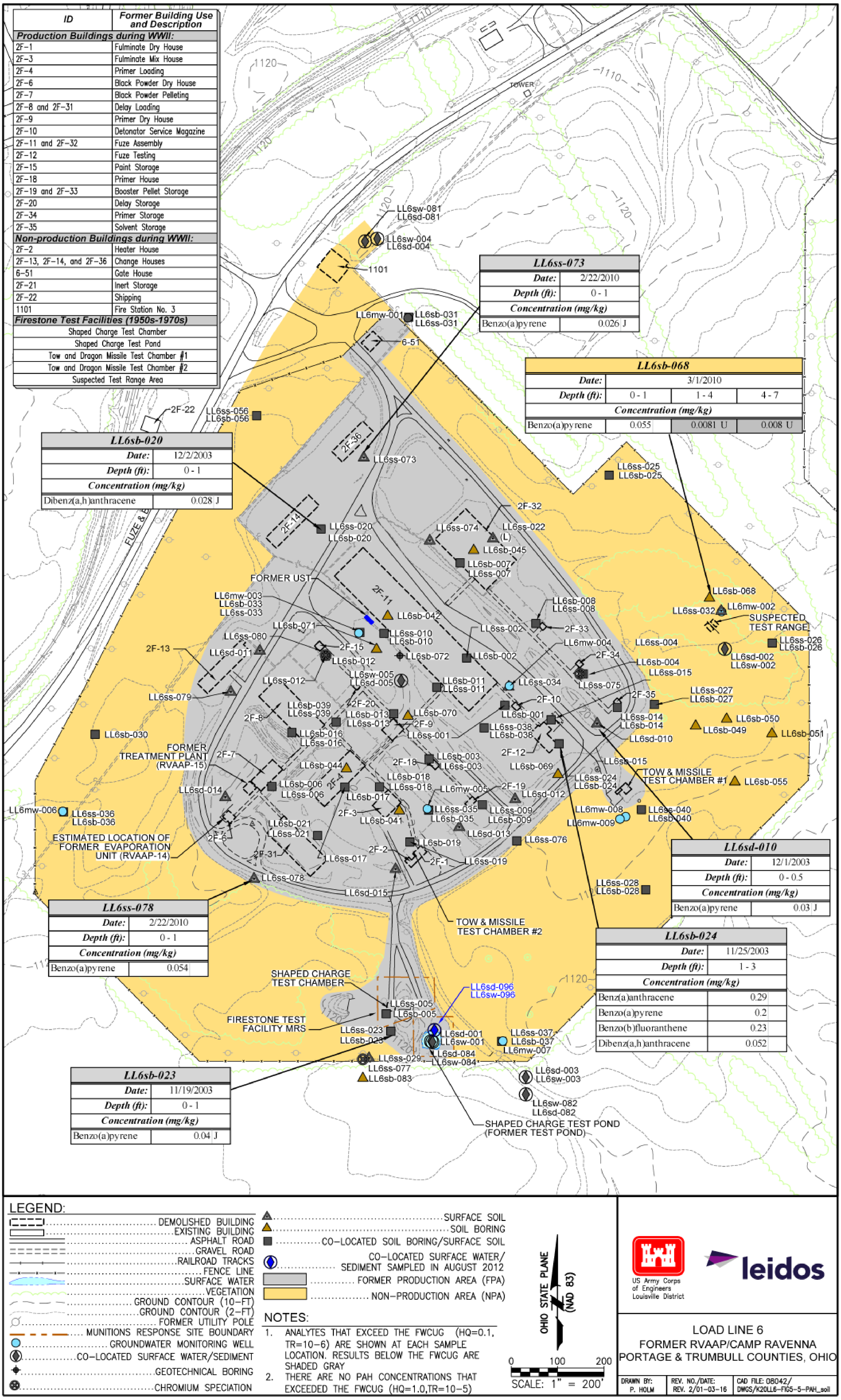
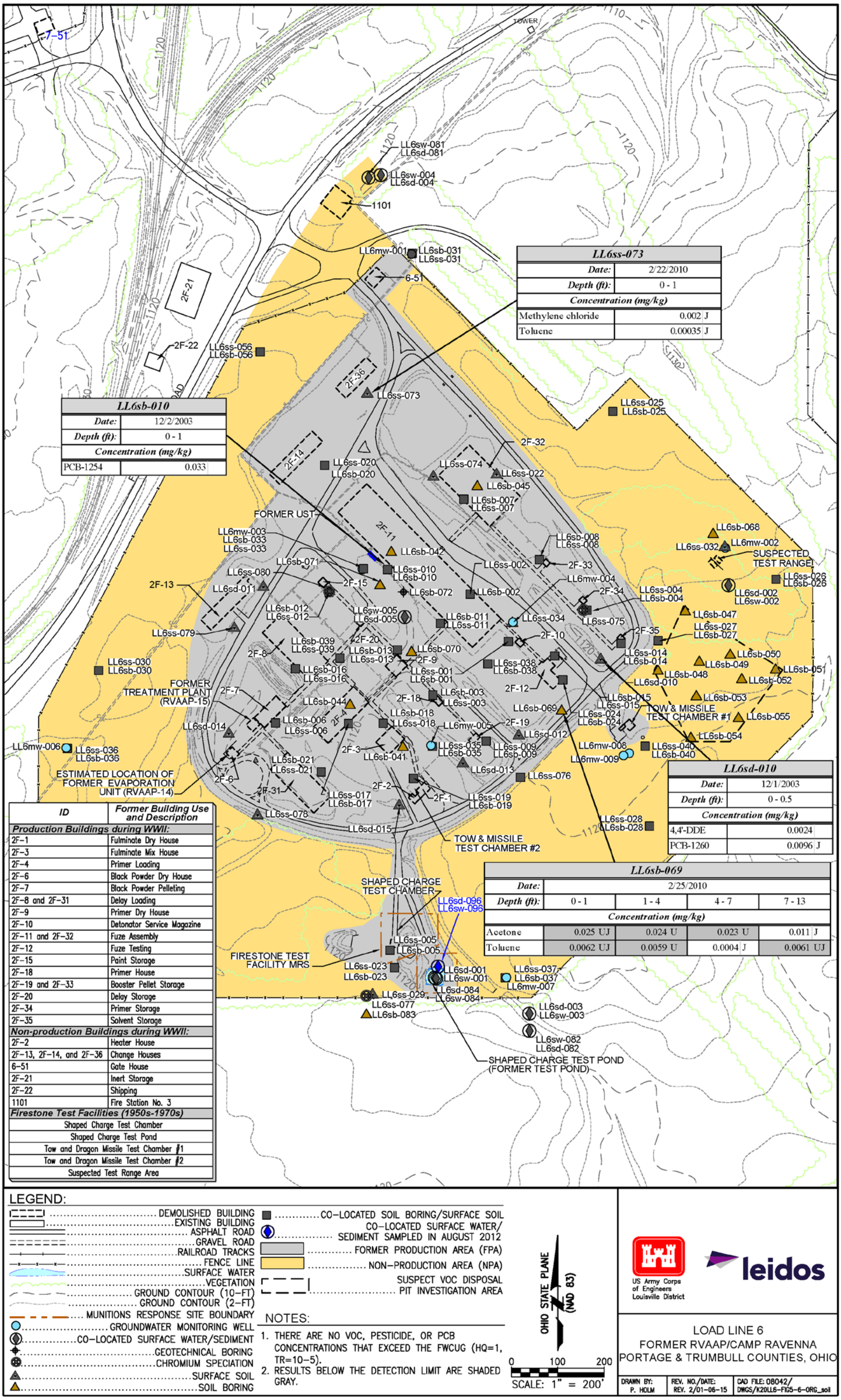


Figure 5-5. Exceedances of FWCUGs (HQ of 0.1, TR of 1E-06) for PAHs in Soil (Discrete Soil Borings)



LL6ss-073	
Date:	2/22/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Methylene chloride	0.002 J
Toluene	0.00035 J

LL6sb-010	
Date:	12/2/2003
Depth (ft):	0 - 1
Concentration (mg/kg)	
PCB-1254	0.033

LL6sd-010	
Date:	12/1/2003
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
4,4'-DDE	0.0024
PCB-1260	0.0096 J

LL6sb-069				
Date:	2/25/2010			
Depth (ft):	0 - 1	1 - 4	4 - 7	7 - 13
Concentration (mg/kg)				
Acetone	0.025 UJ	0.024 U	0.023 U	0.011 J
Toluene	0.0062 UJ	0.0059 U	0.0004 J	0.0061 UJ

ID	Former Building Use and Description
Production Buildings during WWII:	
2F-1	Fulminate Dry House
2F-3	Fulminate Mix House
2F-4	Primer Loading
2F-6	Black Powder Dry House
2F-7	Black Powder Pelleting
2F-8 and 2F-31	Delay Loading
2F-9	Primer Dry House
2F-10	Detonator Service Magazine
2F-11 and 2F-32	Fuze Assembly
2F-12	Fuze Testing
2F-15	Paint Storage
2F-18	Primer House
2F-19 and 2F-33	Booster Pellet Storage
2F-20	Delay Storage
2F-34	Primer Storage
2F-35	Solvent Storage
Non-production Buildings during WWII:	
2F-2	Heater House
2F-13, 2F-14, and 2F-36	Change Houses
6-51	Gate House
2F-21	Inert Storage
2F-22	Shipping
1101	Fire Station No. 3
Firestone Test Facilities (1950s-1970s)	
Shaped Charge Test Chamber	
Shaped Charge Test Pond	
Tow and Dragon Missile Test Chamber #1	
Tow and Dragon Missile Test Chamber #2	
Suspected Test Range Area	

LEGEND:

DEMOLISHED BUILDING
EXISTING BUILDING
ASPHALT ROAD
GRAVEL ROAD
RAILROAD TRACKS
FENCE LINE
SURFACE WATER
VEGETATION
GROUND CONTOUR (10-FT)
GROUND CONTOUR (2-FT)
MUNITIONS RESPONSE SITE BOUNDARY
GROUNDWATER MONITORING WELL
CO-LOCATED SURFACE WATER/SEDIMENT
GEOTECHNICAL BORING
CHROMIUM SPECIATION
SURFACE SOIL
SOIL BORING
CO-LOCATED SOIL BORING/SURFACE SOIL
CO-LOCATED SURFACE WATER/ SEDIMENT SAMPLED IN AUGUST 2012
FORMER PRODUCTION AREA (FPA)
NON-PRODUCTION AREA (NPA)
SUSPECT VOC DISPOSAL PIT INVESTIGATION AREA

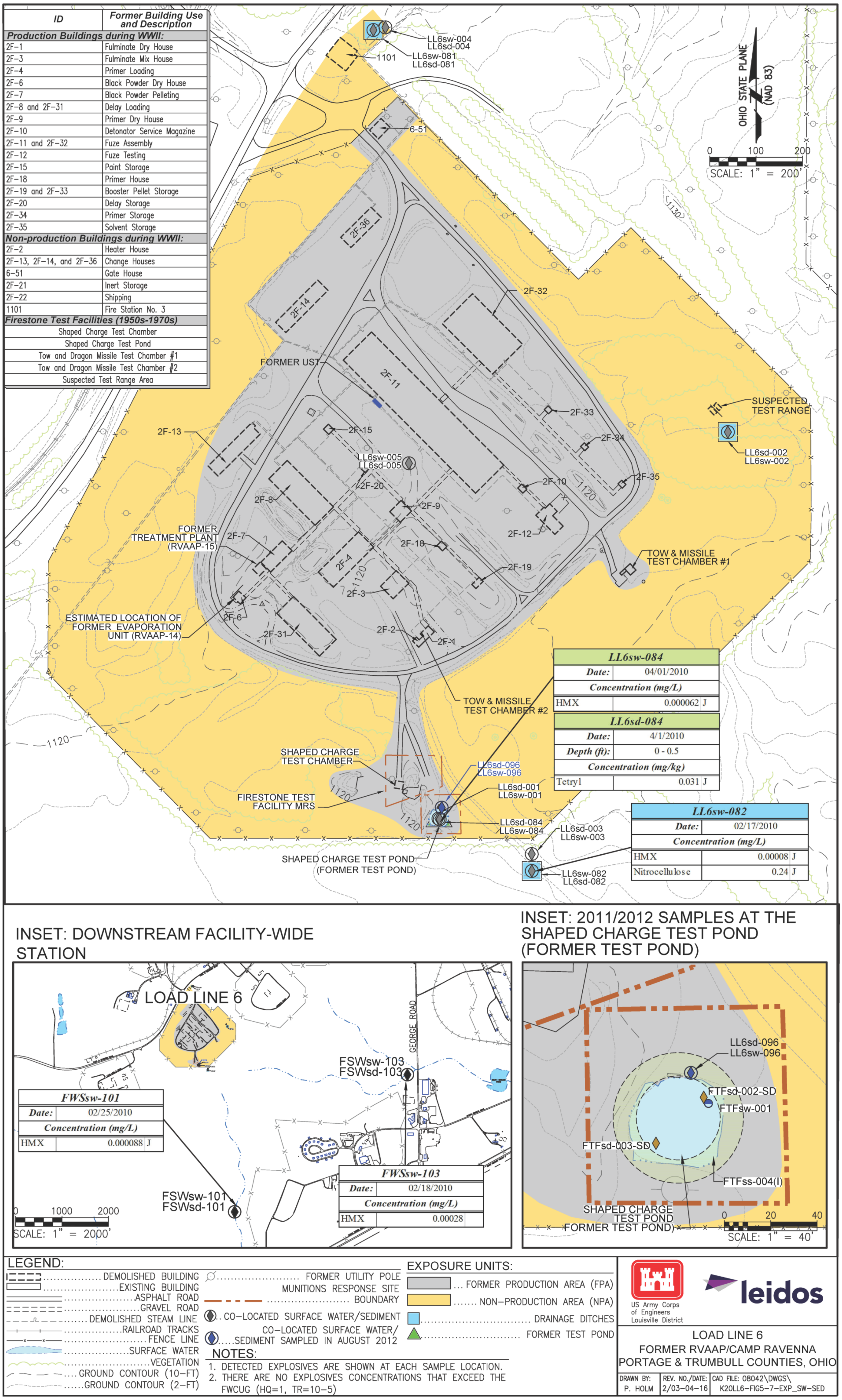
NOTES:

1. THERE ARE NO VOC, PESTICIDE, OR PCB CONCENTRATIONS THAT EXCEED THE FWCUG (HQ=1, TR=10–5).
2. RESULTS BELOW THE DETECTION LIMIT ARE SHADED GRAY.

LOAD LINE 6
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY: P. HOLM	REV. NO./DATE: REV. 2/01-06-15	CAD FILE: 08042/ DWGS/K20LL6-FIG5-6-ORG_soil

Figure 5-6. Detected Concentrations of VOCs, Pesticides, and PCBs in Soil (Discrete Soil Borings)



ID	Former Building Use and Description
Production Buildings during WWII:	
2F–1	Fulminate Dry House
2F–3	Fulminate Mix House
2F–4	Primer Loading
2F–6	Black Powder Dry House
2F–7	Black Powder Pelleting
2F–8 and 2F–31	Delay Loading
2F–9	Primer Dry House
2F–10	Detonator Service Magazine
2F–11 and 2F–32	Fuze Assembly
2F–12	Fuze Testing
2F–15	Paint Storage
2F–18	Primer House
2F–19 and 2F–33	Booster Pellet Storage
2F–20	Delay Storage
2F–34	Primer Storage
2F–35	Solvent Storage
Non-production Buildings during WWII:	
2F–2	Heater House
2F–13, 2F–14, and 2F–36	Change Houses
6–51	Gate House
2F–21	Inert Storage
2F–22	Shipping
1101	Fire Station No. 3
Firestone Test Facilities (1950s-1970s)	
Shaped Charge Test Chamber	
Shaped Charge Test Pond	
Tow and Dragon Missile Test Chamber #1	
Tow and Dragon Missile Test Chamber #2	
Suspected Test Range Area	

LL6sw-084	
Date:	04/01/2010
Concentration (mg/L)	
HMX	0.000062 J

LL6sd-084	
Date:	4/1/2010
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Tetryl	0.031 J

LL6sw-082	
Date:	02/17/2010
Concentration (mg/L)	
HMX	0.00008 J
Nitrocellulose	0.24 J

INSET: DOWNSTREAM FACILITY-WIDE STATION

FWSsw-101	
Date:	02/25/2010
Concentration (mg/L)	
HMX	0.000088 J

FWSsw-103	
Date:	02/18/2010
Concentration (mg/L)	
HMX	0.00028

INSET: 2011/2012 SAMPLES AT THE SHAPED CHARGE TEST POND (FORMER TEST POND)

LEGEND:

▭	DEMOLISHED BUILDING
▭	EXISTING BUILDING
═	ASPHALT ROAD
╌	GRAVEL ROAD
╌	DEMOLISHED STEAM LINE
┼	RAILROAD TRACKS
×—×	FENCE LINE
▬	SURFACE WATER
〰	VEGETATION
╌	GROUND CONTOUR (10–FT)
╌	GROUND CONTOUR (2–FT)
⊘	FORMER UTILITY POLE
▬ ▪ ▬	MUNITIONS RESPONSE SITE BOUNDARY
◈	CO–LOCATED SURFACE WATER/SEDIMENT
◈	CO–LOCATED SURFACE WATER/SEDIMENT SAMPLED IN AUGUST 2012

EXPOSURE UNITS:

⬜	FORMER PRODUCTION AREA (FPA)
🟨	NON–PRODUCTION AREA (NPA)
🟦	DRAINAGE DITCHES
▲	FORMER TEST POND

NOTES:
1. DETECTED EXPLOSIVES ARE SHOWN AT EACH SAMPLE LOCATION.
2. THERE ARE NO EXPLOSIVES CONCENTRATIONS THAT EXCEED THE FWCUG (HQ=1, TR=10–5)

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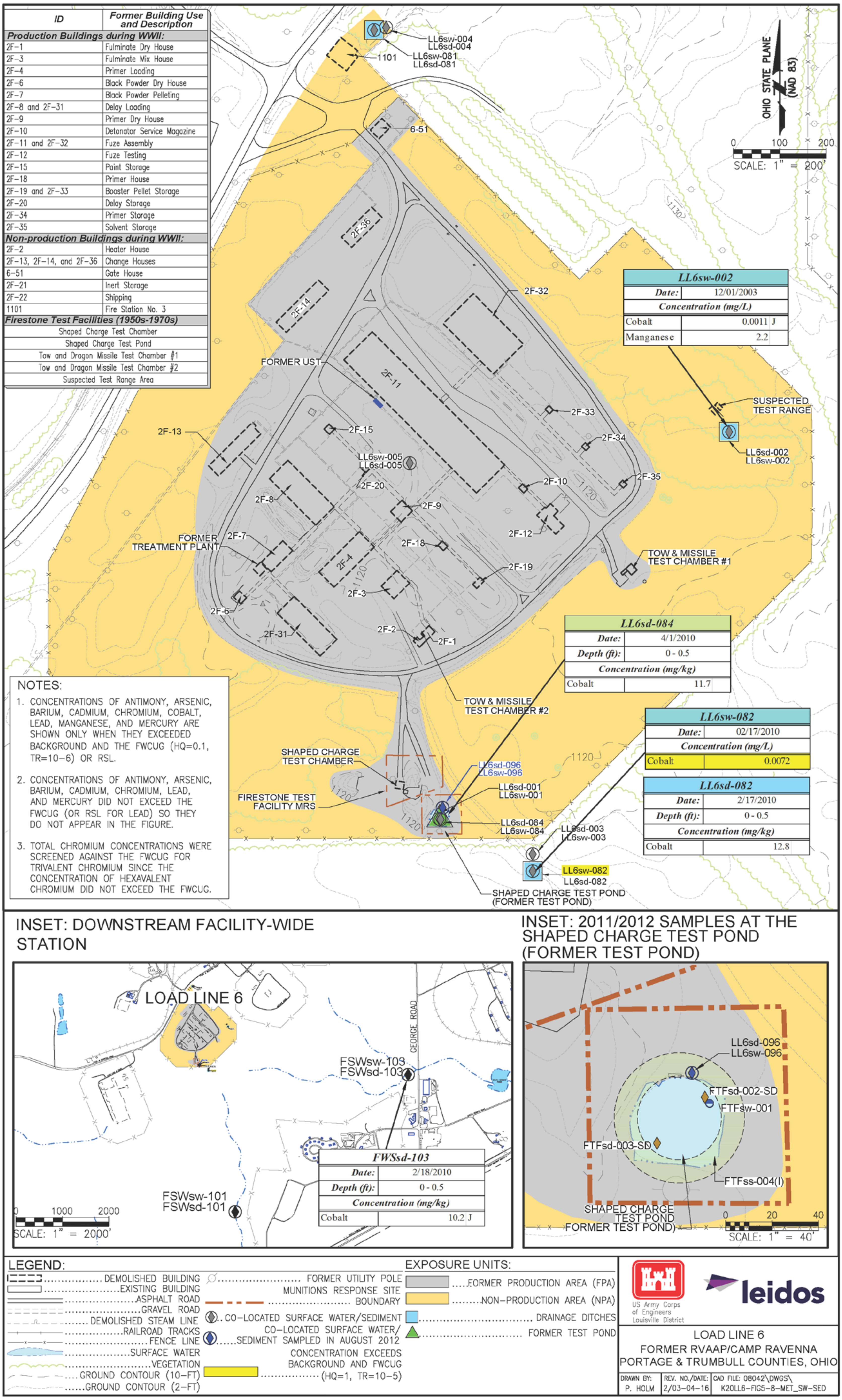
LOAD LINE 6
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE: 08042\DWGS\
P. HOLM	2/03–04–16	K20LL6–FIG5–7–EXP_SW–SED

Figure 5-7. Detected Concentrations of Explosives and Propellants in Surface Water and Sediment



ID	Former Building Use and Description
Production Buildings during WWII:	
2F-1	Fulminate Dry House
2F-3	Fulminate Mix House
2F-4	Primer Loading
2F-6	Black Powder Dry House
2F-7	Black Powder Pelleting
2F-8 and 2F-31	Delay Loading
2F-9	Primer Dry House
2F-10	Detonator Service Magazine
2F-11 and 2F-32	Fuze Assembly
2F-12	Fuze Testing
2F-15	Paint Storage
2F-18	Primer House
2F-19 and 2F-33	Booster Pellet Storage
2F-20	Delay Storage
2F-34	Primer Storage
2F-35	Solvent Storage
Non-production Buildings during WWII:	
2F-2	Heater House
2F-13, 2F-14, and 2F-36	Change Houses
6-51	Gate House
2F-21	Inert Storage
2F-22	Shipping
1101	Fire Station No. 3
Firestone Test Facilities (1950s-1970s)	
Shaped Charge Test Chamber	
Shaped Charge Test Pond	
Tow and Dragon Missile Test Chamber #1	
Tow and Dragon Missile Test Chamber #2	
Suspected Test Range Area	

LL6sw-002	
Date:	12/01/2003
Concentration (mg/L)	
Cobalt	0.0011 J
Manganese	2.2

LL6sd-084	
Date:	4/1/2010
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Cobalt	11.7

LL6sw-082	
Date:	02/17/2010
Concentration (mg/L)	
Cobalt	0.0072

LL6sd-082	
Date:	2/17/2010
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Cobalt	12.8

FWSsd-103	
Date:	2/18/2010
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Cobalt	10.2 J

NOTES:

1. CONCENTRATIONS OF ANTIMONY, ARSENIC, BARIUM, CADMIUM, CHROMIUM, COBALT, LEAD, MANGANESE, AND MERCURY ARE SHOWN ONLY WHEN THEY EXCEEDED BACKGROUND AND THE FWCUG (HQ=0.1, TR=10−6) OR RSL.
2. CONCENTRATIONS OF ANTIMONY, ARSENIC, BARIUM, CADMIUM, CHROMIUM, LEAD, AND MERCURY DID NOT EXCEED THE FWCUG (OR RSL FOR LEAD) SO THEY DO NOT APPEAR IN THE FIGURE.
3. TOTAL CHROMIUM CONCENTRATIONS WERE SCREENED AGAINST THE FWCUG FOR TRIVALENT CHROMIUM SINCE THE CONCENTRATION OF HEXAVALENT CHROMIUM DID NOT EXCEED THE FWCUG.

LEGEND:

- DEMOLISHED BUILDING
- EXISTING BUILDING
- ASPHALT ROAD
- GRAVEL ROAD
- DEMOLISHED STEAM LINE
- RAILROAD TRACKS
- FENCE LINE
- SURFACE WATER
- VEGETATION
- GROUND CONTOUR (10−FT)
- GROUND CONTOUR (2−FT)
- FORMER UTILITY POLE
- MUNITIONS RESPONSE SITE BOUNDARY
- CO−LOCATED SURFACE WATER/SEDIMENT
- CO−LOCATED SURFACE WATER/SEDIMENT SAMPLED IN AUGUST 2012
- CONCENTRATION EXCEEDS BACKGROUND AND FWCUG (HQ=1, TR=10−5)

EXPOSURE UNITS:

- FORMER PRODUCTION AREA (FPA)
- NON−PRODUCTION AREA (NPA)
- DRAINAGE DITCHES
- FORMER TEST POND

US Army Corps of Engineers Louisville District

leidos

LOAD LINE 6
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE: 08042\DWGS\
P. HOLM	2/03−04−16	K20LL6−FIG5−8−MET_SW−SED

Figure 5-8. Exceedances of FWCUGs (HQ of 0.1, TR of 1E-06) for Antimony, Arsenic, Barium, Cadmium, Chromium, Cobalt, Lead, Manganese, and Mercury in Surface Water and Sediment

6.0 CONTAMINANT FATE AND TRANSPORT

Contaminant fate and transport modeling assesses the potential for SRCs to leach from surface soil, subsurface soil, and sediment sources at Load Line 6 and impact groundwater beneath the sources and downgradient receptor locations. Modeling results were included in the decision-making process to determine whether performing remedial actions may be necessary to protect groundwater resources. Surface water exposure pathways are evaluated in the HHRA and ERA presented in Sections 7.2 and 7.3, respectively. A summary of the principles of contaminant fate and transport are presented in this section along with the results of the modeling.

Section 6.1 describes physical and chemical properties of SRCs found in soil and sediment at the AOC. Section 6.2 presents a conceptual model for contaminant fate and transport that considers AOC topography, hydrogeology, contaminant sources, and release mechanisms. Section 6.3 presents a soil screening analysis, and Section 6.4 presents a sediment screening analysis to identify the SRCs with the potential to migrate from soil and sediment to groundwater as initial CMCOPCs. Section 6.5 describes fate and transport modeling of final CMCOPCs and presents CMCOCs. Section 6.6 provides an evaluation of the identified CMCOPCs to identify the final CMCOCs. Section 6.7 presents the summary and conclusions of this fate and transport analysis.

6.1 PHYSICAL AND CHEMICAL PROPERTIES OF SITE-RELATED CONTAMINANTS

The 1978 Installation Assessment identified the major contaminants of the former RVAAP as TNT, Comp B (a combination of TNT and RDX), sulfates, nitrates, lead styphnate, and lead azide. An evaluation of this process summary identified additional potential site-specific contaminants from munitions assembly: black powder, tetryl, RDX, potassium nitrate, mercury fulminate, PETN, antimony sulfide, lead thiocyanate, potassium chlorate, lead, cadmium, barium, mercury, and arsenic. In addition to the chemicals previously mentioned, Octol (a mixture of TNT and HMX) was processed and used at selected buildings and test chambers. Other potential contaminants at Load Line 6 include VOCs from former Building 2F-35 that were utilized for solvent storage, PCBs from on-site transformers, and PAHs from former Building 2F-2 that was used as a heater house.

The evaluation of contaminant fate and transport not only includes those chemicals identified as potential contaminants from previous use but also includes the chemicals that were evaluated as part of the overall RI. The comprehensive list of surface and subsurface soil SRCs (15 inorganic chemicals and 27 organic chemicals in the FPA and 16 inorganic chemicals and 12 organic chemicals in the NPA) and sediment SRCs (8 inorganic chemicals and 1 organic chemical) were detailed in Section 4.0 and are summarized below:

- Inorganic SRCs in surface and subsurface soil: aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, thallium, and zinc.
- Inorganic SRCs in sediment: antimony, beryllium, cadmium, cobalt, copper, lead, nickel, and silver.

- Organic SRCs in surface and subsurface soil: 2-methylnaphthalene, acenaphthene, anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, carbazole, chrysene, di-n-octylphthalate, dibenz(a,h)anthracene, dibenzofuran, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, pyrene, HMX, nitrocellulose, acetone, methylene chloride, toluene, 4,4'-DDE, PCB-1254, and PCB-1260.
- Organic SRCs in sediment: tetryl.

Chemicals released into the environment are susceptible to several degradation pathways, including hydrolysis, oxidation, reduction, isomerization, photolysis, photo-oxidation, biotransformation, and biodegradation. Transformed products resulting from these processes may behave differently than their parent chemical in the environment.

The migration of chemicals is governed by their physical and chemical properties and the surface and subsurface media through which chemicals are transferred. In general, chemicals and structures with similar physical and chemical characteristics will show similar patterns of transformation, transport, or attenuation in the environment. Solubility, vapor pressure data, chemical partitioning coefficients, degradation rates, and Henry’s Law Constant (HLC) provide information that can be used to evaluate contaminant mobility in the environment. Partitioning coefficients are used to assess relative affinities of chemicals for solution or solid phase adsorption. However, the synergistic effects of multiple migrating chemicals and complexity of soil/water interactions, including pH and oxidation-reduction potential, grain size, and clay mineral variability, are typically unknown.

The physical properties of the chemicals defined as SRCs in surface and subsurface soil and sediment are summarized in Tables E-1 and E-2 in Appendix E. These properties are used to assess the anticipated behavior of each chemical under environmental conditions. The physical properties of the chemicals defined as SRCs detected in soil and sediment are summarized in Section 6.1.1 through Section 6.1.5.

6.1.1 Chemical Factors Affecting Fate and Transport

The water solubility of a chemical is a measure of the saturated concentration of the chemical in water at a given temperature and pressure. The tendency for a chemical to be transported by groundwater is directly related to its solubility and inversely related to its tendencies to adsorb to soil and volatilize from water (OGE 1988). Chemicals with high water solubilities tend to desorb from soil, are less likely to volatilize from water, and are susceptible to biodegradation. The water solubility of a chemical varies with temperature, pH, and the presence of other dissolved chemicals (including organic carbon and humic acids).

The octanol-water partition coefficient (K_{ow}) can be used to estimate the tendency for a chemical to partition between environmental phases of different polarity. The K_{ow} is a laboratory-determined ratio of the concentration of a chemical in the n-octanol phase of a two-phase system to the concentration in the water phase. Chemicals with log K_{ow} values less than one are highly hydrophilic, while chemicals with log K_{ow} values greater than four will partition to soil particles (Lyman et al. 1990).

The water/organic carbon partition coefficient (K_{oc}) is a measure of the tendency of an organic chemical to partition between water and organic carbon in soil. The K_{oc} is defined as the ratio of the absorbed chemical per unit weight of organic carbon to the aqueous solute concentration.

This coefficient can be used to estimate the degree to which an organic chemical will adsorb to soil and thus not migrate with groundwater. The higher the K_{oc} value, the greater is the tendency of the chemical to partition into soil (OGE 1988). The soil/water partitioning coefficient (K_d) is calculated by multiplying the K_{oc} value by the fraction of organic carbon in the soil.

Vapor pressure is a measure of the pressure at which a chemical and its vapor are in equilibrium. The value can be used to determine the extent to which a chemical would travel in air, as well as the rate of volatilization from soil and solution (OGE 1988). In general, chemicals with vapor pressures lower than 10^{-7} mm mercury will not be present in the atmosphere or air spaces in soil in significant amounts, while chemicals with vapor pressures higher than 10^{-2} mm mercury will exist primarily in the air (Dragun 1988).

The HLC value for a chemical is a measure of the ratio of the chemical's vapor pressure to its aqueous solubility. The HLC value can be used to make general predictions about a chemical's tendency to volatilize from water. Chemicals with HLC values less than 10^{-7} atm-m^3/mol will generally volatilize slowly, while chemicals with a HLC greater than 10^{-3} atm-m^3/mol will volatilize rapidly (Lyman et al. 1990).

6.1.2 Biodegradation

Organic chemicals with differing chemical structures will biodegrade at different rates. Primary biodegradation consists of any biologically induced structural change in an organic chemical. Complete biodegradation is the biologically mediated degradation of an organic chemical into carbon dioxide, water, oxygen, and other metabolic inorganic products (Dragun 1988). The first order biodegradation rate of an organic chemical is proportional to the concentration:

$$-dC/dt = kC \qquad \text{(Equation 6-1)}$$

Where:

C = concentration
t = time
k = biodegradation rate constant = $\ln 2 / t_{1/2}$
$t_{1/2}$ = biodegradation half-life

The biodegradation half-life is the time necessary for half of the chemical to degrade. The biodegradation rate of an organic chemical generally depends on the presence and population size of soil microorganisms that are capable of degrading the chemical.

6.1.3 Inorganic Chemicals

Inorganic chemicals detected in soil and sediment samples are associated with the aqueous phase and leachable metal ions on soil particles. The transport of this material from unsaturated soil to the underlying water table is controlled by the physical processes of precipitation percolation, chemical interaction with the soil, and downward transport of metal ions by continued percolation. The chemistry of inorganic chemical interactions with percolating precipitation and varying soil conditions is complex and includes numerous chemical transformations that may result in altered oxidation states, including ion exchange, adsorption, precipitation, or complexation. The chemical reactions, which are affected by environmental conditions (pH, oxidation-reduction conditions, type and amount of organic matter, clay content, and the presence of hydrous oxides), may act to enhance or reduce the mobility and toxicity of metal ions. In general, these reactions are reversible and add to the variability commonly observed in distributions of inorganic chemicals in soil.

The chemical form of an inorganic chemical determines its solubility and mobility in the environment; however, chemical speciation is complex and difficult to delineate in routine laboratory analysis. Inorganic chemicals in soil are commonly found in several forms, including dissolved concentrations in soil pore water, metal ions occupying exchange sites on inorganic soil constituents (adsorbed to inorganic soil constituents), metal ions associated with insoluble organic matter, precipitated inorganic chemicals as pure or mixed solids, and metal ions present in the structure of primary or secondary minerals.

The dissolved (aqueous) fraction and its equilibrium sorbed fraction are important when considering the migration potential of inorganic chemicals through soil. Of the inorganic chemicals that are likely to form, chlorides, nitrates, and nitrites are commonly the most soluble. Sulfate, carbonate, and hydroxides generally have low to moderate solubility. Soluble chemicals are transported in aqueous forms subject to attenuation, whereas less soluble chemicals remain as a precipitate and limit the overall dissolution of metal ions. The solubility of the metal ions is also regulated by ambient chemical conditions, including pH and oxidation/reduction.

The attenuation of metal ions in the environment can be estimated numerically using the retardation factor (R), dispersion in higher flow systems (high conductivity environments), and diffusion in low conductivity environments. R defines the extent to which the velocity of the contaminant is slowed, which is largely derived from the K_d. R is calculated using the following equation:

$$R = 1 + (K_d \rho_b)/ \theta_w \qquad \text{(Equation 6-2)}$$

Where:

ρ_b = the soil bulk dry density (g/cm^3)
θ_w = soil moisture content (dimensionless)

Metal ion concentrations in the environment do not attenuate by natural or biological degradation because of low volatility and solubility of the ions. Inorganic chemicals may be biotransformed or bioconcentrated through microbial activity.

6.1.4 Organic Chemicals

Organic chemicals, such as SVOCs or VOCs, may be transformed or degraded in the environment by processes including hydrolysis, oxidation/reduction, photolysis, volatilization, biodegradation, or biotransformation. The half-life of organic chemicals in transport media can vary from minutes to years, depending on environmental conditions and chemical structures. Some types of organic chemicals are very stable, and degradation rates can be very slow. Organic degradation may either enhance (by producing more toxic byproducts) or reduce (reducing concentrations) the toxicity of a chemical in the environment.

6.1.5 Explosives-Related Chemicals

HMX, nitrocellulose, and tetryl were detected in soil and sediment at Load Line 6. Microbiological and photochemical transformation may affect the fate and transport of explosive compounds in the environment. For example, tetryl may undergo biotransformation, hydrolysis, and photodegradation to produce several different transformation products, such as N-methylpicramide and 4-amino-N-methyl-N,2,6-trinitroaniline (USACE 1994).

Limited information exists regarding biotransformation or biodegradation of HMX, nitrocellulose, and tetryl. Biotransformation of HMX, primarily by anaerobic degradation (ERDC 2007), occurs at a slow rate in the environment (USACHPPM 2001). HMX is primarily broken down by photolysis and has a photolytic rate constant of 0.15 days (USEPA 1988). Breakdown products of HMX include nitrate, nitrite, and formaldehyde (USACHPPM 2001). Figure E-1 in Appendix E shows the biotransformation pathway for HMX (ATSDR 1997). Nitroglycerin and nitrocellulose are aliphatic nitrate esters that will gelatinize when mixed together. Nitrocellulose occurs as a fibrous solid that can act as a sorbent that will dissolve in water under highly basic conditions with high temperatures. Nitrocellulose can undergo denitrification as a degradation pathway. Degradation of nitrocellulose to non-reactive nitrocellulose has been observed under methanogenic and fungus-mediated reducing conditions (USACE 2006).

6.2 CONCEPTUAL MODEL FOR FATE AND TRANSPORT

The conceptual site model (CSM), which defines the framework for fate and transport modeling, describes conditions at Load Line 6, including the contaminant sources, surficial and subsurface hydrogeologic conditions, contaminant migration and pathways, and contaminant release mechanisms.

AOC conditions described in Sections 2.0 through 5.0 include contaminant source information, the surrounding geologic and hydrologic conditions, and the magnitude of SRCs and their current spatial distribution. Information from Section 3.0 and the nature and extent evaluation in Section 5.0 were used to develop the CSM for fate and transport modeling by identifying SRCs and migration pathways. The CSM is based on information and data collected for historical investigations, this RI Report, and informed assumptions about the AOC. Assumptions contained in the CSM are reiterated throughout this section. The better the information and the greater the accuracy of the assumptions, the more accurately the CSM describes the AOC, and therefore, the more reliable the fate and transport modeling predictions can be. A summary of the salient elements of the CSM that apply to fate and transport modeling are summarized in the following sections.

6.2.1 Contaminant Sources

No primary contaminant sources are located on the AOC. Secondary sources (contaminated media) identified in previous investigations are further evaluated in this report. Another potential secondary source of contamination at the AOC is contaminated sediment, which if deposited adjacent to a stream/ditch during a storm event, has potential to leach contaminants to the groundwater.

6.2.2 Hydrogeology

A description of regional and AOC-specific geology and hydrology are provided in Sections 3.3.3 and 3.4.2, respectively, and are summarized below.

The topography at Load Line 6 is relatively flat (around 1,120 ft amsl) and slopes gently to the south-central area. Surface water drainage associated with heavy rainfall events would follow the topography and drain through constructed ditches and conveyances toward the drainage ditch south of the AOC (Figure 3-1).

Soil beneath the AOC consists of silt clay loam to clay loam tills with interbedded sands scattered throughout, as observed in subsurface borings installed during the PBA08 RI (Appendix A). Bedrock was encountered at 12.9-20 ft bgs during monitoring well installation under the Phase I RI (MKM 2007).
Seven groundwater monitoring wells were installed at the AOC to an average depth of approximately 20 ft bgs. The monitoring wells at Load Line 6 are screened primarily in the unconsolidated zone, with four of the wells extending into bedrock.

Water level elevations at the AOC ranged from 1105.36-1107.58 ft amsl (approximately 17 ft bgs) with the highest elevation at well LL6mw-006 (Figure 3-1). Potentiometric data indicate the groundwater table occurs within the unconsolidated zone throughout the AOC. The flow direction is to the east to southeast with a hydraulic gradient of 0.00163 (Figure 3-1).

6.2.3 Contaminant Release Mechanisms and Migration Pathways

Based on the information presented above, the following contaminant release mechanisms and migration pathways have been identified at the AOC:

- Contaminant leaching from soil to the water table (vertical migration) and lateral transport to a downgradient receptor (i.e., unnamed tributary to the Mahoning River southeast of Load Line 6);
- Contaminated sediment transported to potential downstream receptors;
- Contaminated surface water migrating to potential downstream receptors;
- Contaminated sediment within wet ditches and deposited on ditch banks as a secondary source of leaching to the water table (vertical migration) and lateral transport to potential downgradient receptors; and

- Contaminated sediment at the bottom of surface water bodies, assuming equilibrium with groundwater, and mixing with surface water based on a calculated, sample-specific dilution attenuation factor (DAF).

The first of these pathways, which considers a primary groundwater transport pathway, is treated explicitly in this fate and transport section. Sediment and surface water exposure pathways are evaluated in the HHRA and ERA presented in Sections 7.2 and 7.3, respectively. The fourth and fifth pathways listed above, which consider a secondary groundwater transport pathway and a primary groundwater transport pathway, respectively, are evaluated using the sediment screening analysis presented in Section 6.4.

One of the principal migration pathways at the AOC is percolation through the unsaturated soil to the water table (i.e., vertical leaching of contaminants from soil into groundwater). However, because of the very heterogeneous nature of the unconsolidated glacial material, groundwater flow patterns within the unconsolidated soil are difficult to predict. Precipitation that does not leave the AOC as surface runoff percolates into the subsurface. Some of the percolating water leaves this environment via evapotranspiration after little or no vertical migration.

The remainder of the water percolates into the water table. As discussed in Section 6.2.4, the rate of percolation is controlled by soil cover, ground slope, saturated conductivity of the soil, and meteorological conditions. Figure 6-1 illustrates the contaminant migration conceptual model.

Once the contaminant leachate percolates through the soil and reaches the water table, it migrates with the local groundwater and discharges at the downgradient receptors. Groundwater flow likely occurs along preferential pathways (e.g., sand seams, channel deposits, or other stratigraphic discontinuities) having higher permeabilities. For inorganic chemicals, lateral migration through groundwater will be very limited due to their high retardation by the bedrock material (USACE 2003b).

Additional factors that affect the leaching rate include a chemical's solubility, sorption capacity (expressed by the K_d), and the amount of percolation. Insoluble chemicals will precipitate out of the solution in the subsurface or remain in insoluble forms with little leaching.

Another factor that affects whether a chemical will reach the water table through percolation of precipitation is the chemical's rate of decay. Most organic compounds decay at characteristic rates proportional to the chemical's half-life. For a given percolation rate, those chemicals with long half-lives have a greater potential for contaminating groundwater than those with shorter half-lives. For this analysis, the rate of decay/half-life was not considered.

Contaminant releases through gaseous emissions and airborne particulates are not significant at Load Line 6. The AOC is vegetated, located in a humid temperate climate, and soil moisture is typically high, which prevents dust borne contaminant migration. Therefore, there is likely little to no gaseous emission, and contaminant levels in the air pathway are minor to nonexistent.

6.2.4 Water Budget

The potential for contaminant transport begins with precipitation. Percolation is the driving mechanism for leaching of soil contaminants to groundwater. The actual amount of rainwater available for flow and percolation to groundwater is highly variable and depends upon soil type and climatic conditions. A water balance calculation can be used as a tool to quantitatively account for all components of the hydrologic cycle. The quantified elements of the water balance are used for inputs to the soil leaching and groundwater transport models discussed later. The components of a simple steady-state water balance model include precipitation, evapotranspiration, surface runoff, and groundwater recharge or percolation.

These terms are defined as follows:

$$P = ET + Sr + q \qquad \text{(Equation 6-3)}$$

or

$$\text{Rainwater available for flow} = Sr + q = P - ET \qquad \text{(Equation 6-4)}$$

Where:

P = precipitation
Sr = surface runoff
ET = evapotranspiration
q = groundwater recharge or percolation

It is expected that loss of runoff also occurs in the form of evaporation. The remaining water, after runoff and evaporation, is available for percolation, which includes loss to the atmosphere by evapotranspiration. The water balance estimations were developed using the Hydrologic Evaluation of Landfill Performance (HELP) model (USEPA 1994). See Table E-3 in Appendix E for parameters used in the HELP model to develop the water budget estimates used in the evaluation. Calculations using precipitation and temperature data for a 100-year period were generated synthetically using coefficients for Cleveland, Ohio (e.g., the nearest weather station to Camp Ravenna with HELP model coefficients).

The annual average water balance estimates indicate an evapotranspiration of 28% (10.3 inches) of total precipitation (37 inches). The remaining 72% (26.7 inches) of rainwater is available for surface water runoff and percolation to groundwater. Of the 72% (27 inches) of water available for runoff or percolation, groundwater recharge (percolation) accounts for 13% (3.6 inches), and surface runoff (along downgradient topography to nearest surface water bodies) accounts for the remaining 87% (23.1 inches).

6.3 SOIL SCREENING ANALYSIS

Soil screening analyses are screening evaluations performed to identify SRCs with the potential to leach to groundwater as CMCOPCs. The five steps for the soil leachability analysis are illustrated in Figure 6-2.

6.3.1 Soil Screening Analysis

The first step of the soil screening analysis is developing SRCs, as presented in Section 4.0. A summary of SRCs identified for soil and sediment is presented in Section 6.1.

The second step of the soil screening process (Figure 6-2) involves comparing the maximum concentrations of the SRCs with MCL-based Generic Soil Screening Levels (GSSLs). GSSLs were developed for Superfund sites for contaminant migration to groundwater (USEPA 1996a, USEPA 2015). The GSSL is defined as the concentration of a chemical in soil that represents a level of contamination below which there is no concern for impacts to groundwater under CERCLA, provided conditions associated with USEPA risk-based Soil Screening Level (SSLs) are met. Generally, if chemical concentrations in soil fall below the GSSL, and there are no groundwater receptors of concern or anticipated exposures, then no further study or action is warranted for that chemical. If the GSSL for a chemical is not available, the USEPA risk-based SSL for groundwater migration, dated June 2015 (USEPA 2015), will be obtained from the USEPA RSL website and used. If neither the GSSL nor the USEPA risk-based SSL for a chemical is available, then no further evaluation of the chemical is performed and it is eliminated from the list of the initial CMCOPCs. However, some chemicals have been assigned surrogates by risk assessors if the chemical without an SSL is similar to another chemical with an SSL. Surrogates used for this analysis include pyrene for benzo(ghi)perylene and phenanthrene.

One soil SRC, carbazole, was eliminated as an initial CMCOPC because it does not have an associated GSSL or USEPA risk-based SSL. Because this constituent does not have an associated USEPA RSL or MCL, an AOC-specific SSL could not be calculated. Carbazole was detected in 1 of 16 soil samples at the FPA at a maximum concentration of 0.14 mg/kg. Carbazole is an SVOC with a relatively high K_{oc} value (9.16E+03 L/kg); therefore, this compound has the tendency to partition into soil and is not likely to pose a risk to groundwater. Carbazole was not detected in groundwater samples collected at Load Line 6 under the 2009 FWGWMP (EQM 2010).

The initial CMCOPC screen, as presented in Table E-4 in Appendix E, eliminates 4 inorganic chemicals and 10 organic chemicals from the NPA, and 4 inorganic chemicals and 20 organic chemicals from the FPA from further consideration. Twelve inorganic and 2 organic SRCs from the NPA, and 11 inorganic and 7 organic SRCs from the FPA, were carried forward to the next screening step.

The third step of the soil screening process (Figure 6-2) involves comparing the maximum chemical concentrations with the site-specific soil screening level (SSSLs). The SSSL is defined as the GSSL (or the USEPA risk-based SSL for groundwater protection if a GSSL is not available) multiplied by the AOC-specific dilution attenuation factor (DAF). Direct partitioning is used to derive the GSSLs, assuming groundwater is in contact with the chemicals in soil and the groundwater concentration is equal to the leachate concentration. However, as leachate moves through soil, chemical concentrations are attenuated by adsorption and degradation. When the leachate reaches the water table, dilution by groundwater further reduces leachate concentrations. This concentration reduction can be expressed by a DAF. DAFs can vary based on AOC-specific characteristics (e.g., hydrogeologic properties, contaminated source area, and depth to contamination). As described in the *Soil Screening Guidance: Technical Background Document* (USEPA 1996a), chemical dilution in groundwater is estimated at each AOC from an AOC-specific DAF. The DAF, which is defined as the ratio of soil leachate concentration to receptor point concentration, is minimally equal to one.

Dilution in groundwater is derived from a simple mixing zone equation (Equation 6-5) and relies upon estimation of the mixing zone depth (Equation 6-6).

$$\mathrm{DAF} = 1 + \frac{(\mathrm{K} \times i \times \mathrm{d})}{(\mathrm{q} \times \mathrm{L})} \qquad \text{(Equation 6-5)}$$

Where:

DAF = dilution attenuation factor
K = aquifer hydraulic conductivity (m/yr)
i = horizontal hydraulic gradient (m/m)
q = percolation rate (m/yr)
L = source length parallel to groundwater flow (m)
d = mixing zone depth (m) (which is defined below)

$$\mathrm{d} = \sqrt{0.0112 \times \mathrm{L}^2} + \mathrm{d_a} \times \left[1 - \exp\left(\frac{-\mathrm{L} \times \mathrm{I}}{\mathrm{K} \times i \times \mathrm{d_a}}\right)\right] \qquad \text{(Equation 6-6)}$$

Where:

d_a = aquifer thickness (m)
$d \leq d_a$

As stated above, if the aquifer thickness is less than the calculated mixing zone depth, then the aquifer thickness is used for “d” in the DAF calculation. The DAF calculation for the AOC is presented in Table E-5 in Appendix E. It should be noted that the purpose of this screen is not to identify the chemicals that may pose risk at downgradient locations, but to target those chemicals that pose the greatest problem if they migrate from the AOC.

Based on this screening and an AOC-specific DAF of 1.76 for the NPA, nickel and zinc were eliminated from further consideration. Based on this screening and an AOC-specific DAF of 1.63 for the FPA, methylene chloride was eliminated from further consideration. All the remaining SRCs exceeded their published or calculated GSSL multiplied by the respective DAF and were identified as initial CMCOPCs, based on leaching to groundwater. The SRCs identified as initial CMCOPCs are presented in Table E-6 in Appendix E.

The fourth step of the soil screening process (Figure 6-2) involves eliminating initial CMCOPCs identified in the SSSL evaluation that require more than 1,000 years to leach through the unsaturated zone before reaching the water table from further consideration. A period of 1,000 years was conservatively selected to evaluate eventual migration of the contaminant front to the water table despite uncertainties in vadose zone hydraulic parameters and groundwater recharge over time. Additionally, USACE suggests a screening value of 1,000 years be used due to the high uncertainty associated with predicting conditions beyond that time frame (USACE 2003b). Therefore, the initial

CMCOPCs at the selected sources were screened against a travel time of greater than 1,000 years. The travel time in this screen is the time required for a CMCOPC to migrate vertically from the base of the soil interval detected above the background concentration to the water table. This distance is the leaching zone, which is evaluated in Table E-7 of Appendix E, which may vary across the AOC based on the varying depths of soil sample concentrations above the facility-wide background concentrations and the elevation of the water table. The estimated travel time for each initial CMCOPC to reach the water table is determined using the following equations:

$$T = \frac{Lz \times R}{V_p} \qquad \text{(Equation 6-7)}$$

Where:

T = leachate travel time (year)
Lz = thickness of attenuation zone (ft)
R = retardation factor (dimensionless) (Equation 6-2)
V_p = porewater velocity (ft/year)

and

$$V_p = \frac{q}{\theta_w} \qquad \text{(Equation 6-8)}$$

Where:

q = percolation rate (ft/year)
θ_w = fraction of total porosity that is filled by water

If the travel time for a chemical from a source area exceeded 1,000 years, then the chemical was eliminated from the list of initial CMCOPCs. Seven inorganic and two organic SRCs from the NPA and 10 inorganic and 5 organic SRCs from the FPA were eliminated from further consideration based on their travel times exceeding 1,000 years. Initial CMCOPCs with travel times less than 1,000 years were retained for further evaluation (Appendix E, Table E-7). The constituents selected for further evaluation with Seasonal Soil Compartment Model (SESOIL) are listed in Table 6-1.

In the fifth step (Figure 6-2), the initial CMCOPCs were further evaluated using fate and transport models provided in Section 6.5.

6.3.2 Limitations and Assumptions of Soil Screening Analysis

It is important to recognize that acceptable soil concentrations for individual chemicals are highly AOC-specific. The GSSLs used in this screening are based on a number of default assumptions chosen to be protective of human health for most AOC conditions (USEPA 1996a). These GSSLs are expected to be more conservative than SSSLs based on AOC conditions. The conservative assumptions included in this analysis are: (1) no adsorption in the unsaturated zone or in the aquifer, (2) no biological or chemical degradation in the soil or aquifer, and (3) contamination is uniformly distributed throughout the source. However, the GSSL does not incorporate the existence of contamination already present within the aquifer.

6.4 SEDIMENT SCREENING ANALYSIS

Sediment SRCs were developed in Section 4.0 and are presented in Section 6.1. The purpose of this screening analysis is to identify the CMCOPCs based on contaminant migration from the sediment to the groundwater. Any identified CMCOPCs are modeled with Analytical Transient 1-, 2-, 3-Dimensional (AT123D) to a downgradient receptor if present. The four steps for the sediment screening analysis are illustrated in Figure 6-3.

Sediment SRCs were screened by developing leachate concentrations assuming equilibrium between sediment and groundwater. The predicted leachate concentrations were diluted based on a sample-specific DAF calculated by dividing the calculated leachate concentrations by the co-located surface water concentrations. The DAF was calculated for each chemical that was detected in the sediment and surface water at the same sample location. The calculated DAF was then used to calculate the maximum groundwater concentration, considering dilution for sediment SRCs and assuming that the sediment is in direct contact with groundwater. The lowest DAF calculated for the sample area was used for sediment SRCs that did not have a sample-specific DAF. The DAFs calculated for each chemical are shown in Table 6-2 and Table E-8 in Appendix E.

This sediment screening analysis assumed that the sediment concentration and the recharging groundwater concentration were in equilibrium and a sample-specific DAF for each chemical was used for dilution in the aquifer. Based on this screening analysis (see Table 6-2), there were no CMCOPCs from the sediment samples.

6.5 FATE AND TRANSPORT MODELING

Contaminant fate and transport modeling represents the fifth step in the fate and transport screening and evaluation process (Figure 6-2). SESOIL modeling was performed for chemicals identified as initial CMCOPCs from the soil screening analysis presented in Section 6.3 and summarized in Table 6-1. SESOIL modeling was performed to predict chemical concentrations in the leachate immediately beneath the selected source areas and just above the water table. If the predicted maximum leachate concentration of an initial CMCOPC was higher than the facility-wide background concentration and the lowest risk-based screening value (Resident Receptor Adult FWCUG, MCL, or RSL), the CMCOPC was further evaluated using the AT123D model to predict future maximum concentrations in groundwater beneath the source, as well as at downgradient receptor locations, if applicable. The downgradient receptor location (if required) is the closest surface water body feature downgradient from the source areas that is connected to the groundwater. The predicted concentrations of CMCOPCs in groundwater beneath the source were compared to available groundwater monitoring results for the AOC to validate modeling results and provide WOE for identifying or eliminating CMCOCs.

6.5.1 Modeling Approach

Contaminant transport includes the movement of water and dissolved material from the source areas to groundwater. This occurs as rainwater infiltrates the surface and percolates through the area of contamination, its surrounding soil, and into the saturated zone. The downward movement of water, driven by gravitational potential, capillary pressure, and other components of total fluid potential, mobilizes the contaminants and carries them through the soil into the mixing zone with the water table. Lateral transport within the unconsolidated zone is controlled by the groundwater gradient. Vertical transport (evaluated with the SESOIL model) through the overburden to the water table and horizontal transport (evaluated with the AT123D model) through the unconsolidated zone to downgradient receptor locations are illustrated in Figure 6-1.

The output of the contaminant fate and transport modeling is presented as the expected maximum concentration of modeled contaminants at the selected receptor locations. For SESOIL, the receptor location is the groundwater table beneath the source area. For this analysis, four discrete sampling locations were considered as sources of contamination based on the results of the soil screening analysis. A separate SESOIL analysis was performed for each initial CMCOPC listed in Table 6-1 and is presented in Figure 6-4.

The predicted maximum leachate concentration just above the water table, observed in the SESOIL results, was compared against its applicable RVAAP facility-wide background concentration, as well as RVAAP FWCUGs for the Resident Receptor Adult, MCL, and RSL. If the predicted maximum leachate concentration of an initial CMCOPC was higher than the facility-wide background concentration, and the lowest risk-based screening value (Resident Receptor Adult FWCUG, MCL, or RSL), the CMCOPC was further evaluated using the AT123D model to predict future maximum concentrations in groundwater beneath the source, as well as at downgradient receptor locations, if applicable.

If a predicted maximum leachate concentration was lower than the screening criteria, the chemical was no longer considered a CMCOPC.

For chemicals identified as CMCOPCs, maximum concentrations predicted by AT123D in groundwater directly below the source areas and at the downgradient receptor locations were compared to the applicable RVAAP facility-wide background concentrations, as well as RVAAP FWCUGs for the Resident Receptor Adult, MCL, and RSL. If the predicted maximum concentration of a CMCOPC was higher than its facility-wide background concentration, and the lowest risk-based screening value (i.e., Resident Receptor Adult FWCUG, MCL, or RSL), the chemical was retained as a CMCOC. If the predicted maximum concentration of a CMCOPC in groundwater directly below the source areas and at the downgradient receptor location was lower than the screening criteria, the chemical would not be considered a CMCOC.

CMCOCs identified by modeling results were evaluated with respect to WOE for retaining or eliminating CMCOCs from further consideration as a basis for potential soil remedial actions. Lines of evidence include validating modeling results using available AOC-specific groundwater monitoring data. Modeled timelines for potential leaching and lateral transport were evaluated with respect to estimated times for contaminant releases during RVAAP operations to determine if peak leaching concentrations would likely have occurred in the past. Some CMCOCs present at or below RVAAP soil background concentrations may have predicted leachate or groundwater concentrations exceeding risk-based criteria due to conservative model assumptions; therefore, these were also identified and considered in the evaluation. Additionally, identified CMCOCs were compared to COCs identified in the HHRA to determine if they had an associated risk related to direct exposure to soil or if CMCOCs and COCs were co-located and may be addressed simultaneously under a potential remedial action.

6.5.2 Model Applications

The SESOIL model (GSC 1998) used for leachate modeling, when applicable, estimates pollutant concentrations in the soil profile following introduction via direct application and/or interaction with transport media. The AT123D model (DOE 1992) is an analytical groundwater pollutant fate and transport model. It computes the spatial-temporal concentration distribution of waste in the aquifer system and predicts the transient spread of a contaminant plume through a groundwater aquifer. The application of both of these models is discussed in the following subsections.

6.5.2.1 SESOIL Modeling

The SESOIL model defines the soil column as compartments extending from the ground surface through the unsaturated zone and to the upper level of the saturated soil zone or top of bedrock. Processes simulated in SESOIL are categorized in three cycles: the hydrologic, sedimentation, and pollutant. Each cycle is a separate submodule in the SESOIL code. The hydrologic cycle includes rainfall, surface runoff, percolation, soil-water content, evapotranspiration, and groundwater recharge. The sediment washload cycle includes erosion and sediment transport.

The pollutant cycle includes convective transport, volatilization, adsorption/desorption, and degradation/decay. A chemical in SESOIL can partition in up to four phases: liquid, adsorbed, air, and pure. Data requirements for SESOIL are not extensive and utilize a minimum of AOC-specific soil and chemical parameters and monthly or seasonal meteorological values as input.

The SESOIL model output includes pollutant concentrations at various soil depths and pollutant loss from the unsaturated soil zone in terms of surface runoff, percolation to groundwater, volatilization, and degradation. The mathematical representations in SESOIL generally consider the rate at which the modeled processes occur, the interaction of different processes with each other, and the initial conditions of the waste area and surrounding subsurface matrix material.

The input data for SESOIL can be grouped into four types: climatic, chemical, soil, and application data. There are 61 separate parameters contained in these 4 data groups. Wherever possible, AOC-specific parameter values were used for modeling. However, certain parameters were not available for the source areas and were estimated based on pertinent scientific literature, geochemical investigations, and checks for consistency between model results and historical data. Conservative estimates were used when a range of values existed or parameter values were not available.

6.5.2.2 Climate Data

The climatic data file of SESOIL consists of an array of mean monthly temperature, mean monthly cloud cover fraction, average monthly relative humidity, average monthly reflectivity of the earth's surface (i.e., shortwave albedo), average daily evapotranspiration, monthly precipitation, mean number of storm events per month, mean duration of rainfall, and mean length of rainy season. The climatic data are presented in Table E-9 of Appendix E. The data set was taken from the Youngstown National Weather Service Office weather station at the Youngstown-Warren Regional Airport in Vienna, Ohio, as it was determined to be most appropriate in corresponding to the latitude and longitude at Camp Ravenna.

Climate data from the Youngstown weather station did not have all of the necessary climatic parameters for the HELP model simulation. Accordingly, the water balance evaluation presented in Section 6.2.4 was based on the nearest available weather station data with all necessary coefficients stored within the HELP model (Cleveland, Ohio). Inputs for the SESOIL model (Youngstown station) and HELP model (Cleveland station) produced virtually the same recharge rate (9.40 cm/yr for Cleveland and 9.42 cm/yr for Youngstown) for each location. Therefore, the use of the two different weather station data sets did not impact modeling results.

6.5.2.3 Chemical Data

The pollutant fate cycle of SESOIL focuses on various chemical transport and transformation processes that may occur in the soil zone. These processes include volatilization/diffusion, adsorption/desorption, cation exchange, biodegradation and hydrolysis, and metal complexation. The chemical-specific parameters used for SESOIL are presented in Appendix E (Table E-10). The distribution coefficients (K_ds) for inorganic chemicals and the K_{oc} values for organic chemicals were obtained from the chemical-specific parameter table associated with the USEPA Risk Based Generic Screening Tables (USEPA 2015). The K_ds for organic chemicals were estimated from organic, carbon-based K_{oc} using the relationship $K_d = (f_{oc})(K_{oc})$, where f_{oc} = mass fraction of the organic carbon soil content obtained from AOC-specific measurements. In general, biodegradation rates are not applicable for inorganic CMCOPCs and biodegradation was not considered for the organic chemicals in this evaluation.

6.5.2.4 Soil Data

The soil data file of SESOIL contains input parameters describing the physical characteristics of the subsurface soil and is presented in Table 6-3. These parameters include soil bulk density, intrinsic permeability, soil disconnectedness index, soil porosity, organic carbon content, and cation exchange capacity. AOC-specific data were used from geotechnical samples collected at the AOC during the PBA08 RI (Table 5-6). There is, however, no measurement method for the soil disconnectedness index or a measured value of the Freundlich exponent. Soil disconnectedness index is a parameter that relates the soil permeability to the moisture content. Thus, SESOIL default values were used for these two parameters.

An average intrinsic permeability for the vadose zone, representing the unconsolidated zone above the water table, was calibrated using the percolation rate of 9.42 cm/yr (3.6 inches/year) as the calibration target. The model was calibrated against the percolation rate by varying the intrinsic permeability and keeping all other AOC-specific geotechnical parameters fixed. The final hydrogeologic parameter values used in this modeling are shown in Table 6-3. The soil porosity was set to the AOC-specific value. The intrinsic permeability, calibrated in SESOIL to the percolation rate (determined from a water balance estimated in HELP), was found to match the AOC-specific measurements from geotechnical samples.

The soil disconnectedness index replaces the moisture retention curves (or characteristic curves) used by other unsaturated zone leaching models. SESOIL's User Guide defines this parameter to be the exponent relating the "wetting" and "drying" time-dependent permeability of soil to its saturated permeability (Hetrick and Scott 1993). This "one variable" approach of using the soil disconnectedness index in SESOIL simplifies the data estimation process and reduces computational time. In addition, this parameter was calibrated for four different soil types ranging from sandy loam to clay (Hetrick et al. 1986), and calibrated values fell within the default range specified in the SESOIL's User Guide.

6.5.2.5 Source Terms

Analytical data from surface and subsurface soil collected at the AOC were used as source terms for SESOIL modeling. All the samples collected at different depth intervals were compiled to provide a detailed loading option for the SESOIL model. The maximum soil concentrations for each CMCOPC, listed in Table 6-1, were used as source term concentrations for the SESOIL model.

6.5.2.6 Application Data

Three different layering schemes were developed for sample locations within the AOC due to varying thicknesses of the loading and leaching zones that are based on varying soil sample and groundwater depths throughout the AOC. Details of the model layers utilized in this modeling are presented in Table E-11 in Appendix E.

Each model was arranged in four layers. The top layer (Layer 1) for each model consisted of the loading zone, with the exception of the naphthalene model for the FPA.

The thicknesses of Layer 2 varied between the models and served as either a loading or leaching zone depending on the chemical. The thickness of Layer 3 varied between the models for each chemical but served as a leaching zone in each. The fourth layer (Layer 4) was 0.5 ft thick and did not contain sublayers. Layer 4 was included just above the water table to read output results at the water table/vadose zone interface (i.e., leachate concentration entering groundwater).

For the arsenic model in the NPA, Layer 1 served as a 1-ft loading zone in the 17-ft-thick vadose zone. Layers 2, 3, and 4 served as the leaching zone of 16 ft. For the selenium model in the NPA, Layers 1 and 2 served as a 3-ft loading zone in the 17-ft-thick vadose zone. Layers 3 and 4 served as the leaching zone of 14 ft. For the selenium model in the FPA, Layers 1 and 2 served as a 7-ft loading zone in the 17-ft-thick vadose zone. Layers 3 and 4 served as the leaching zone of 10 ft. For the naphthalene model in the FPA, Layer 2 served as a 2-ft loading zone in the 17-ft-thick vadose zone. Layers 3 and 4 served as the leaching zone of 14 ft. In each of these models, Layer 4 was included just above the water table to read output results at the water table/vadose zone interface (i.e., leachate concentration entering groundwater).

6.5.3 SESOIL Modeling Results

SESOIL modeling was performed for initial CMCOPCs (i.e., arsenic and selenium at the NPA and selenium and naphthalene at the FPA) that have the potential to reach the water table within 1,000 years based on the soil screening analysis results (Table 6-1). Table 6-4 presents the predicted peak leachate concentrations beneath the source areas relative to the discrete sample locations corresponding to the time of peak leachate concentrations. The Resident Receptor Adult FWCUGs, RVAAP facility-wide background concentrations, and MCL/RSL values for the CMCOPCs, if available, are also shown in this table for comparison purposes. Arsenic in the NPA was eliminated as a final CMCOPC based on the results of the SESOIL modeling, as the leachate below the source and just above the water table was below its screening criterion. The remaining SRCs were selected as final CMCOPCs. Figures E-2 through E-5 in Appendix E show the leachate mass flux versus time plots generated by SESOIL.

Selenium in the NPA and selenium and naphthalene in the FPA were identified as the final soil CMCOPCs based on SESOIL results for each sample location within the AOC where the leachate concentration exceeded its screening criteria. This leachate concentration is not reflective of the groundwater concentration beneath the source. When the leachate reaches the water table, dilution by groundwater further reduces leachate concentrations.

6.5.4 AT123D Modeling in the Saturated Zone

The fate and transport processes accounted for in the AT123D model include advection, dispersion, adsorption/retardation, and decay. This model can be used as a tool for estimating the dissolved concentration of a chemical in three dimensions in the groundwater resulting from a mass release over a source area (point, line, area, or volume source). The model can handle instantaneous, as well as continuous, source loadings of CMCOPC concentrations. AT123D is frequently used by the scientific and technical community to perform quick and conservative estimates of groundwater plume movements in space and time. SESOIL and AT123D are linked in a software package (RISKPRO) so that mass loading to the groundwater predicted by SESOIL can be transferred directly to AT123D. Therefore, AT123D was chosen to predict the maximum concentration of contaminants in groundwater after mixing with the leachate and the future concentrations for the contaminants in groundwater at the receptor locations.

The hydrogeologic parameter values used in this modeling are shown in Table 6-3. Most of the parameters presented in this table are AOC-specific values, unless otherwise indicated. The chemical-specific parameters used for AT123D are presented in Table E-12 in Appendix E. A discussion of model assumptions and limitations is presented in Section 6.5.6.

Figures E-6 through E-8 in Appendix E show the predicted concentration versus time curves based on AT123D modeling for final CMCOPCs for both soil and sediment.

6.5.5 AT123D Modeling Results

Results of AT123D modeling for final soil and sediment CMCOPCs are shown in Table 6-5. The results show predicted groundwater concentrations for CMCOPCs beneath the source area and at the selected downgradient receptor location (i.e., unnamed tributary to the Mahoning River southeast of Load Line 6). Observed groundwater concentrations from AOC monitoring wells are included in Table 6-5; however, it should be noted that these wells may not exist at the sample location with the maximum concentration and should not be considered in direct correlation. The observed groundwater concentrations were added for comparison, not for screening criteria. The distances to the downgradient receptors were based on the distance along the groundwater flow direction to the closest surface water body.

The maximum predicted concentrations of selenium in the NPA and selenium and naphthalene in the FPA were predicted to exceed the screening criteria in groundwater beneath the source area and were, therefore, modeled to the downgradient receptors (i.e., unnamed tributary to the Mahoning River southeast of Load Line 6).

Lateral transport modeling showed the maximum predicted concentrations of final soil CMCOPCs (selenium in the NPA and FPA and naphthalene in the FPA) did not exceed the screening criteria at their downgradient receptor location (unnamed tributary to the Mahoning River southeast of Load Line 6). However, these soil CMCOPCs (selenium in the NPA and selenium and naphthalene in the FPA) exceeded screening criteria in groundwater beneath their respective source areas and were retained for further evaluation. Figure 6-5 presents CMCOCs identified based on AT123D modeling.

6.5.6 Limitations/Assumptions

In general, a conservative modeling approach was used, which may overestimate the contaminant concentration in the leachate for migration from observed soil concentrations. Important assumptions used in this analysis include:

- The contaminant fate and transport evaluation included not only chemicals identified as being previously used during historical operations but also chemicals identified during the RVAAP SRC screening process.
- Some SRCs were identified due to the lack a background concentration data available or having limited or slight exceedances of the established background concentrations.
- Chemical and biological degradation rates for organic CMCOPCs were not considered in the SESOIL and AT123D models.
- The use of K_d and R to describe the reaction term of the transport equation assumes that an equilibrium relationship exists between the solid-phase and solution-phase concentrations and that the relationship is linear and reversible.
- Since AOC-specific data are not available, the K_d and K_{oc} values used in this analysis for all CMCOPCs represent literature or calculated values and may not represent conditions at the AOC.

- The K_d for inorganic chemicals used here assumed a pH of 6.8 [i.e., the middle value in the USEPA's evaluation presented in the soil screening guidance document (USEPA 1996a)]. The K_d for inorganic chemicals varies with pH (generally decreasing with decreasing pH, although there are few exceptions); therefore, if AOC-specific pH measurements are greater or less than 6.8, the K_d and calculated screening parameters (such as R) will deviate from those presented here.
- Flow and transport in the vadose zone is one-dimensional (i.e., only in the vertical direction).
- This modeling used the current soil concentrations that were collected approximately 65 years after historical operations were terminated at the AOC. Therefore, it does not account for constituents that have already leached to groundwater.
- Flow and transport are not affected by density variations.
- A realistic distribution of soil contamination was not considered. The maximum concentration value was used as the source term concentrations for SESOIL model layers; this is a highly conservative assumption that is expected to produce higher leachate concentrations for the CMCOPCs than the average condition. The horizontal distribution of soil contamination was assumed based on concentration levels from nearby sample locations as opposed to taking into account the entire area.
- The water balance represents an overall average rainwater recharge and assumes an even distribution of infiltration in the modeled area. An average water balance assumes some areas will have higher or lower recharge based on the heterogeneity of the soil and varying topography.

The inherent uncertainties associated with using these assumptions must be recognized. K_d values are highly sensitive to changes in the major chemistry of the solution phase. Therefore, it is important that the values be measured or estimated under conditions that will closely represent those of the contaminant plume. Deviations from actual AOC-specific parameter values from assumed literature values may significantly affect contaminant fate predictions. It is also important to note that the contaminant plume will change over time and will be affected by multiple solutes present at the AOC. The effects of heterogeneity and anisotropy are not addressed in these simulations.

The discrepancy between the contaminant concentrations measured in the field and the values predicted by the model could be investigated by performing sensitivity analyses on the model input parameters that have the most influence on the model predictions.

These parameters are: (1) biodegradation rate constants for organic chemicals; (2) saturated hydraulic conductivity; (3) soil porosity; (4) fraction of soil organic carbon-content (f_{oc}) for organic chemicals; (5) K_d for inorganic chemicals; and (6) longitudinal, transverse, and vertical dispersivity values. Generally, higher biodegradation rates will produce lower concentrations, and lower rates will produce higher concentrations for organic chemicals without impacting the results of the inorganic chemicals. Higher hydraulic conductivity and dispersivity causes higher advection and dispersion, thereby producing lower peaks near the source area, but increasing the migration distance. The reverse will be true with lower hydraulic conductivity and dispersivity values. Higher f_{oc} values have a similar effect on organic chemicals as higher K_d has on inorganic chemicals; they decrease the mobility of the chemicals as well as produce lower concentrations in groundwater.

6.6 EVALUATION TO IDENTIFY CMCOCS

This evaluation of contaminant fate and transport uses a soil screening analysis to identify SRCs that have potential to leach to groundwater, performs SESOIL modeling to conservatively estimate final CMCOPC leachate concentrations before the SRCs enter the groundwater system beneath the sources with highest level of contamination, and uses AT123D modeling to present a conservative maximum concentration in groundwater of final CMCOPCs beneath the sources and at downgradient receptor locations.

This analysis also includes a sediment screening analysis that was performed for sediment samples at the AOC. Chemical-specific DAFs were calculated using co-located surface water and sediment concentrations for identified sediment SRCs. These DAFs were used in the sediment screening analysis to identify CMCOPCs for predictive modeling and further evaluation.

The limitations and assumptions of the overall process are presented in Section 6.5.6. The text below provides a list of the remaining final CMCOCs and a qualitative assessment of the results and considerations of the limitations and assumptions.

6.6.1 Evaluation of Remaining Soil CMCOPCs at the Non-Production Area (NPA)

Selenium. The maximum soil concentration for selenium was 2.5 mg/kg at LL6sb-030, which is well below its RSL of 39 mg/kg and only slightly above the subsurface soil background concentration of 1.5 mg/kg. Selenium has not been detected in the AOC groundwater samples collected from 2009-2015 (Table 6-5). Using the maximum soil concentration, selenium modeling results in the NPA indicate it would take nearly 350 years for a breakthrough in groundwater to occur beneath the source at a concentration above the RSL (0.050 mg/L), and selenium is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (see Table 6-5).

6.6.2 Evaluation of Remaining Soil CMCOPCs at the Former Production Area (FPA)

Selenium. The maximum soil concentration for selenium in the FPA is 1.8 mg/kg at LL6sb-070, which is well below its RSL of 39 mg/kg and only slightly above the subsurface soil background concentration of 1.5 mg/kg. Selenium has not been detected in the AOC groundwater samples collected from 2009-2015 (Table 6-5). Using the maximum soil concentration, selenium modeling results in the FPA indicated it would take nearly 250 years for a breakthrough in groundwater to occur beneath the source at a concentration above the RSL (0.050 mg/L), and selenium is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (see Table 6-5).

Naphthalene. Naphthalene was detected in only 1 of 26 soil samples in the FPA. The soil concentration for naphthalene (0.078 mg/kg at LL6sb-024) was below the Resident Receptor Adult FWCUG at a TR or 1E-06, HQ of 0.1 (368 mg/kg) and RSL of 122 mg/kg, and was not considered a COPC in the HHRA. The naphthalene modeling results using this concentration indicated it would take nearly 150 years for a breakthrough to occur in groundwater beneath the source at a concentration above the RSL (0.00017 mg/L). Naphthalene has not been detected in the AOC groundwater samples collected from 2009-2015 (Table 6-5). Therefore, this evaluation concludes that the model predicted concentrations are conservative and naphthalene would be expected to be below its RSL based on its estimated site-specific biodegradation rate.

This qualitative assessment concludes that the soil contaminants identified as CMCOCs for evaluation, due to predicted groundwater concentrations beneath a source or at the downgradient receptor location, are not adversely impacting groundwater quality based on current data and are not predicted to have future impacts. Potential additional investigation under the Facility-wide Groundwater AOC may be warranted, but based on the fate and transport evaluation, CMCOCs are not identified for Load Line 6, and no further action is required of soil and sediment to be protective of groundwater.

6.7 SUMMARY AND CONCLUSIONS

Inorganic and organic SRCs exist in surface soil, subsurface soil, and sediment at Load Line 6. These SRCs include chemicals that were identified as potential contaminants from previous site usage and chemicals that were identified from the SRC screening process using available data. All SRCs were further evaluated to determine if residual concentrations in soil and sediment may potentially impact groundwater quality and warrant evaluation in an FS.

All SRCs identified in the surface soil, subsurface soil, and sediment at Load Line 6 were evaluated through the stepwise fate and transport evaluation. For sediment, the screening analysis eliminated all sediment SRCs as posing future impacts to groundwater at Load Line 6. Evaluation of modeling results with respect to current AOC groundwater data and model limitations identified the following CMCOPCs for soil:

- Selenium in the NPA was predicted to exceed the screening criteria in groundwater beneath the source area; however, it was not predicted to exceed the screening criteria in groundwater at the downgradient receptor location.
- Selenium and naphthalene in the FPA were predicted to exceed the screening criteria in groundwater beneath the source area; however, neither of these constituents were predicted to exceed the screening criteria in groundwater at the downgradient receptor location.

A qualitative assessment of the sample results and considerations of the limitations and assumptions of the models were performed to identify if any CMCOCs are present in soil or sediment at Load Line 6 that may potentially impact groundwater beneath the source or at the downgradient receptor location. This qualitative assessment concluded that there were no CMCOCs present in soil and sediment that may impact the groundwater beneath the source or at the downgradient receptor location. No further action is required of soil and sediment to be protective of groundwater.

Table 6-1. Initial CMCOPCs Evaluated with SESOIL Modeling

SRCs	Maximum Concentrations (mg/kg)	Discrete Sample Locations	Sample Depth (ft bgs)	Leachate Modeling Required? (Yes/No)
Non-Production Area				
Inorganic chemicals				
Arsenic	3.11E+01	LL6sd-081-5243-SD	0.0-0.5	Yes
Selenium	2.50E+00	LL6sb-030-0001-SO	0.0-3.0	Yes
Former Production Area				
Inorganic chemicals				
Selenium	1.80E+00	LL6sb-070-5224-SO	0.0-7.0	Yes
Semi-volatile organic compounds				
Naphthalene	7.80E-02	LL6sb-024-0001-SO	0.0-3.0	Yes

bgs = Below ground surface.
CMCOPC = Contaminant migration contaminant of potential concern.
ft = Feet.
mg/kg = Milligrams per kilogram.
SESOIL = Seasonal Soil Compartment Model.
SRC = Site-related contaminant.

Table 6-2. Sediment Screening Results for Load Line 6

Analyte	CAS Number	Background Criteria (mg/kg)[a]	Maximum Sediment Concentration (mg/kg)	Sediment Sample ID	K_{oc} (L/kg)	Reference	K_d (L/kg)	Reference	Maximum Groundwater Concentration (mg/L)[b]	DAF[c]	Maximum Groundwater Concentration (mg/L)/DAF	MCL or RSL (mg/L)	MCL or RSL?	CMCOPC? (Yes/No)
Drainage Ditch														
Inorganic Compounds														
Antimony	7440-36-0	0.00E+00	1.30E-01	LL6sd-082-6063-FD	NA	-	4.50E+01	d	2.89E-03	11	2.63E-04	6.00E-03	MCL	No
Beryllium	7440-41-7	3.80E-01	5.50E-01	LL6sd-082-5245-SD	NA	-	7.90E+02	d	6.96E-04	2	3.48E-04	4.00E-03	MCL	No
Cobalt	7440-48-4	9.10E+00	1.28E+01	LL6sd-082-5245-SD	NA	-	4.50E+01	d	2.84E-01	40	7.10E-03	2.70E-01	RSL	No
Nickel	7440-02-0	1.77E+01	1.90E+01	LL6sd-082-5245-SD	NA	-	6.50E+01	d	2.92E-01	26	1.12E-02	2.60E+01	RSL	No
Former Test Pond														
Inorganic Compounds														
Antimony	7440-36-0	0.00E+00	1.70E+00	LL6sd-084-5795-SD	NA	-	4.50E+01	d	3.78E-02	130	2.91E-04	6.00E-03	MCL	No
Beryllium	7440-41-7	3.80E-01	7.10E-01	LL6sd-001-0001-SD	NA	-	7.90E+02	d	8.99E-04	130	6.92E-06	4.00E-03	MCL	No
Cadmium	7440-43-9	0.00E+00	8.80E-01	LL6sd-084-5795-SD	NA	-	7.50E+01	d	1.17E-02	130	9.00E-05	5.00E-03	MCL	No
Cobalt	7440-48-4	9.10E+00	1.17E+01	LL6sd-084-5795-SD	NA	-	4.50E+01	d	2.60E-01	2,889	9.00E-05	2.70E-01	RSL	No
Copper	7440-50-8	2.76E+01	9.17E+01	LL6sd-084-5795-SD	NA	-	3.50E+01	d	2.62E+00	130	2.02E-02	1.30E+00	MCL	No
Lead	7439-92-1	2.74E+01	1.56E+02	LL6sd-001-0001-SD	NA	-	9.00E+02	d	6.13E-02	219	2.80E-04	1.50E-02	MCL	No
Nickel	7440-02-0	1.77E+01	2.84E+01	LL6sd-001-0001-SD	NA	-	6.50E+01	d	4.37E-01	130	3.36E-03	2.60E+01	RSL	No
Silver	7440-22-4	0.00E+00	2.10E-01	LL6sd-084-5795-SD	NA	-	8.30E+00	d	2.53E-02	130	1.95E-04	8.00E-01	RSL	No

Table 6–2. Sediment Screening Results for Load Line 6 (continued)

Analyte	CAS Number	Background Criteria (mg/kg)[a]	Maximum Sediment Concentration (mg/kg)	Sediment Sample ID	K_{oc} (L/kg)	Reference	K_d (L/kg)	Reference	Maximum Groundwater Concentration (mg/L)[b]	DAF[c]	Maximum Groundwater Concentration (mg/L)/DAF	MCL or RSL (mg/L)	MCL or RSL?	CMCOPC? (Yes/No)
Explosives														
Tetryl	479-45-8	0.00E+00	3.10E-02	LL6sd-084-5795-SD	4.61E+03	d	6.45E+00	e	4.81E-03	130	3.70E-05	3.90E-01	RSL	No

[a] Background criteria for sediment from final facility-wide background values for Ravenna Army Ammunition Plant, published in the *Final Phase II Remedial Investigation Report for Winklepeck Burning Grounds at Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 2001b).

[b] Maximum groundwater concentration = maximum sediment concentration divided by the distribution coefficient.

[c] An aggregate-specific DAF was calculated by dividing the calculated groundwater concentration by the co-located surface water concentration. The lowest calculated DAF (130) for antimony in the Former Test Pond was used for analytes that did not have an aggregate-specific DAF.

[d] U.S. Environmental Protection Agency regional screening levels generic tables June 2015; found at: http://www2.epa.gov/risk/risk-based-screening-table-generic-tables.

[e] K_d value for organic chemicals calculated by multiplying K_{oc} by fraction organic carbon (f_{oc}) of 0.0014 [average of the Performance-Based Acquisition 2008 Remedial Investigation (PBA08 RI) geotechnical samples LL6SB-072-5231-SO and LL6SB-072-5232-SO].

CAS = Chemical Abstract Service.
CMCOPC = Contaminant migration contaminant of potential concern.
DAF = Dilution attenuation factor.
ID = Identification.
K_d = Distribution coefficient.
K_{oc} = Organic carbon distribution coefficient .
L/kg = Liters per kilogram.
MCL = Maximum contaminant level.
mg/kg = Milligrams per kilogram.
mg/L = Milligrams per liter.
NA = Not applicable.
RSL = Regional screening level.
SRC = Site-related contaminant
Bold = Final CMCOPC to be modeled with analytical transient 1-,2-,3-dimensional modeling.

Table 6-3. Unit-Specific Parameters Used in SESOIL and AT123D Modeling

Parameters	Symbol	Units	Value	Source for Value
SESOIL				
Percolation Rate (Recharge Rate)	q	m/yr	9.42E-02	0.1 * SESOIL Precipitation for Youngstown, Ohio.
Horizontal Area of Aggregate	A_p	cm^2	Varies	Sample specific.
Intrinsic Permeability – clayey sand	p	cm^2	1.05E-10	Calibrated from SESOIL model.
Disconnectedness Index	c	unitless	11	Calibrated from SESOIL model.
Freundlich Equation Exponent	n	unitless	1	SESOIL default.
Fraction Organic Carbon	f_{oc}	unitless	1.40E-03	The average of the PBA08 RI geotechnical samples LL6SB-072-5231-SO and LL6SB-072-5232-SO.
Bulk Density	ρ_b	kg/L	1.83	
Moisture Content	w	wt %	13.0	
Water-filled Soil Porosity	Tw	unitless	0.238	
Air-filled Soil Porosity	Ta	unitless	0.000	
Porosity – total	n_T	unitless	0.238	
Vadose Zone Thickness	Vz	m	5.18	Average depth to water table from potentiometric surface map (Figure 6-4).
Leaching Zone Thickness	Th	m	5.03 or 4.27 (Non-Production Area) 3.05 or 4.27 (Former Production Area)	Based on distance from deepest detection of a CMCOPC above criteria to the water table from potentiometric surface maps (Figure 6-4).
AT123D				
Aquifer Thickness	h	m	6	Conservative assumption for sallow bedrock aquifer. Facility-wide assumption for the unconsolidated aquifer presented the Load Line 1 investigation was 6 meters (USACE 2003b).
Hydraulic Conductivity in Saturated Zone	K_S	cm/s	4.47E-03	Average of slug test results (MKM 2007).
Hydraulic Gradient	i	unitless	1.63E-03	Calculated from Load Line 6 potentiometric surface map (see Figure 6-4).

Table 6-3. Unit-Specific Parameters Used in SESOIL and AT123D Modeling (continued)

Parameters	Symbol	Units	Value	Source for Value
Effective porosity	n_e	unitless	0.2	Assumed for sandstone (USEPA 1985).
Dispersivity, longitudinal	α_L	m	30	Assumed.
Dispersivity, transverse	α_T	m	3	0.1 $\alpha_{L.}$
Dispersivity, vertical	α_V	m	0.3	0.01 $\alpha_{L.}$
Retardation factor	R_d	unitless	chemical-specific	Presented in Table E-7 in Appendix E.

MKM 2007. Characterization of 14 AOCs at Ravenna Army Ammunition Plant (March 2007).

USACE 2003b. Phase II Remedial Investigation Report for the Load Line 1 at the Ravenna Army Ammunition Plant, Ravenna, Ohio. June 2003.

USEPA (U.S. Environmental Protection Agency) 1985. Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water, Revised 1985 Parts 1 and 2, EPA/600/6-85/002. Office of Research and Development, Environmental Research Laboratory, Athens, Georgia. September 1985.

AT123D = Analytical transient 1-,2-,3-Dimensional model.
cm^2 = Square centimeters.
CMCOPC = Contaminant migration chemical of potential concern.
cm/s = Centimeters per second.
FWGWMP = Facility-wide Groundwater Monitoring Program.
kg/L = Kilograms per liter.
m = Meter.
m/yr = Meters per year.
PBA08 RI = Performance Based Acquisition 2008 Remedial Investigation.
SESOIL = Seasonal soil compartment model.
wt % = Weight percent.

Table 6-4. Summary of SESOIL Modeling Results

Initial CMCOPC	Maximum Soil Concentration (mg/kg)	ISM Area or Discrete Sample Location	Maximum Depth of Contamination (ft bgs)	Depth to Groundwater (ft bgs)	Predicted $C_{leachate, max}$ Beneath Source (mg/L)	Time Required to Reach $C_{leachate, max}$ (years)	MCL/RSL (mg/L)	Resident Receptor Adult FWCUG[a] (mg/L)	Facility-wide Background Bedrock Groundwater (mg/L)	Final CMCOPC?[b] (yes/no)
Non-Production Area										
Inorganic Chemicals										
Arsenic	3.11E+01	LL6sd-081	0.5	17	0.00E+00	NA	1.00E-02	5.60E-05	1.17E-02	No
Selenium	**2.50E+00**	**LL6sb-030**	**3**	**17**	**1.85E-01**	**303**	**5.00E-02**	**None**	**0.00E+00**	**Yes**
Former Production Area										
Inorganic Chemicals										
Selenium	**1.80E+00**	**LL6sb-070**	**7**	**17**	**3.13E-01**	**265**	**5.00E-02**	**None**	**0.00E+00**	**Yes**
Semi-volatile Organic Compounds										
Naphthalene	**7.80E-02**	**LL6sb-024**	**3**	**17**	**9.30E-03**	**133**	**1.70E-04**	**None**	**None**	**Yes**

[a] The Resident Receptor Adult FWCUG is based on a target risk of 1E-06 and a hazard quotient of 0.1.

[b] The Final CMCOPC was identified comparing predicted maximum leachate concentration to MCL/RSL, Resident Receptor Adult FWCUGs, and facility-wide background concentrations. A constituent is a CMCOPC if its predicted leachate concentration exceeds its MCL/RSL within 1,000 years.

bgs = Below ground surface.
CMCOPC = Contaminant migration chemical of potential concern.
FWCUG = Facility-wide cleanup goal.
ft = Feet.
ISM = Incremental sampling methodology.
MCL = Maximum contaminant level.
mg/kg = Milligrams per kilogram.
mg/L = Milligrams per liter.
NA = Not available.
RSL = Regional screening level.
SESOIL = Seasonal soil compartment model.
Bold = CMCOPCs exceeding MCL/RSL, Resident Receptor Adult FWCUGs, and facility-wide background concentrations.

Table 6-5. Summary of AT123D Modeling Results

Final CMCOPC	Maximum Leachate Concentration[a] (mg/L)	Predicted Max Groundwater[b] (C_{MAX}) Beneath Source (mg/L)	Predicted Max Groundwater[b] (C_{MAX}) Downgradient Receptor (mg/L)	Distance to Downgradient Receptor (ft)	Observed Maximum Groundwater Concentrations[c] (mg/L)	MCL/RSL (mg/L)	Resident Adult FWCUG[d] (mg/L)	Facility-wide Background Bedrock Groundwater (mg/L)	CMCOC for Further WOE Evaluation?[e] (yes/no)
Final CMCOPCs in Soil									
Non-Production Area									
Inorganic chemicals									
Selenium	1.85E-01	5.96E-02	1.27E-06	2,000	ND	5.00E-02	None	0.00	Yes
Former Production Area									
Inorganic chemicals									
Selenium	3.13E-01	7.29E-02	2.97E-04	1,400	ND	5.00E-02	None	0.00	Yes
Semi-volatile Organic Compounds									
Naphthalene	9.30E-03	8.29E-03	1.57E-04	1,100	ND	1.70E-04	None	None	Yes

[a] Represents SESOIL predicted maximum leachate concentration just above the water table.

[b] The predicted concentration was estimated using the results from SESOIL and applying AT123D model.

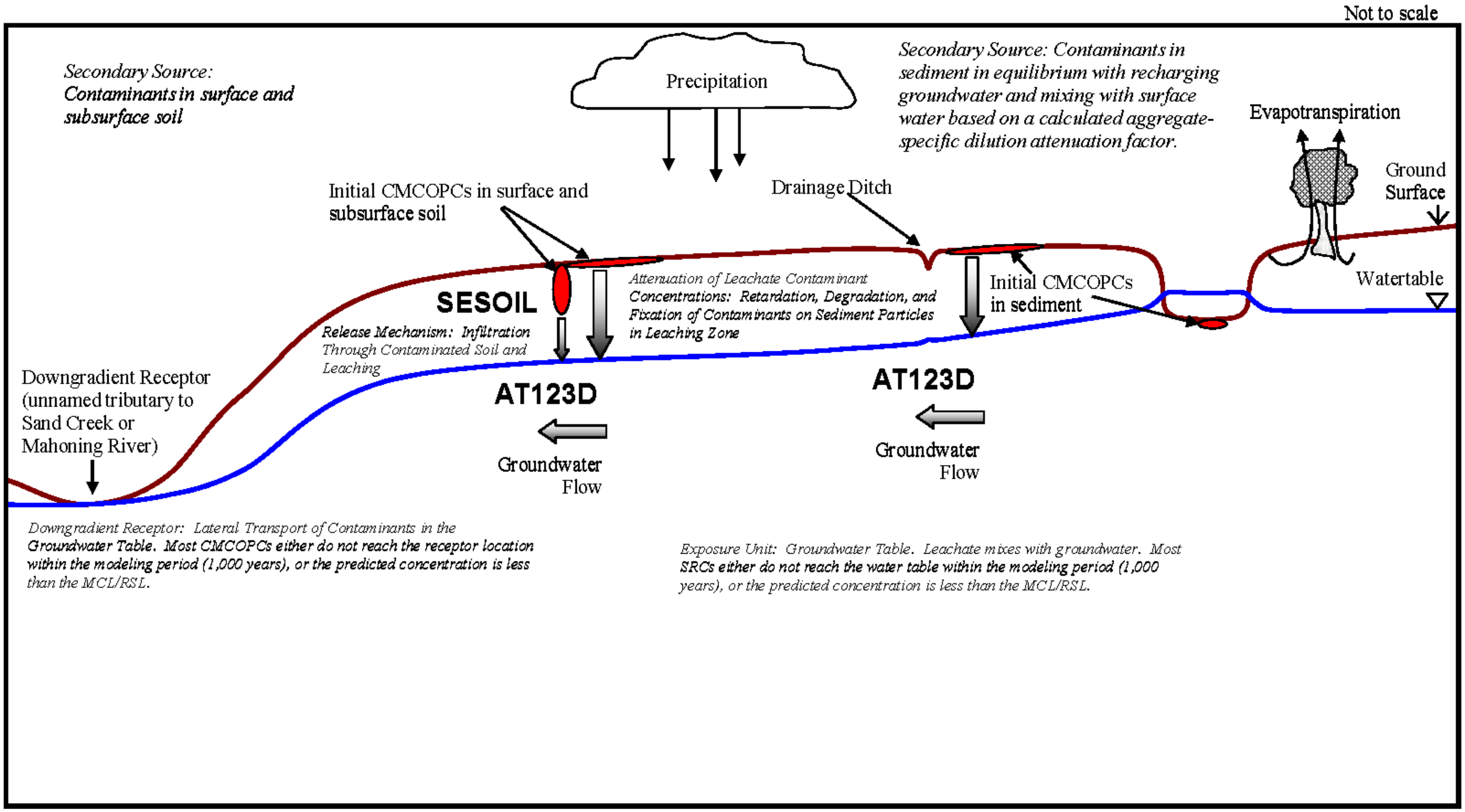
[c] Observed groundwater concentrations were reported in the *RVAAP Facility-wide Groundwater Monitoring Program 2009 Annual Report* (EQM 2010) and sampling events through 2013.

[d] The Resident Receptor Adult FWCUG is based on a target risk of 10^{-6} and a hazard quotient of 0.1.

[e] The CMCOC was identified comparing predicted concentration in groundwater to MCL/RSL, Resident Receptor Adult FWCUGs, and facility-wide background concentrations. A constituent is a CMCOC if its predicted concentration in groundwater exceeds all its screening criteria within 1,000 years.

[f] Maximum groundwater concentration = maximum sediment concentration divided by the distribution coefficient.

AT123D = Analytical transient 1-,2-,3-dimensional model.
CMCOC = Contaminant migration chemical of concern.
CMCOPC = Contaminant migration chemical of potential concern.
FWCUG = Facility-wide cleanup goal.
ft = Feet.
MCL = Maximum contaminant level.
mg/L = Milligrams per liter.
ND = Not detected.
RSL = Regional screening level.
SESOIL = Seasonal soil compartment model.



Secondary Source: Contaminants in surface and subsurface soil

Secondary Source: Contaminants in sediment in equilibrium with recharging groundwater and mixing with surface water based on a calculated aggregate-specific dilution attenuation factor.

Release Mechanism: Infiltration Through Contaminated Soil and Leaching

Attenuation of Leachate Contaminant Concentrations: Retardation, Degradation, and Fixation of Contaminants on Sediment Particles in Leaching Zone

Downgradient Receptor: Lateral Transport of Contaminants in the Groundwater Table. Most CMCOPCs either do not reach the receptor location within the modeling period (1,000 years), or the predicted concentration is less than the MCL/RSL.

Exposure Unit: Groundwater Table. Leachate mixes with groundwater. Most SRCs either do not reach the water table within the modeling period (1,000 years), or the predicted concentration is less than the MCL/RSL.

Figure 6-1. Contaminant Migration Conceptual Model

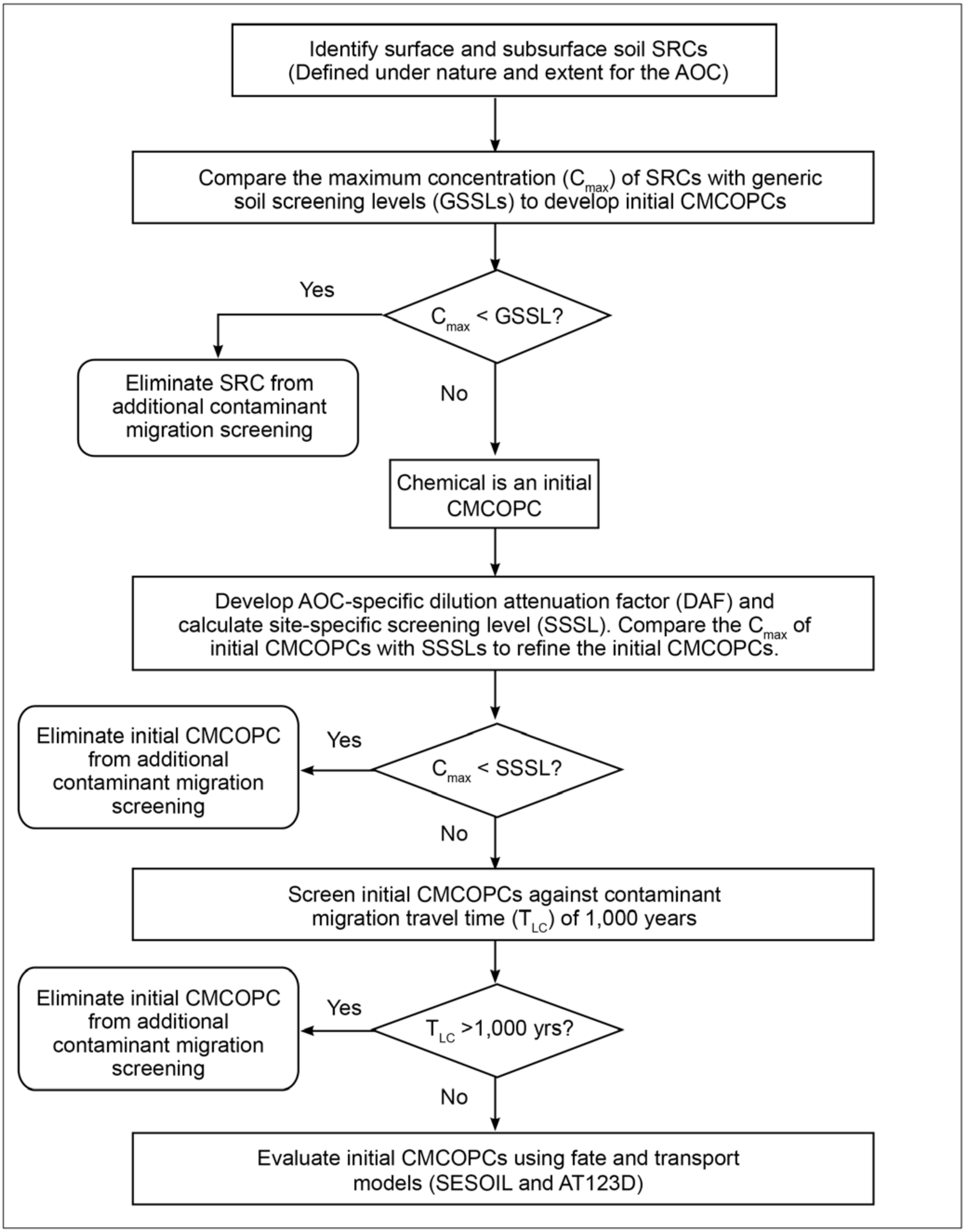


Figure 6-2. Initial CMCOPCs Identified in Soil Screening Analysis for SESOIL Evaluation

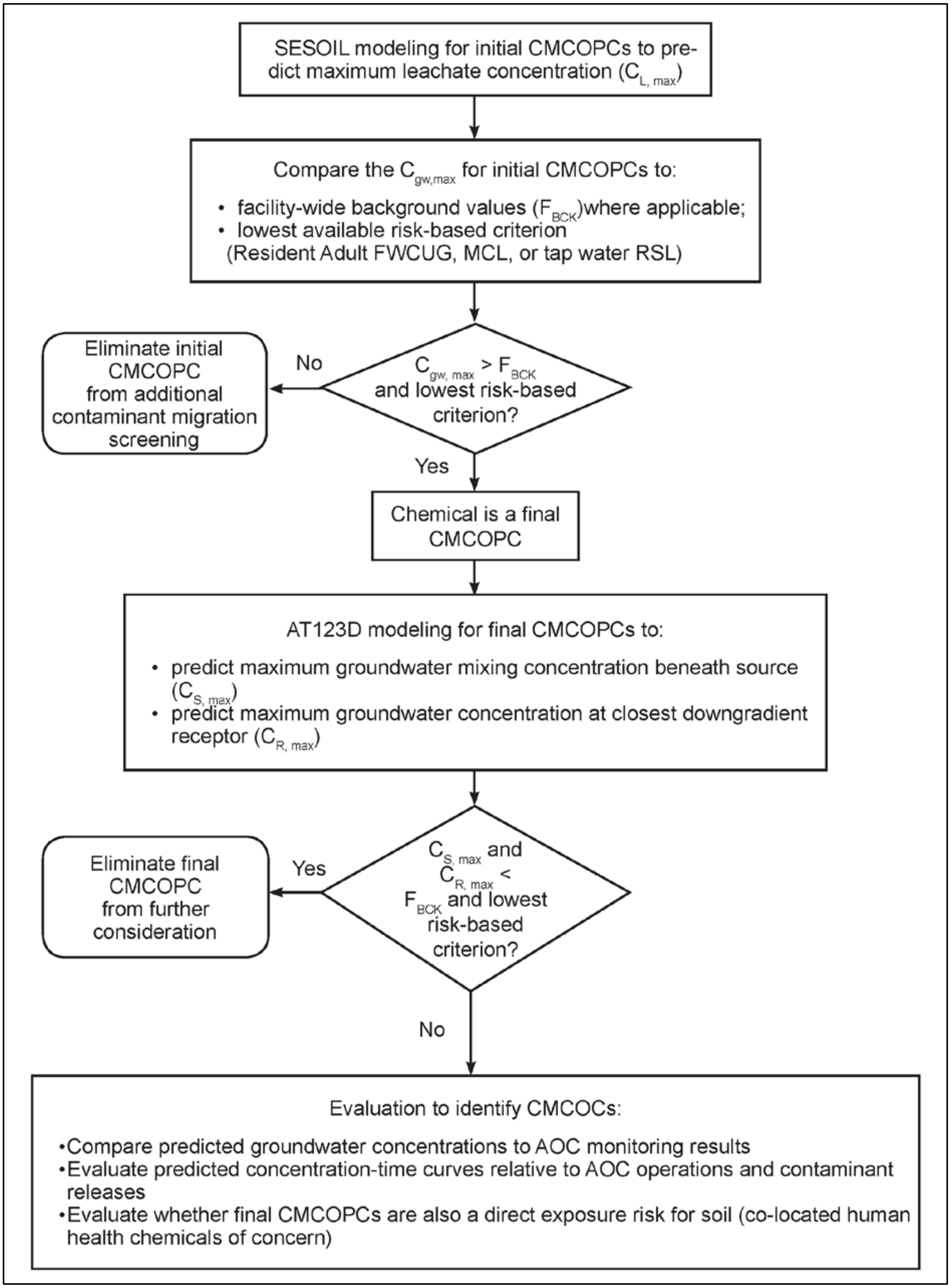


Figure 6-2. Initial CMCOPCs Identified in Soil Screening Analysis for SESOIL Evaluation (continued)

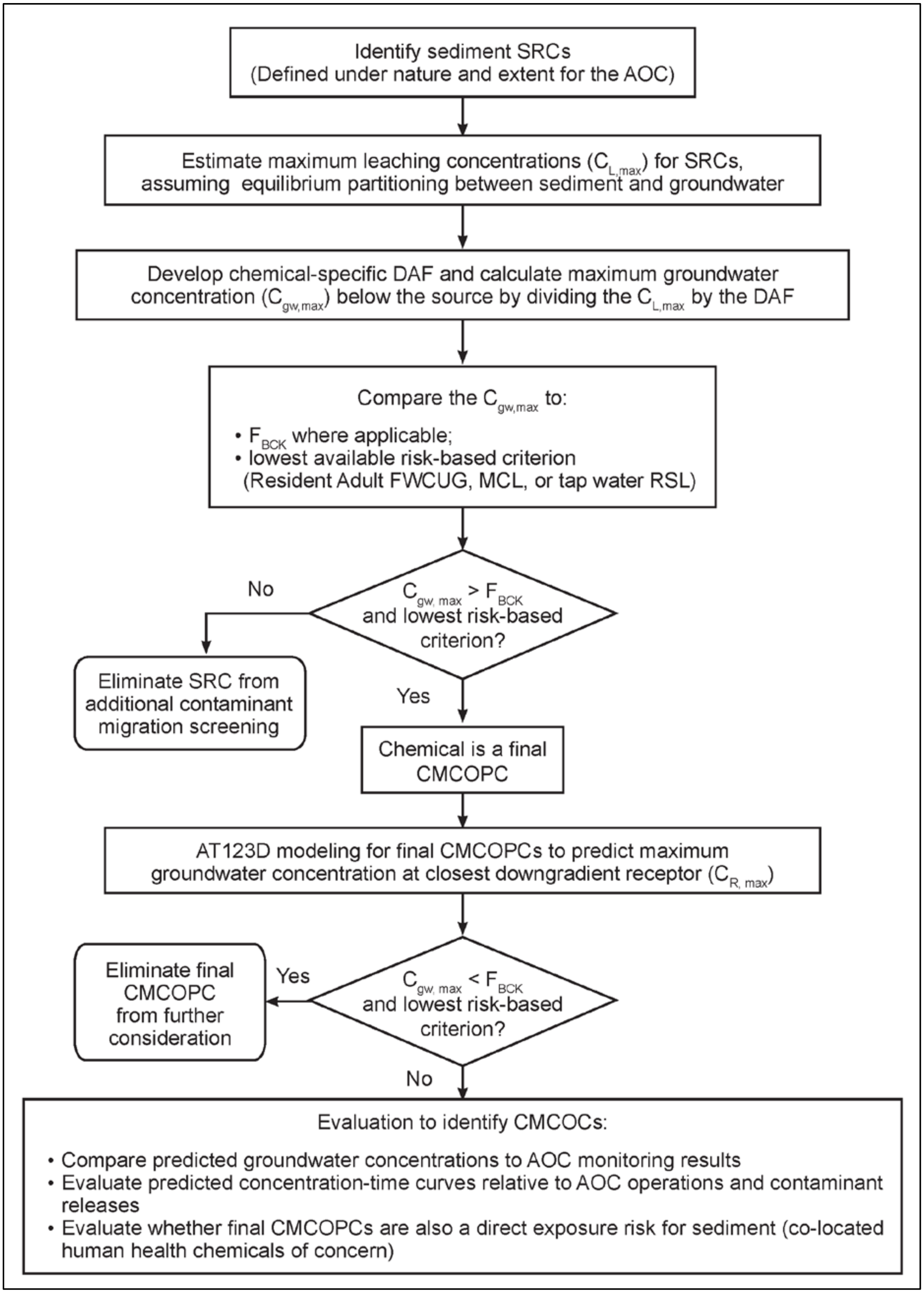
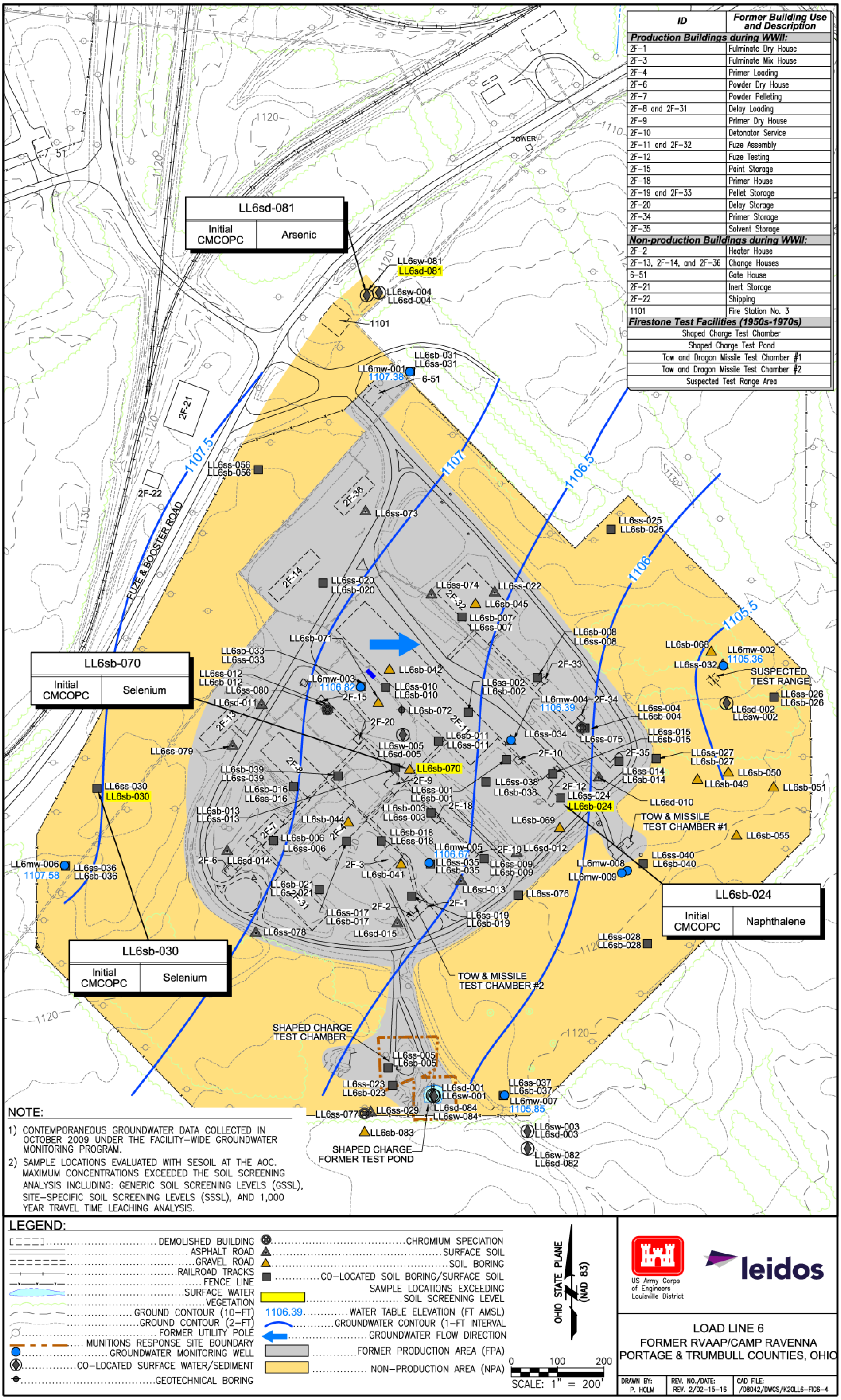


Figure 6-3. AOC Fate and Transport Modeling Approach - Sediment



ID	Former Building Use and Description
Production Buildings during WWII:	
2F-1	Fulminate Dry House
2F-3	Fulminate Mix House
2F-4	Primer Loading
2F-6	Powder Dry House
2F-7	Powder Pelleting
2F-8 and 2F-31	Delay Loading
2F-9	Primer Dry House
2F-10	Detonator Service
2F-11 and 2F-32	Fuze Assembly
2F-12	Fuze Testing
2F-15	Paint Storage
2F-18	Primer House
2F-19 and 2F-33	Pellet Storage
2F-20	Delay Storage
2F-34	Primer Storage
2F-35	Solvent Storage
Non-production Buildings during WWII:	
2F-2	Heater House
2F-13, 2F-14, and 2F-36	Change Houses
6-51	Gate House
2F-21	Inert Storage
2F-22	Shipping
1101	Fire Station No. 3
Firestone Test Facilities (1950s-1970s)	
Shaped Charge Test Chamber	
Shaped Charge Test Pond	
Tow and Dragon Missile Test Chamber #1	
Tow and Dragon Missile Test Chamber #2	
Suspected Test Range Area	

NOTE:

1) CONTEMPORANEOUS GROUNDWATER DATA COLLECTED IN OCTOBER 2009 UNDER THE FACILITY-WIDE GROUNDWATER MONITORING PROGRAM.
2) SAMPLE LOCATIONS EVALUATED WITH SESOIL AT THE AOC. MAXIMUM CONCENTRATIONS EXCEEDED THE SOIL SCREENING ANALYSIS INCLUDING: GENERIC SOIL SCREENING LEVELS (GSSL), SITE-SPECIFIC SOIL SCREENING LEVELS (SSSL), AND 1,000 YEAR TRAVEL TIME LEACHING ANALYSIS.

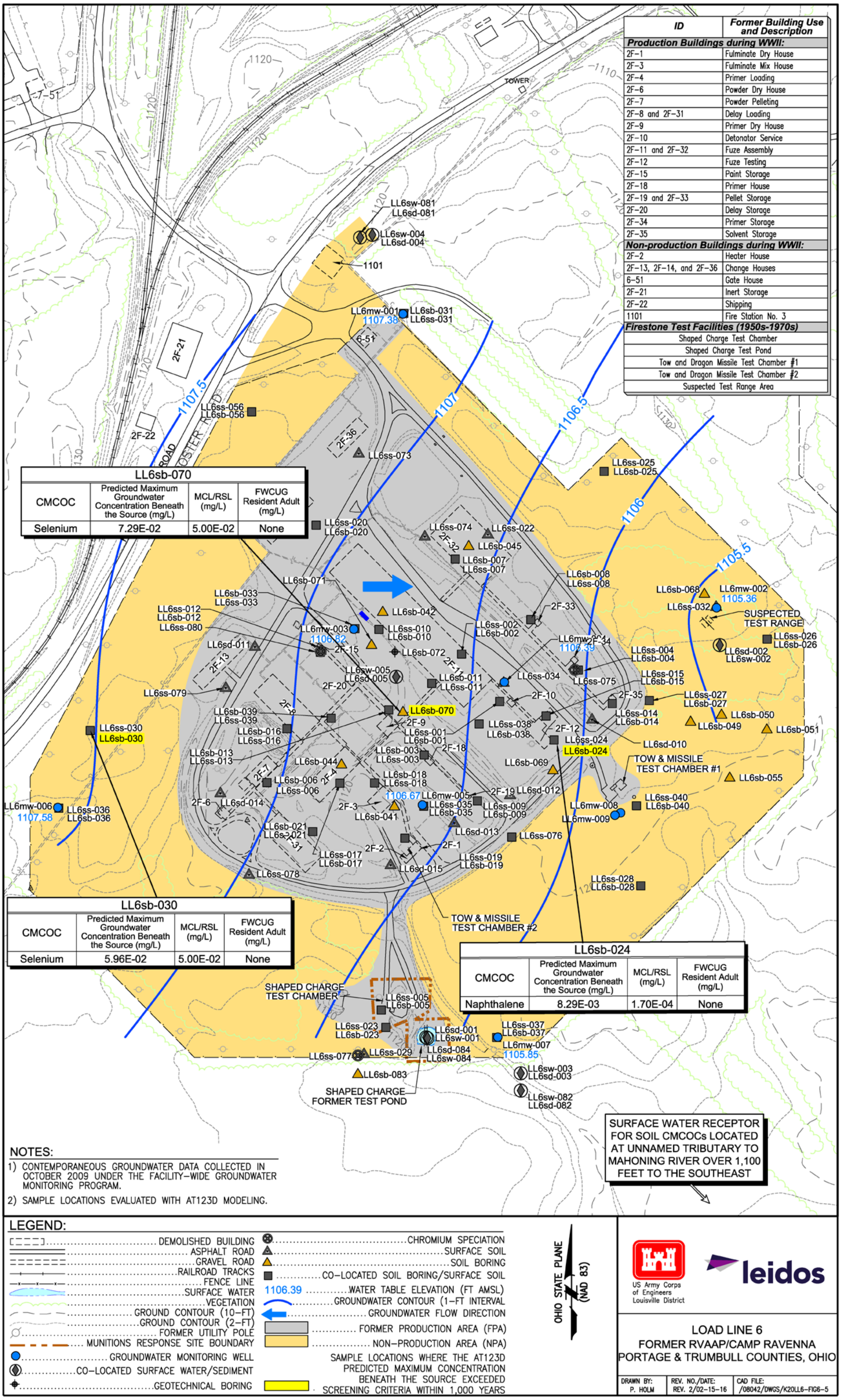
LEGEND:

[‒‒‒]	DEMOLISHED BUILDING
═	ASPHALT ROAD
‒ ‒ ‒	GRAVEL ROAD
─┼─	RAILROAD TRACKS
─x─	FENCE LINE
	SURFACE WATER
	VEGETATION
─ ─	GROUND CONTOUR (10-FT)
‐ ‐	GROUND CONTOUR (2-FT)
○	FORMER UTILITY POLE
‒ ‒	MUNITIONS RESPONSE SITE BOUNDARY
●	GROUNDWATER MONITORING WELL
◐	CO-LOCATED SURFACE WATER/SEDIMENT
⌖	GEOTECHNICAL BORING
⊗	CHROMIUM SPECIATION
▲	SURFACE SOIL
△	SOIL BORING
■	CO-LOCATED SOIL BORING/SURFACE SOIL
🟨	SAMPLE LOCATIONS EXCEEDING SOIL SCREENING LEVEL
1106.39	WATER TABLE ELEVATION (FT AMSL)
⌒	GROUNDWATER CONTOUR (1-FT INTERVAL
←	GROUNDWATER FLOW DIRECTION
▨	FORMER PRODUCTION AREA (FPA)
🟧	NON-PRODUCTION AREA (NPA)

LOAD LINE 6
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
P. HOLM	REV. 2/02-15-16	/08042/DWGS/K20LL6-FIG6-4

Figure 6-4. Initial CMCOPCs Identified in Soil Screening Analysis for SESOIL Evaluation



ID	Former Building Use and Description
Production Buildings during WWII:	
2F-1	Fulminate Dry House
2F-3	Fulminate Mix House
2F-4	Primer Loading
2F-6	Powder Dry House
2F-7	Powder Pelleting
2F-8 and 2F-31	Delay Loading
2F-9	Primer Dry House
2F-10	Detonator Service
2F-11 and 2F-32	Fuze Assembly
2F-12	Fuze Testing
2F-15	Paint Storage
2F-18	Primer House
2F-19 and 2F-33	Pellet Storage
2F-20	Delay Storage
2F-34	Primer Storage
2F-35	Solvent Storage
Non-production Buildings during WWII:	
2F-2	Heater House
2F-13, 2F-14, and 2F-36	Change Houses
6-51	Gate House
2F-21	Inert Storage
2F-22	Shipping
1101	Fire Station No. 3
Firestone Test Facilities (1950s-1970s)	
Shaped Charge Test Chamber	
Shaped Charge Test Pond	
Tow and Dragon Missile Test Chamber #1	
Tow and Dragon Missile Test Chamber #2	
Suspected Test Range Area	

LL6sb-070

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Resident Adult (mg/L)
Selenium	7.29E-02	5.00E-02	None

LL6sb-030

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Resident Adult (mg/L)
Selenium	5.96E-02	5.00E-02	None

LL6sb-024

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Resident Adult (mg/L)
Naphthalene	8.29E-03	1.70E-04	None

SURFACE WATER RECEPTOR FOR SOIL CMCOCs LOCATED AT UNNAMED TRIBUTARY TO MAHONING RIVER OVER 1,100 FEET TO THE SOUTHEAST

NOTES:

1) CONTEMPORANEOUS GROUNDWATER DATA COLLECTED IN OCTOBER 2009 UNDER THE FACILITY-WIDE GROUNDWATER MONITORING PROGRAM.

2) SAMPLE LOCATIONS EVALUATED WITH AT123D MODELING.

LEGEND:

[▭]	DEMOLISHED BUILDING	⊗	CHROMIUM SPECIATION
═	ASPHALT ROAD	▲	SURFACE SOIL
╌	GRAVEL ROAD	▲	SOIL BORING
┼	RAILROAD TRACKS	■	CO-LOCATED SOIL BORING/SURFACE SOIL
─x─	FENCE LINE	1106.39	WATER TABLE ELEVATION (FT AMSL)
⬭	SURFACE WATER	⌒	GROUNDWATER CONTOUR (1-FT INTERVAL
∿	VEGETATION	⬅	GROUNDWATER FLOW DIRECTION
─ ─	GROUND CONTOUR (10-FT)	▨	FORMER PRODUCTION AREA (FPA)
╌	GROUND CONTOUR (2-FT)	🟧	NON-PRODUCTION AREA (NPA)
⌀	FORMER UTILITY POLE		
─ ─	MUNITIONS RESPONSE SITE BOUNDARY		
●	GROUNDWATER MONITORING WELL		
◈	CO-LOCATED SURFACE WATER/SEDIMENT		
⌖	GEOTECHNICAL BORING	🟨	SAMPLE LOCATIONS WHERE THE AT123D PREDICTED MAXIMUM CONCENTRATION BENEATH THE SOURCE EXCEEDED SCREENING CRITERIA WITHIN 1,000 YEARS

US Army Corps of Engineers Louisville District

LOAD LINE 6
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
P. HOLM	REV. 2/02-15-16	/08042/DWGS/K20LL6-FIG6-5

Figure 6-5. CMCOPCs Identified for Further Weight-of Evidence Evaluation Based on AT123D Modeling

7.0 RISK ASSESSMENT

7.1 DATA EVALUATION FOR HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENTS

The purpose of this data evaluation is to develop a set of chemical data suitable for use in the HHRA and ERA. Load Line 6 data were evaluated to establish data aggregates and to identify a list of SRCs.

7.1.1 Data Aggregates

This section provides a description of the data aggregates for the media for which human and ecological receptors are potentially exposed, followed by a summary of SRCs in Section 7.1.2. Section 4.0 provides a summary of available data. Soil data collected at Load Line 6 were grouped (aggregated) by exposure depth (e.g., surface soil) and EU, as described in Section 5.1.1. Samples included in the risk assessment data sets for soil are listed in Tables 7-1 and 7-2. Samples included in the risk assessment data sets for sediment and surface water are listed in Tables 7-3 and 7-4.

7.1.1.1 Soil Data

EUs were established at Load Line 6 as part of the data aggregation prior to the risk assessment evaluations. The EUs take into account how the areas were previously used and the extensiveness of potential contamination within a given area. In establishing EUs at Load Line 6, the area within the perimeter road is assumed to have the maximum potential contamination; therefore, that area was identified as a separate EU (i.e., FPA) from the rest of the AOC (i.e., NPA), as shown in Figure 5-1.

Soil data were aggregated by the following depth intervals:

- Surface soil with an exposure depth of 0-1 ft bgs was evaluated for the Resident Receptor (Adult and Child) and for potential risk to ecological receptors, as this layer is the most active biological zone (USACE 2003a). Table 7-1 presents the risk assessment data set for surface soil (0-1 ft bgs) data. For this risk assessment, discrete surface soil samples collected during the March 2002 lead azide screening, the 2003 Phase I RI (MKM 2007), and the 2010 PBA08 RI were used to characterize surface soil.
- Subsurface soil with an exposure depth of 1-13 ft bgs was evaluated for the Resident Receptor (Adult and Child). Discrete soil data from samples collected in 2003 during the Phase I RI and the 2010 PBA08 RI with a starting depth within this interval were used to evaluate subsurface soil. Table 7-2 presents the risk assessment data for subsurface soil (1-13 ft bgs).

7.1.1.2 Surface Water and Sediment Data

On-site surface water at Load Line 6 is limited to the Former Test Pond (a small pond formerly used for testing of explosives) and intermittently flooded drainage ditches or gullies. Samples included in the risk assessment data sets for surface water and sediment are listed in Tables 7-3 (surface water) and 7-4 (sediment). The small size of the surface water and sediment data sets is reflective of the small size of these EUs. Previously collected sediment and/or surface water samples that were not included in the risk assessment data set are discussed below.

- Sediment and surface water samples LL6sd/sw-001, LL6sd/sw-003, and LL6sd/sw-004 were collected during the 2003 Phase I RI and were replaced in the risk assessment data set with samples collected during the 2010 PBA08 RI at the same location.
- Sediment sample LL6sd-081 was originally classified as sediment but was re-classified as soil because this location is from a ditch not generally covered by water (i.e., it is not part of an aquatic environment).
- Surface water sample LL6sw-005 was collected from a temporary puddle identified during the RI.
- Surface water sample LL6sw-006 was collected from the sewers.
- FWSsd/sw-101 and FWSsd/sw-103 are not considered AOC-specific samples. Rather, these samples were collected to assess drainage off all AOCs on Fuze and Booster Hill. While a risk assessment was not performed on these samples, a discussion of results is presented in Section 5.0.
- Sediment and surface water samples FTFsw-001, FTFsd-002, FTFsd-003, and LL6sd/sw-096 were collected after the original 2010 PBA08 RI. These sample results were used qualitatively to further assess the concentrations of the Former Test Pond. Results from these samples are discussed in Section 5.0 and confirm findings from this HHRA that there is no unacceptable risk in the Former Test Pond.

7.1.2 Identification of SRCs

Section 4.4 presents the statistical methods and screening criteria used to identify SRCs. The purpose of identifying SRCs is to determine the presence or absence of contamination that is above naturally occurring levels.

The 1978 Installation Assessment identified the major contaminants of the former RVAAP as TNT, Comp B (a combination of TNT and RDX), sulfates, nitrates, lead styphnate, and lead azide. An evaluation of this process summary identified additional potential site-specific contaminants from munitions assembly: black powder, tetryl, RDX, potassium nitrate, mercury fulminate, PETN, antimony sulfide, lead thiocyanate, potassium chlorate, lead, cadmium, barium, mercury, and arsenic. In addition to the chemicals previously mentioned, Octol (a mixture of TNT and HMX) was processed and used at selected buildings and test chambers. Other potential contaminants at Load Line 6 include VOCs from former Building 2F-35 that were utilized for solvent storage, PCBs from on-site transformers, and PAHs from former Building 2F-2 that was used as a heater house.

The SRC screen was not limited to only contaminants that may have been a product of previous site use.

Rather, the SRC screen followed the three steps outlined in the FWCUG Report, as summarized below, using all chemical data available:

- ***Background screening.*** MDCs of naturally occurring inorganic chemicals were compared to the facility-wide background concentrations for RVAAP, which are summarized in the FWCUG Report. Inorganic constituents detected above facility-wide background concentrations or having no background concentrations were retained as SRCs. All detected organic chemicals were retained as SRCs.
- ***Screening of essential human nutrients.*** Chemicals considered essential nutrients (e.g., calcium, chloride, iodine, iron, magnesium, potassium, phosphorous, and sodium) are an integral part of the human food supply and are often added to foods as supplements. USEPA recommends these chemicals not be evaluated provided they are: (1) present at low concentrations (i.e., only slightly elevated above naturally occurring levels), and (2) toxic at only very high doses (i.e., much higher than those that could be associated with contact at the AOC) (USEPA 1989). Essential nutrients detected near or below their RDA/RDI-based SLs were eliminated as SRCs.
- ***Frequency of detection screening.*** In accordance with the FWCUG Report and as revised in the *Final (Revised) USACE RVAAP Position Paper for the Application and Use of Facility-wide Human Health Cleanup Goals* (USACE 2012b) (hereafter referred to as the Position Paper for Human Health CUGs), analytes detected in less than 5% of the samples are screened out from further consideration with the exception of explosives and propellants).

Details of the SRC screening for each exposure medium are provided in Tables G-1 through G-4 of Appendix G. The SRCs identified for Load Line 6 are summarized in Table 7-5.

7.2 HUMAN HEALTH RISK ASSESSMENT

This HHRA identifies COCs that may pose potential health risks to humans resulting from exposure to contamination at Load Line 6. This HHRA was conducted as part of the PBA08 RI and is based on the methods from the following guidance documents:

- FWHHRAM (USACE 2005a),
- FWCUG Report (USACE 2010a),
- Position Paper for Human Health CUGs (USACE 2012b), and
- Technical Memorandum (ARNG 2014).

To accomplish the goal of streamlined risk-based decision making, the FWCUG Report was developed to support risk assessments of the remaining AOCs within the former RVAAP. The FWCUG Report contains calculated FWCUGs and guidance for applying the FWCUGs to accelerate the risk assessment process. This approach takes advantage of the many risk assessment inputs and decisions that have previously been accepted by stakeholders through the application of the CERCLA process at the former RVAAP.

Most of the agreed upon risk assessment methodology has been documented in the FWHHRAM (USACE 2005a) and follows standard USEPA-approved risk assessment guidance. This includes the process to identify RVAAP COPCs (presented in Figure 4-6), a TR of 1E-06 and HQ of 0.1 to identify COPCs, and a TR of 1E-05 and HQ of 1 to identify COCs.

Other approaches, such as calculating the sum-of-ratios (SOR), were developed in the FWCUG Report (USACE 2010a) and Position Paper for Human Health CUGs (USACE 2012b). The Technical Memorandum (ARNG 2014) amends the risk assessment process to establish future Land Uses and applicable receptors to be evaluated in an RI.

The approach to risk-based decision making is as follows:

- ***Develop FWCUGs.*** Use the risk assessment process presented in the FWHHRAM to develop FWCUGs for all COPCs identified from the facility-wide data set at RVAAP. This process has been completed in the FWCUG Report.
- ***RI Characterization Sampling.*** Perform sampling and analysis to characterize an AOC and establish baseline chemical concentrations. A summary and the results of the RI characterization sampling for Load Line 6 are presented in Section 4.0 of this report.
- ***Mapping and Data Analysis to Identify SRCs and COPCs.*** Follow the requirements specified in the FWHHRAM and the Position Paper for Human Health CUGs (USACE 2012b), perform data analysis and mapping to identify SRCs and COPCs, establish EUs, and calculate exposure point concentrations (EPCs) for each COPC. The results of the mapping and data analysis for Load Line 6 to identify SRCs are presented in Sections 4.0 and 5.0 of this report and are summarized in Section 7.1.
- ***Identification of COCs.*** Compare EPCs to FWCUGs to determine COCs.
- ***Address Identified COCs.*** Develop FS, PP, and ROD to address any COCs requiring remedy.

Identifying COPCs and COCs follows the four steps for a streamlined risk assessment established in the FWCUG Report and shown in Figure 1-3: identify media of concern; identify COPCs; present AOC Land Use and appropriate receptors; and compare to appropriate FWCUGs to identify COCs. These steps are discussed in the following subsections.

7.2.1 Identify Media of Concern

Media of concern at Load Line 6 are surface soil, subsurface soil, sediment, and surface water, as defined in Section 7.1.1. Groundwater is present at this AOC and will be evaluated (including risk assessment) in a separate document, as described in Section 1.2.

7.2.2 Identify COPCs

Section 4.4 presents the statistical methods and screening criteria used to identify SRCs. COPCs are a subset of the SRCs in each exposure medium present at concentrations that indicate the potential for impacts to human receptors. The COPC screen follows the approach specified in the FWCUG Report and is summarized in this section.

To identify COPCs, the MDC of all SRCs was screened against the most stringent chemical-specific FWCUG of all RVAAP receptors at a target cancer risk level of 1E-06 and non-carcinogenic target HQ of 0.1 for the Resident Receptor (Adult and Child) and National Guard Trainee. If no FWCUGs existed for an SRC, the USEPA residential RSL (from RSL table dated June 2015) was used for this screen. No reference dose (RfD) or cancer potency factors are available for benzo(ghi)perylene and phenanthrene; therefore, the RSL for pyrene was used for these PAHs (NDEP 2006).

FWCUGs are available for both hexavalent chromium and trivalent chromium. Existing historical data at other AOCs indicate chromium exists predominantly in the trivalent state rather than the more toxic hexavalent state. To determine whether the FWCUG for trivalent or hexavalent chromium is most applicable to Load Line 6 and to support risk management decisions, three discrete surface soil samples were collected and analyzed for hexavalent chromium and total chromium per the PBA08 SAP, as described in Sections 4.2.3.2 and 5.2. Two samples were collected from areas previously identified as having elevated total chromium concentrations, and one was collected from an area identified as having chromium concentrations near background concentrations. This process has been approved and was documented in the *Remedial Investigation Report Addendum No. 1 for the RVAAP-49 Central Burn Pits* (USACE 2008). Hexavalent chromium was not detected in any of the speciation samples collected at Load Line 6; therefore, the FWCUG for trivalent chromium was used at this AOC.

Details of the COPC screening for each exposure medium are provided in Tables G-1 through G-4 of Appendix G. The COPCs identified for the media of concern at Load Line 6 are presented in Table 7-6 and are summarized below.

7.2.2.1 COPCs in Surface Soil

- **Former Production Area.** Of the 45 chemicals detected in surface soil (0-1 ft bgs) samples at the FPA; 36 (14 inorganic chemicals, 15 SVOCs, 2 VOC, 1 pesticide, 2 PCBs, and 2 explosives) were identified as SRCs. Risk-based screening identified five inorganic chemicals (arsenic, cadmium, cobalt, copper, and manganese), and two SVOCs [benzo(a)pyrene and dibenz(a,h)anthracene] as COPCs in surface soil (0-1 ft bgs).
- **Non-Production Area.** Of the 34 chemicals detected in surface soil (0-1 ft bgs) samples at the NPA, 27 (16 inorganic chemicals and 11 SVOCs) were identified as SRCs. Risk-based screening identified four organic chemicals (aluminum, arsenic, cobalt, and manganese), and one SVOC [benzo(a)pyrene] as COPCs in surface soil (0-1 ft bgs).

7.2.2.2 COPCs in Subsurface Soil

- **Former Production Area.** Of the 45 chemicals detected in subsurface soil (1-13 ft bgs) samples at the FPA; 33 (11 inorganic chemicals, 19 SVOCs, 2 VOC, and 1 explosive) were identified as SRCs. Risk-based screening identified two inorganic chemicals (arsenic and cobalt), and four SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] as COPCs in subsurface soil.

- **Non-Production Area.** Of the 24 chemicals detected in subsurface soil (1-13 ft bgs) samples at the NPA; six (five inorganic chemicals and one SVOC) were identified as SRCs. Risk-based screening did not identify any COPCs in subsurface soil at the NPA.

7.2.2.3 COPCs in Sediment

- **Drainage Ditches.** Of the 21 chemicals detected in sediment samples collected at the Drainage Ditches; five (all inorganic chemicals) were identified as SRCs. Risk-based screening identified only cobalt as a COPC in drainage ditch sediment.
- **Former Test Pond.** Of the 22 chemicals detected in sediment samples collected at the Former Test Pond; nine (eight inorganic chemicals and one explosive) were identified as SRCs. Only cobalt was identified as a COPC in pond sediment.

7.2.2.4 COPCs in Surface Water

- **Drainage Ditches.** Of the 24 chemicals detected in surface water samples collected at the Drainage Ditches; 18 (14 inorganic chemicals, 2 explosives, 1 SVOC, and 1 VOC) were identified as SRCs. Risk-based screening identified cobalt and manganese as COPCs in ditch surface water.
- **Former Test Pond.** Of the 15 chemicals detected in surface water samples collected at the Former Test Pond; five (three inorganic chemicals, one explosives, and one pesticide) were identified as SRCs. Risk-based screening did not identify any COPCs in pond surface water.

7.2.3 Determine AOC Land Use and Appropriate Receptors

Camp Ravenna is a controlled-access facility. Load Line 6 is located in the south-central portion of the facility and is not currently used for training. Three Land Uses for the RVAAP restoration program are specified in the Technical Memorandum (ARNG 2014) for consideration in the RI along with the following Representative Receptors:

1. Unrestricted (Residential) Land Use – Resident Receptor (Adult and Child),
2. Military Training Land Use – National Guard Trainee, and
3. Commercial/Industrial Land Use – Industrial Receptor (USEPA’s Composite Worker).

Unrestricted (Residential) Land Use is considered protective for all three Land Uses at Camp Ravenna. Therefore, if an AOC meets the requirements for Unrestricted (Residential) Land Use, then the AOC is also considered to have met the requirements of the other Land Uses (i.e., Commercial/Industrial and Military Training), and those other Land Uses do not require evaluation.

As stated in Paragraph 6.d of the Technical Memorandum, if an AOC fails to meet the Unrestricted (Residential) Land Use, then an FS will be completed that evaluates cleanup options for all three Land Uses [i.e., Unrestricted (Residential) Land Use, Military Training Land Use, and Commercial/Industrial Land Use]. Remedial alternatives for meeting each Land Use are to be evaluated per the current guidelines for selecting a remedy for the AOC. The preferred remedy is one that would meet Unrestricted (Residential) Land Use. RI/FS Reports in progress at the time of the Technical Memorandum’s approval on February 11, 2014 will not be revised to include an evaluation of the Commercial/Industrial Land Use as an Alternative if it achieves no further action for Unrestricted (Residential) Land Use.

7.2.4 Compare to Appropriate FWCUGs

Previous sections have outlined the process for identifying SRCs and COPCs. Comparing COPC exposure concentrations to FWCUGs and determining COCs follows guidance presented in the Position Paper for Human Health CUGs (USACE 2012b) and Technical Memorandum (ARNG 2014).

The COC determination process is as follows:

- Report all carcinogenic- and non-carcinogenic based FWCUGs corresponding to a TR of 1E-05 and target HQ of 1 using the most stringent of the Resident Receptor Adult and Resident Receptor Child FWCUGs to evaluate Unrestricted (Residential) Land Use for each COPC. If no FWCUG is available for a COPC, the Residential RSL, adjusted to represent a TR of 1E-05 or target HQ of 1, is used.
- Report critical effect and target organ for each non-carcinogenic based FWCUG.
- Compare the selected FWCUG to the EPC, including an SOR.
    - For non-carcinogens, compare the EPC to the target HQ FWCUG. Sum the ratios of EPC/FWCUG for COPCs that affect similar target organs or do not have an identified target organ.
    - For carcinogens, compare the EPC to the TR FWCUG. Sum the ratios of the EPC/FWCUG for all carcinogens.
- Identify the COPC as a COC if:
    - The EPC exceeds the most stringent of the Resident Receptor Adult and Resident Receptor Child FWCUGs for either the 1E-05 target cancer risk or the 1 target HQ; or
    - The SOR for all carcinogens or all non-carcinogens that may affect the same organ is greater than one. Chemicals contributing at least 10% to the SOR are also considered COCs. In accordance with the Position Paper for Human Health CUGs (USACE 2012b), chemicals contributing greater than 5% but less than 10% to the SOR must be further evaluated before being eliminated as COCs.

The process for calculating FWCUGs rearranges cancer risk or non-cancer hazard equations in order to obtain a concentration that will produce a specific risk or hazard level (USEPA 1991, USACE 2010a). For example, the FWCUG for arsenic at the cancer risk level of 1E-05 for the Resident Receptor Adult is the concentration of arsenic that produces a risk of 1E-05 when using the exposure parameters specific to the Resident Receptor Adult.

For carcinogens, risk is expressed as the probability that an individual will develop cancer over a lifetime as a result of exposure to the carcinogen. Cancer risk from exposure to contamination is expressed as the increased chance of cancer above the normal background rate. In the United States, the background chance of contracting cancer is a little more than 3 in 10 for women and a little less than 5 in 10 for men, or 3E-01 to 5E-01 (American Cancer Society 2015). The calculated incremental lifetime cancer risks (ILCRs) are compared to the range specified in the NCP of 10^{-6} to 10^{-4}, or 1 in a million to 1 in 10,000 exposed persons developing cancer (USEPA 1990). Cancer risks below 10^{-6} are considered acceptable; cancer risks above 10^{-4} are considered unacceptable. The range between 10^{-6} and 10^{-4} is of concern, and any decisions to address risks further in this range, either through additional study or engineered control measures, should account for the uncertainty in the risk estimates. The Ohio EPA Division of Environmental Response and Revitalization (DERR) program has adopted a human health cumulative ILCR goal within this range of 1E-05 to be used as the level of acceptable excess cancer risk and for developing remediation goals for the site. The DERR notes that the defined risk goal should be applied as a goal, recognizing the need to retain flexibility during the evaluation and selection of remedial alternatives.

In addition to developing cancer from exposure to chemicals, an individual may experience other adverse effects. The term “adverse effects” is used here to describe a wide variety of systemic effects ranging from minor irritations, such as eye irritation and headaches, to more substantial effects, such as kidney or liver disease and neurological damage. The risk associated with toxic (i.e., non-carcinogenic) chemicals is evaluated by comparing an estimated exposure (i.e., intake or dose) from AOC media to an acceptable exposure expressed as an RfD. The RfD is the threshold level below which no adverse effects are expected to occur in a population, including sensitive subpopulations. The ratio of intake over the RfD is the HQ (USEPA 1989).

The SOR is used to account for the potential additive effects from exposure to multiple chemicals that can cause the same effect (e.g., cancer) or affect the same target organ. Cancer risk is assumed to be additive for all carcinogens. Non-cancer risk is assumed to be additive for chemicals with similar sites of toxicological action (i.e., target organ such as liver or critical effect such as adversely affecting the ability to reproduce). This approach compares the EPC of each COPC to the FWCUG to determine a ratio. The sum of these individual ratios is then compared to one. The SOR method is based on the principle that a ratio greater than one represents unacceptable cumulative exposure (i.e., above FWCUGs if adjusted for exposure to multiple COPCs), and a ratio less than or equal to one represents acceptable cumulative exposure (i.e., below FWCUGs if adjusted for exposure to multiple COPCs). The FWCUGs for some chemical/receptor combinations are less than the background concentration. In these instances, the chemical concentrations are compared to background concentrations to identify COCs. Since the background concentration is not risk-based, these chemicals are not included in the SOR calculations.

COCs identified by comparing EPCs to FWCUGs are further evaluated in an uncertainty analysis to identify COCs requiring evaluation in the FS. Selecting FWCUGs, calculating EPCs for comparison to the FWCUGs, and the resulting risk-based COCs are detailed in the following sections.

7.2.4.1 Selection of Appropriate FWCUGs

As specified in the Technical Memorandum (ARNG 2014), EPCs for each AOC should initially be evaluated using the most stringent of the Resident Receptor Adult and Resident Receptor Child FWCUGs to determine if no further action is necessary at an AOC to attain Unrestricted (Residential) Land Use. If this assessment indicates COCs exist that prevent Unrestricted (Residential) Land Use, an FS must be completed to evaluate cleanup options for all three Land Uses [i.e., Unrestricted (Residential) Land Use, Military Training Land Use, and Commercial/Industrial Land Use].

Unrestricted (Residential) Land Use is evaluated using FWCUGs for the Resident Receptor (Adult and Child). The Resident Receptor (Adult and Child) FWCUGs provided in Tables 7-7 and 7-8 are the lower of the Resident Receptor Adult or Resident Receptor Child values for each COPC and endpoint (non-cancer and cancer corresponding to a TR of 1E-05 and target HQ of 1). The critical effect or target organ associated with the toxicity values used to calculate the FWCUGs are also provided in these tables.

7.2.4.2 Exposure Point Concentrations for Comparison to FWCUGs

Soil EPCs

EPCs were calculated for each depth interval and EU using analytical results from the discrete samples presented in Tables 7-1 and 7-2. Per the FWHHRAM, the EPC is either the 95% upper confidence limit (UCL) of the mean or the MDC, whichever value is lowest. If the 95% UCL could not be determined, the EPC is the MDC.

Sediment and Surface Water EPCs

Two discrete sediment samples and three discrete surface water samples collected from the Drainage Ditches and one discrete sediment sample and one discrete surface water sample collected from the Former Test Pond were used to characterize risks from exposure to sediment and surface water. These samples are presented in Tables 7-3 and 7-4. Because of the small number of samples, each ditch and the pond were evaluated individually, and the EPC was equal to the detected concentration in each sample.

7.2.4.3 Identification of COCs for Unrestricted (Residential) Land Use

Load Line 6 COCs for Unrestricted (Residential) Land Use, as represented by the Resident Receptor (Adult and Child), are presented below.

COCs for Surface Soil (0-1 ft bgs)

COC screening for surface soil (0-1 ft bgs) for the Resident Receptor (Adult and Child) is detailed in Tables G-5 through G-7 of Appendix G. No COCs were identified for the Resident Receptor (Adult and Child), as explained below:

COPCs with EPCs lower than the Resident Receptor (Adult and Child) FWCUG: All aluminum, cadmium, cobalt, copper, manganese, benzo(a)pyrene, and dibenz(a,h)anthracene EPCs are lower than the Resident Receptor (Adult and Child) FWCUG.

COPCs with EPCs exceeding the Resident Receptor (Adult and Child) FWCUG: The arsenic EPCs at the FPA and NPA exceed the FWCUG. The EPCs for arsenic in surface soil at the FPA (13.1 mg/kg) and NPA (14 mg/kg) exceed the FWCUG of 4.25 mg/kg but are below the surface soil facility-wide background concentration of 15.4 mg/kg. Because the FWCUG is less than the background concentration, the background concentration is used as the CUG for this inorganic chemical. Thus, arsenic is representative of background and is not a COC in surface soil.

SOR Analysis: No COCs were identified based on the SOR analysis, as summarized below:

- Six COPCs (aluminum, arsenic, cadmium, cobalt, copper, and manganese) identified in surface soil have FWCUGs for non-cancer endpoints. The EPCs for aluminum, arsenic, cobalt, and manganese are less than the facility-wide background concentrations for surface soil; therefore, these metals are not included in the SOR. At the NPA no COPCs with non-cancer endpoints are present above background concentrations; therefore, no SOR is calculated for this EU. Two COPCs (cadmium and copper) have EPCs above background concentrations at the FPA. The total SOR for these COPCs at the FPA is less than one.
- Five COPCs [arsenic, cadmium, cobalt, benzo(a)pyrene, and dibenz(a,h)anthracene] identified in surface soil have FWCUGs for the cancer endpoint. The EPCs for arsenic and cobalt are less than the facility-wide background concentrations for surface soil; therefore, these metals are not included in the SOR. An SOR was calculated for the remaining COPCs at each EU (Table G-6). The calculated SORs are less than one.

COCs for Subsurface Soil (1-13 ft bgs)

COC screening for subsurface soil (1-13 ft bgs) for the Resident Receptor (Adult and Child) is detailed in Tables G-8 and G-9 of Appendix G. No COCs were identified for the Resident Receptor (Adult and Child), as explained below:

COPCs with EPCs lower than the Resident Receptor (Adult and Child) FWCUG: All cobalt, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene EPCs at the FPA are lower than the Resident Receptor (Adult and Child) FWCUG. No COPCs were identified in subsurface soil at the NPA.

COPCs with EPCs exceeding the Resident Receptor (Adult and Child) FWCUG: The arsenic EPCs at the FPA and NPA exceed the FWCUG. The EPC for arsenic in surface soil at the FPA (14.2 mg/kg) exceeds the FWCUG of 4.25 mg/kg but is below the subsurface soil facility-wide background concentration of 19.8 mg/kg. Because the FWCUG is less than the background concentration, the background concentration is used as the CUG for this inorganic chemical. Thus, arsenic is representative of background and is not a COC in subsurface soil.

SOR Analysis: No COCs were identified based on the SOR analysis, as summarized below:

- Two COPCs (arsenic and cobalt) identified in subsurface soil have FWCUGs for non-cancer endpoints. The EPCs for both arsenic and cobalt are less than the facility-wide background concentrations for subsurface soil; therefore, no SOR is calculated.
- Six COPCs [arsenic, cobalt, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] identified in subsurface soil have FWCUGs for the cancer endpoint. The EPCs for arsenic and cobalt are less than the facility-wide background concentrations for subsurface soil; therefore, these metals are not included in the SOR. An SOR was calculated for the remaining COPCs (Table G-6). The calculated SOR is less than one.

COCs for Sediment and Surface Water

COC screening for sediment and surface water for the Resident (Adult and Child) receptor is detailed in Tables G-10 (sediment) and G-11 (surface water) of Appendix G. No COCs were identified in these media as summarized below:

- The only sediment COPC (cobalt) was present below the FWCUG and is not a COC.
- The only surface water COPCs (cobalt and manganese) were present below the FWCUGs or RSLs in all but one sample. The concentration of cobalt (0.0072 mg/L) in sample LL6sw-082 from the Drainage Ditches slightly exceeds the cobalt tap water RSL of 0.006 mg/L. This surface water sample was collected from a ditch that contains water for short periods of time only during precipitation or periods of snow melt. No surface water FWCUG is available for cobalt; therefore, the tap water RSL was used for screening. Because the reported concentration in surface water present intermittently in a ditch only slightly exceeds the very conservative tap water RSL cobalt is not COC.

No COCs were identified based on the SOR analysis as summarized below:

- Only one COPC was identified in sediment. Therefore, no SOR was calculated for sediment.
- The SORs for cobalt and manganese in surface water are less than or equal to 1.

7.2.5 Uncertainty Assessment

The sources of uncertainty, as well as the potential bias they impart to the risk assessment (i.e., whether conservatism is increased or decreased) and approaches for minimizing their impact on the conclusions of the RI, are briefly discussed below.

7.2.5.1 Uncertainty in Estimating Potential Exposure

Sources of uncertainty in estimating potential human exposure include sampling and analysis limitations, comparison to background concentrations to identify SRCs, and estimation of EPCs.

Sampling Limitations. Uncertainties arise from limits on the media sampled, the total number and specific locations that can be sampled, and the parameters chosen for analysis to characterize the AOC. Fifty-nine surface (0-1 ft bgs) soil samples were available for the HHRA. Samples were collected from areas biased toward areas anticipated to have the highest level of potential contamination (i.e., around former buildings) to delineate potential sources. The results of surface soil sampling were used to efficiently guide selection of locations for subsurface soil sampling with a bias toward the areas of highest potential contamination.

Analytical Limitations. Uncertainty is associated with the chemical concentrations detected and reported by the analytical laboratory. The quality of the analytical data used in the risk assessment was maximized and uncertainty was minimized by implementing QA/QC procedures that specify how samples are selected and handled; however, sampling errors, laboratory analysis errors, and data analysis errors can occur. Beyond the potential for errors, there is normal variability in analytical results.

Some current analytical methods are limited in their ability to achieve detection limits at or below risk-based SLs. Under these circumstances, it is uncertain whether the true concentration is above or below the SLs, which are protective of human health. When analytes have a mixture of detected and non-detected concentrations, EPC calculations may be affected by these detection limits. Risks may be overestimated as a result of some sample concentrations being reported as non-detected at the method detection level (MDL), when the actual concentration may be much smaller than the MDL. Risks also may be underestimated if some analytes that were not detected in any sample were removed from the COPC list. If the concentrations of these analytes are below the MDL but are above the SL, the risk from these analytes would not be included in the risk assessment results.

Identification of SRCs. Part of determining SRCs is to identify chemicals detected above the established RVAAP facility-wide background concentrations. This screen does not account for the potential sources of chemicals, and background values are only available for inorganic chemicals.

Uncertainty associated with screening against background results from statistical limitations and natural variation in background concentrations. Because of this variation, inorganic chemical concentrations below the background concentration are likely representative of background conditions. Inorganic chemical concentrations above the background concentration may be above background concentrations, or may reflect natural variation. This is especially true for measured concentrations close to the background concentration.

At Load Line 6, 11 inorganic chemicals (aluminum, arsenic, barium, beryllium, chromium, cobalt, manganese, nickel, selenium, vanadium, and zinc) had MDCs in surface and/or subsurface soil that were one to two times the background concentration. The consequences of carrying most of these inorganic chemicals forward as SRCs, even if they are actually representative of background concentrations, is negligible because they are not toxic at near background concentrations. By contrast, naturally occurring (background) arsenic and manganese in soil exceeds risk-based CUGs. Therefore, the consequence of identifying arsenic or manganese as an SRC if it is, in fact, representative of background can have a significant impact on the conclusions of the risk assessment. The EPCs of these two metals are less than background concentrations.

Organic chemicals are not screened against background concentrations even though some organic compounds are present in the environment as a result of natural or human activities not related to the CERCLA releases at the AOC. For example, PAHs are present in the environment as a result of burning fossil fuels and as a component of road dust, vehicle exhaust, tire wear particles, pavement, and slag used as railroad ballast and fill. Samples collected near roadways or parking areas may represent normal "urban" sources of PAHs. These issues represent significant sources of uncertainty at sites where low levels of PAHs are found over large areas of the AOC. At Load Line 6, PAHs were detected across the AOC (i.e., in 11 of 16 surface soil samples analyzed for SVOCs), generally at low (less than FWCUGs) concentrations in all areas.

Exposure Point Concentrations. Generally, the 95% UCL on the arithmetic mean was adopted as the EPC for discrete sample results and was considered to represent a conservative estimate of the average concentration. This imparts a small but intentional conservative bias to the risk assessment, provided the sampling captured the most highly contaminated areas. Representative EPCs for the EU were calculated from discrete data based on the assumption that the samples collected from the EU were truly random samples. This assumption is not true for Load Line 6 where sample locations were biased to identify areas of highest contaminant concentrations. Therefore, EPCs generated from these data are likely to represent an upper bound of potential exposure concentrations. In addition to calculating EPCs for each EU, individual discrete sample results above FWCUGs were evaluated to identify whether potential hot spots are present as a result of specific source areas.

The EPCs of arsenic are less than FWCUGs but the MDCs exceed FWCUGs at a few soil locations. The MDCs of arsenic in surface soil at Load Line 6 are 41 mg/kg at the FPA at LLss-007 collected in 2003 in the footprint of Building 2F-32 (Fuze Assembly) and 31.1 mg/kg at LLsd-081 in a drainage ditch at the NPA. Reported arsenic concentrations in the remaining 57 surface soil samples collected at Load Line 6 range from 2.2 to 18 mg/kg. Other samples in the footprint of Building 2F-32 had arsenic concentrations of 15 mg/kg (LL6sb-045) and 12 mg/kg (LL6ss-022). The MDCs of arsenic in subsurface soil are 26 mg/kg at the FPA at 6-8 ft bgs at LLsb6-033 collected in 2003 near MW-003 and 18.9 mg/kg at the NPA. Reported arsenic concentrations in the remaining 52 subsurface soil samples collected at Load Line 6 range from 2.6 to 20 mg/kg. The nearest boring to LLsb6-033 is LLsb6-071, with arsenic concentrations at three sampled depths ranging from 10.2 to 12.1 mg/kg. No source of arsenic is evident at any of these locations and the elevated arsenic concentrations are not widespread.

The background concentrations for arsenic at RVAAP are 15.4 mg/kg for surface soil and 19.8 mg/kg for subsurface soil; however, earthmoving (e.g., building removal, grading, and other building/demolition activities) has blurred the distinction between surface and subsurface soil. Vosnakis and Perry (2009) recently published the results of arsenic background studies that included 313 samples of Ohio soil. Naturally occurring arsenic in these samples ranged from 1.6 to 71.3 mg/kg with 95th percentiles of 21.7 mg/kg in surface soil, 25.5 mg/kg in subsurface soil, and UTLs of 22.8 and 29.6 mg/kg for surface and subsurface soil respectively. In other studies, native soil concentrations of arsenic in Ohio have been reported as ranging from 0.5 to 56 mg/kg (Ohio EPA 1996) and the U.S. Geological Survey's Certificate of Analysis of the Devonian Ohio Shale estimates arsenic concentrations of 68.5 mg/kg are naturally present in bedrock shales (USGS 2004). Based on this evaluation, arsenic does not represent a hot spot and is not identified as a COC.

7.2.5.2 Uncertainty in Use of FWCUGs

Sources of uncertainty in the FWCUGs used to identify COCs include the selection of appropriate receptors and the exposure parameters, exposure models, and toxicity values used in the calculation of FWCUGs.

Selection of Representative Receptors. Load Line 6 is not currently used for training. While residential Land Use is unlikely, an evaluation using Resident Receptor (Adult and Child) FWCUGs is included to provide an Unrestricted (Residential) Land Use evaluation as required by CERCLA and the Army. As stated in Paragraph 6.d of the Technical Memorandum, if an AOC fails to meet the Unrestricted (Residential) Land Use, then all three Land Uses [i.e., Unrestricted (Residential) Land Use, Military Training Land Use, and Commercial/Industrial Land Use] will be evaluated.

Exposure Parameters and Exposure Models. For each primary exposure pathway included in the FWCUGs, assumptions are made concerning the exposure parameters (e.g., amount of contaminated media a receptor can be exposed to and intake rates for different routes of exposure) and the routes of exposure. Most exposure parameters have been selected so that errors occur on the side of human health protection. When several of these upper-bound values are combined in estimating exposure for any one pathway, the resulting risks can be in excess of the 99th percentile and, therefore, outside of the range that may be reasonably expected. Therefore, the consistent selection of upper-bound parameters generally leads to overestimation of the potential risks.

Toxicity Values. The toxicity of chemicals is under constant study and values change from time to time. The toxicity values used in calculating the FWCUGs were the most recent values available at the time (September 2008). These values are designed to be conservative and provide an upper-bound estimate of risk.

The toxicity and mobility of many inorganic chemicals in the environment is dependent on the chemical species present. Two important examples are arsenic and chromium. The toxicity values used in developing the FWCUGs are for inorganic arsenic and do not distinguish between arsenite and arsenate.

Chromium is generally present in the environment as either the trivalent (Cr+3) or hexavalent (Cr+6) species, with the trivalent form generally being more stable and, therefore, more common. FWCUGs are available for both hexavalent chromium and trivalent chromium. Trivalent chromium has not been shown to be carcinogenic. Hexavalent chromium is much more toxic than trivalent chromium. It is classified as a known human carcinogen and also may cause non-cancer effects.

Three discrete surface soil samples were collected and analyzed for hexavalent chromium and total chromium at Load Line 6 during the PBA08 RI. No hexavalent chromium was detected in any of the speciation samples. Based on these results, hexavalent chromium is not of concern at Load Line 6; therefore, the use of the trivalent chromium FWCUG is appropriate for the identification of COCs and minimizing the associated uncertainty.

7.2.5.3 Uncertainty in the Identification of COCs

All of the sources of uncertainty described in the previous sections potentially impact the identification of COCs. The exposure and toxicity values used to calculate FWCUGs as well as the approach for identifying SRCs, COPCs, and ultimately COCs based on the FWCUGs were designed to ensure the over- rather than under-estimation of potential risk. The uncertainty assessment attempts to put the identified COCs in perspective to facilitate informed risk management decisions for the AOC.

The SOR is used to account for the potential additive effects from exposure to multiple chemicals that can cause the same critical effect or affect the same target organ. Cancer risk is assumed to be additive for all carcinogens. Non-cancer risk is assumed to be additive for chemicals with similar sites of toxicological action. In the event that any combination of COPCs results in synergistic effects, risk might be underestimated. Conversely, the assumption of additivity would overestimate risk if a combination of COPCs acted antagonistically. It is unclear whether the potential for chemical interaction has been inadvertently understated or overstated. It seems unlikely that the potential for chemical interaction contributes significant uncertainty to the conclusions of the risk assessment.

7.2.6 Identification of COCs for Potential Remediation

COCs were identified in Section 7.2.4 as any COPC having an EPC greater than an applicable FWCUG or contributing more than 5-10% to an SOR greater than one. For inorganic chemicals with FWCUGs or RSLs below background concentrations, the background concentration was used as the point of comparison. The TR for the FWCUGs and RSLs used to identify COCs is 1E-05 per the Ohio EPA DERR program, which has adopted a human health cumulative ILCR goal of 1E-05 to be used as the level of acceptable excess cancer risk and for developing site remediation goals.

The results of the COC screening (Section 7.2.4) are combined with the results of the uncertainty assessment (Section 7.2.5) to identify COCs to be carried forward for potential remediation.

No COCs were identified based on comparison to FWCUGs. No COCs were identified by the uncertainty assessment (including evaluation of individual data points).

7.2.7 Summary of HHRA

This HHRA documents COCs that may pose potential health risks to human receptors resulting from exposure to contamination at Load Line 6. This HHRA was conducted as part of the RI and was based on the streamlined approach described in the FWCUG Report (USACE 2010a), Position Paper for Human Health FWCUGs (USACE 2012b), and Technical Memorandum (ARNG 2014). The components of the risk assessment (receptors, exposure media, EPCs, and results) are summarized below.

Receptors. Camp Ravenna is a controlled access facility. Load Line 6 is located in the south-central portion of the facility and is not currently used for training. Three Land Uses for the RVAAP restoration program are specified in the Technical Memorandum (ARNG 2014) for consideration in the RI along with their Representative Receptors. Unrestricted (Residential) Land Use [Resident Receptor (Adult and Child)] is considered protective for all three Land Uses at Camp Ravenna. Therefore, if an AOC meets the requirements for Unrestricted (Residential) Land Use, then the AOC is also considered to have met the requirements of the other Land Uses (i.e., Commercial/Industrial and Military Training).

Exposure Media. Media of concern at Load Line 6 are surface soil, subsurface soil, sediment, and surface water. Soil data associated with Load Line 6 were aggregated into surface and subsurface soil at the FPA and NPA.

Estimation of EPCs. The EPCs for soil were calculated from the results of all of the discrete samples collected from a given depth interval at each EU. The EPC was either the 95% UCL of the mean or the MDC, whichever value is lowest. The limited number of sediment and surface water samples were evaluated individually (i.e., the number of samples was too small to calculate 95% UCLs).

Results of Human Health Risk Assessment. No COCs were identified for further evaluation in an FS for soil, sediment, or surface water at Load Line 6.

7.3 ECOLOGICAL RISK ASSESSMENT

7.3.1 Introduction

The ERA presented in this RI Report follows a unified approach of methods integrating Army, Ohio EPA, and USEPA guidance. This ERA approach is consistent with the general approach by these agencies and primarily follows the Level I Scoping ERA, Level II Screening ERA, and Level III Baseline ERA outlined in the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008), with specific application of components from the FWERWP, *Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE 2010b), and *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA 1997). The process implemented in this RI Report combines these guidance documents to meet requirements of the Ohio EPA and Army, while following previously accepted methods established for RVAAP. This unified approach resulted from coordination between USACE and Ohio EPA during the summer of 2011.

7.3.1.1 Scope and Objective

Load Line 6 contains habitat (soil, sediment, and surface water) that supports ecological receptors. The terrestrial and aquatic habitats have known chemical contamination (MKM 2007). Habitat types and an assessment of the ecological resources found at Load Line 6 are presented in subsequent subsections. In addition, the results of a historical ERA [a SERA performed as part of the *Report for the Phase I Remedial Investigation at Load Line 6 (RVAAP 33)*] and the PBA08 RI are provided to determine whether a qualitative ERA (Level I) is sufficient, based on the quality of the habitat and the presence of contamination, or whether a more rigorous ERA (Level II or III) should be conducted.

7.3.2 Level I: Scoping Level Ecological Risk Assessment

The ERA method for Level I follows guidance documents listed in Section 7.3.1. Level I is intended to evaluate if the AOC had past releases or the potential for current contamination and if there are important ecological resources on or near the AOC.

The following two questions should be answered when the Level I ERA is complete:

1. **Are current or past releases suspected at the AOC?** Current or past releases are determined by evidence that chemical contaminants or COPECs are present.
2. **Are important ecological resources present at or in the locality of the AOC?** Important ecological resources are defined in the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008) and *Technical Document for Ecological Risk Assessment: Process for Developing Management Goals* (BTAG 2005).

If an AOC has contaminants but lacks important ecological resources, the ERA process can stop at Level I. Contamination and important ecological resources must both be present to proceed to a Level II Screening Level ERA.

7.3.2.1 AOC Description and Land Use

Load Line 6 is approximately 43 acres. The habitat is mostly field and shrubland with some forest and is large enough to completely support cover and food for small birds and mammals that typically require approximately 1 acre of habitat (USEPA 1993). The habitat area at Load Line 6 represents 0.20% of the 21,683 acres at Camp Ravenna.

Future use at Load Line 6 is anticipated to be within the Military Training or Commercial/Industrial Land Use scenarios.

7.3.2.2 Evidence of Historical Chemical Contamination

The 1978 Installation Assessment identified the major contaminants of the former RVAAP as TNT, Comp B (a combination of TNT and RDX), sulfates, nitrates, lead styphnate, and lead azide. An evaluation of this process summary identified additional potential site-specific contaminants from munitions assembly: black powder, tetryl, RDX, potassium nitrate, mercury fulminate, PETN, antimony sulfide, lead thiocyanate, potassium chlorate, lead, cadmium, barium, mercury, and arsenic. In addition to these chemicals, Octol (a mixture of TNT and HMX) was processed and used at selected buildings and test chambers. Other potential contaminants at Load Line 6 include VOCs from former Building 2F-35 that were utilized for solvent storage, PCBs from on-site transformers, and PAHs from former Building 2F-2 that was used as a heater house.

The goal of the historical ERA (MKM 2007) was to identify COPECs in soil, sediment, and surface water for Load Line 6. Bioaccumulative compounds were identified and HQs based on food chain models were calculated in the Phase I RI (MKM 2007); this will be discussed if the PBA08 ERA continues to Level III. The Phase I RI followed instructions presented in the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2003) and included the first two of six steps listed in Figure III of the FWERWP (USACE 2003a). These two steps identified the evaluation procedures, which were used to determine AOC-related COPECs. First, the MDC of each chemical was compared to its respective facility-wide background concentration. Chemicals were not considered COPECs if the MDC was below the background concentration. For all chemicals detected above background concentrations, the MDC was compared to an ESV. The hierarchy of screening values was based on the guidance included in the FWERWP and *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2003). In addition to the ESV comparison, it was determined if the chemical was a persistent, bioaccumulative, and toxic (PBT) compound. For sediment, chemicals were also compared with the Ohio Sediment Reference Value (SRV). Chemicals were retained as COPECs if they exceeded background concentrations and the ESV, if the chemical exceeded background concentrations and SRV (sediment only), if the chemical exceeded background concentrations and had no toxicity information, or if the chemical was considered a PBT compound.

Groundwater was not included in the historical ERA. As explained in Section 3.2.2 of the FWERWP, groundwater is not considered an exposure medium to ecological receptors because these receptors are unlikely to contact groundwater greater than 5 ft bgs. While it is unknown if groundwater is discharging and mixing with surface water in the Former Test Pond, this pathway is included indirectly in the assessment of the surface water.

The historical ERA tables are provided in Tables H-1, H-2, and H-3 of Appendix H and include the following applicable components to the Level I assessment:

- Frequency of detection,
- Minimum concentration,
- MDC,
- Mean concentration,
- Average of positive detects,
- Sample of maximum detect,
- Background concentration,
- Comparison of MDC to background (SRC determination),
- SRVs (sediment only),
- Screening values (ESVs),

- HQ (MDC/ESV),
- PBT compound identification (soil only),
- COPEC determination, and
- COPEC rationale.

Historical COPECs for Soil. The historical ERA conducted as part of the Phase I RI reported 46 chemicals in deep surface soil (0-4 ft) at Load Line 6 (MKM 2007). Of the 46 chemicals detected, 4 chemicals (calcium, magnesium, potassium, and sodium) were essential nutrients and were excluded from the COPEC screen. A total of 16 detected inorganic chemicals and 24 organic chemicals were determined to be SRCs because they exceeded background concentrations, or they did not have an associated background concentration for comparison. A total of 14 of the inorganic chemicals (aluminum, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, vanadium, and zinc) were identified as COPECs because detected concentrations were above ESVs (Table 7-9). Four chemicals (carbazole, dibenzofuran, HMX, and nitrocellulose) were identified as COPECs due to a lack of ESVs. PCB-1254 (Aroclor-1254) was identified as a COPEC because it is a PBT compound. One COPEC that exceeded its ESV (mercury) was also a PBT compound. Table H-1 of Appendix H presents the Phase I RI ecological screening for deep surface soil (0-4 ft bgs) at Load Line 6.

Historical COPECs for Sediment. The historical ERA conducted as part of the Phase I RI reported 39 chemicals in sediment (MKM 2007). Of the 39 chemicals detected, 4 chemicals (calcium, magnesium, potassium, and sodium) were essential nutrients and were excluded from the COPEC screen (Appendix H, Table H-2). A total of 9 inorganic chemicals and 18 organic chemicals were determined to be SRCs because they exceeded background concentrations and the SRV, or they did not have an associated background concentration for comparison. Of the 27 SRCs, 5 inorganic chemicals (arsenic, cadmium, copper, lead, and mercury) exceeded the ESVs and were identified as COPECs (Table 7-9). In addition, one inorganic chemical (beryllium) and one organic chemical (nitrocellulose) were selected as COPECs because they did not have an ESV.

Historical COPECs for Surface Water. The historical ERA conducted as part of the Phase I RI reported 23 chemicals in surface water at Load Line 6 (MKM 2007). Of the 23 chemicals detected, 4 chemicals (calcium, magnesium, potassium, and sodium) were essential nutrients and were excluded from the COPEC screen (Appendix H, Table H-3). A total of 18 inorganic chemicals and 3 organic chemicals were determined to be SRCs because they exceeded background concentrations, or they did not have an associated background concentration for comparison. Of the 21 SRCs, 6 inorganic chemicals (aluminum, copper, iron, lead, selenium, and zinc) exceeded the ESVs and were identified as COPECs (Table 7-9). In addition, one inorganic chemical (manganese) and two organic chemicals (acetone and nitrocellulose) were selected as COPECs because they did not have an ESV.

Summary of Historical ERA. As explained previously, a historical ERA was performed to determine COPECs at Load Line 6 in deep surface soil (0-4 ft bgs), sediment, and surface water and compute ratios of ESVs and MDCs. Table 7-9 summarizes the COPECs by media. Based on the identified COPECs, ecological risk in all three media was predicted in the historical investigation, and an additional investigation was recommended for Load Line 6 (MKM 2007).

7.3.2.3 Ecological Significance

Sources of data and information about the ecological resources at Load Line 6 include the *Integrated Natural Resource Management Plan* (OHARNG 2014) (herein referred to as the INRMP), *Facility-wide Biological and Water Quality Study* (USACE 2005b) where applicable, previous characterization work [e.g., the Phase I RI], and visits to Load Line 6 conducted for the PBA08 RI.

One of the two key questions to answer in the Level I Scoping ERA is whether there are ecologically important and especially ecologically significant resources at Load Line 6. Ecological importance is defined as a place or resource that exhibits unique, special, or other attributes that makes it of great value. Ecological significance is defined as an important resource found at an AOC, or in its vicinity, that is subject to contaminant exposure. The underlying basis for this distinction can be found in *Ecological Significance and Selection of Candidate Assessment Endpoints* (USEPA 1996b), and is stated as follows:

> "A critical element in the ERA process requires distinguishing important environmental responses to chemical releases from those that are inconsequential to the ecosystem in which the site resides: in other words, determining the ecological significance of past, current, or projected site-related effects."

Important places and resources identified by the Army and Ohio EPA (Appendix H, Table H-4) include wetlands, terrestrial areas used for breeding by large or dense aggregations of animals, habitat known to be used by threatened or endangered species, state land designated for wildlife or game management, locally important ecological places, and state parks. The Army and Ohio EPA recognize 17 important places and resources. The Army recognizes an additional 16 important places (BTAG 2005), and the Ohio EPA recognizes another 6 important places (Ohio EPA 2008). In total, there are 39 important places. Presence or absence of an ecologically important place can be determined by comparing environmental facts and characteristics of Load Line 6 with each of the important places and resources listed in Table H-4 of Appendix H.

Presence of an important ecological resource or place and proximity to contamination at an AOC makes a resource ecologically significant. Thus, any important places and resources listed in Table H-4 of Appendix H are elevated to ecologically significant when present on the AOC and there is exposure to contaminants. For all 39 important places and resources, it is relatively clear that the ecological place or resource is either present or absent on the AOC; therefore, the decision process is objective. If no important or significant resource is present at an AOC, the evaluation will not proceed to Level II regardless of the presence of contamination. Instead, the Level I Scoping ERA would acknowledge that there are important ecological places but that those resources are not ecologically significant, and no further evaluation is required.

Management Goals for the AOC. Regardless of whether the evaluation is concluded at Level I or continues to Level II, there is another level of environmental protection for Load Line 6 through the natural resource management goals expressed in the INRMP (OHARNG 2014). OHARNG manages the ecological and natural resources at Camp Ravenna to maintain or enhance the current integrity of the natural resources and ecosystems at the facility. Natural resource management activities in place at Camp Ravenna also may also be applicable to any degradation noted from contamination.

Some natural resources management goals of OHARNG (listed in Appendix H, Table H-5) benefit Load Line 6. For example, Goal 1 states the natural resources need to be managed in a compatible way with the military mission, and Goal 5 requires the Army to sustain usable training lands and native natural resources by implementing a natural resource management plan that incorporates invasive species management and by utilizing native species mixes for revegetation after ground disturbance activities. These management goals help detect minor degradation (whether from training activities or historical contamination). While the applicability of the remaining 10 management goals to Load Line 6 varies, all of the management goals are intended to monitor, maintain, or enhance the facility's natural resources and its ecosystem. While these goals are for managing all types of resources at and near Load Line 6, they do not affect the decisions already concluded in Section 7.3.2.3 concerning the presence or absence of important or significant ecological places or resources at Load Line 6.

Important Places and Resources. Ecological importance means a place or resource that exhibits a unique, special, or other attribute that makes it of great value. Examples of important places and resources include wetlands, terrestrial areas used for breeding by large or dense aggregations of animals, and habitat of state-listed or federally listed species. An important resource becomes significant when found on an AOC and there is contaminant exposure. The wetlands and pond are important/significant ecological resources at Load Line 6 (Appendix H, Table H-4).

Terrestrial Resources. Load Line 6 is dominated by terrestrial resources, as described below.

Habitat Descriptions and Species**.** The INRMP and AOC visits by SAIC scientists showed Load Line 6 consists of three predominant vegetation types (Figure 7-1 and Photographs 7-1 and 7-2). The vegetation community throughout most of the habitat area is a dry, early-successional, herbaceous field (Photograph 7-1). The southwest portion of the habitat area consists of a temporarily flooded forest alliance of green ash (*Fraxinus pennsylvanica),* American elm (*Ulmus americana),* and hackberry *(Celtis occidentalis* and *laevigata).* One other community was represented in the northeastern portion of the habitat area consisting of the mixed-deciduous successional forest community (Figure 7-1). This characterization was originally established by a vegetation study using aerial photography and field verification (USACE 1999) and was later used in the INRMP (OHARNG 2008).

A field survey conducted by SAIC scientists on May 20, 2010 at Load Line 6 determined there have been changes in vegetation at the AOC, including (1) an increase of a dry, mid-successional, cold-deciduous, shrubland; (2) a decrease in the dry, early-successional, herbaceous field; and (3) an increase in the temporarily flooded forest alliance.

The increase in shrubland is attributable to plant succession. In the absence of continued disturbance from periodic mowing and recent demolition activities, shrubs and small trees have invaded areas that were dominated by herbaceous plants. Over time, these trees and shrubs have grown taller. Many of the shrub species are colonial and spread by vegetative propagation. Common species include various willows (*Salix* spp.), gray dogwood (*Cornus racemosa*), autumn olive (*Elaeagnus umbellata*), blackberry (*Rubus allegheniensis*), hawthorn (*Crataegus* spp.), and multiflora rose (*Rosa multiflora*). The shrubland areas occur between the habitat area boundary and the roadway that encircles the FPA.

The decreasing dry, early-successional, herbaceous field habitat is found inside the roadway that encircles the FPA (Figure 7-1). Demolition activities associated with removing buildings and other infrastructure have helped maintain this community. Dominant plants include an assortment of grasses, forbs, and seedlings of trees and shrubs. Based on the survey conducted in May 2010, common species include several species of goldenrod (*Solidago* spp.), clasping-leaf dogbane (*Apocynum cannabinum*), yarrow (*Achillea millefolium*), gray dogwood (*Cornus racemosa*), blackberry (*Rubus allegheniensis*), autumn olive (*Elaeagnus umbellata*), and multiflora rose (*Rosa multiflora*).

The increase in forested area is also attributable primarily to plant succession, as young tree species in the upland herbaceous habitat grow into more mature trees. In wetter areas, the forest is dominated by pin oak (*Quercus palustris*) and swamp white oak (*Quercus bicolor*). In drier habitat, the dominant tree species include red maple (*Acer rubrum*), quaking aspen (*Populus tremuloides*), black cherry (*Prunus serotina*), and black locust (*Robinia pseudoacacia*). The forested areas occur between the habitat area boundary and the roadway that encircles the FPA. Despite the apparent increase in forested habitat, there is far less forested habitat at Load Line 6 than field or shrubland habitats. The forest includes small open areas and understory that result in multi-story vegetation. This, in turn, provides various layers of vegetation for foraging height preferences of birds, mammals, insects, and other organisms.

The habitats at Load Line 6 were assessed to be healthy and functioning based on June 2008 and May 2010 observations by an SAIC biologist (Photographs 7-1 and 7-2). Functional habitat was determined by noting the absence of large bare spots and dead vegetation or other obvious visual signs of an unhealthy ecosystem. Additional habitat photographs are provided in Appendix H.

Threatened and Endangered and Other Rare Species. The northern long-eared bat (*Myotis septentrionalis*; federally threatened) exists at Camp Ravenna. There are no other federally listed species and no critical habitat on Camp Ravenna. Load Line 6 has not been previously surveyed for rare, threatened, or endangered species; however, there have been no documented sightings of rare, threatened, or endangered species at the AOC (OHARNG 2014).

Other Terrestrial Resources. While there are no other known important features, there are other resources at or near Load Line 6 (e.g., vegetation, animals) that interact in their ecosystems and support nutrient cycling and energy flow. For example, wildlife such as wild turkey (*Meleagris gallopavo*) and white-tailed deer (*Odocoileus virginianus*) could use the area. The INRMP provides information about species and habitat surveys at Camp Ravenna (e.g., timber and ecological succession) (OHARNG 2014). Aside from the natural resource map in the INRMP (OHARNG 2014) as shown in Figure 7-1, there are no other reported surveys of habitats and animals at Load Line 6.

Photograph 7-1. Herbaceous Field in the Middle of the Habitat Area (photograph taken June 11, 2008)

Photograph 7-2. Former Test Pond with Forest in Background in the Southern Part of the Habitat Area (photograph taken May 20, 2010)

Aquatic Resources. Load Line 6 has three types of aquatic resources as described below.

Habitat Descriptions and Species. There are three types of aquatic resources at Load Line 6: a pond, drainage ditches/natural conveyances, and four small wetlands.

Perennial surface water at Load Line 6 is limited to the Former Test Pond located at the south-central portion of the AOC formerly utilized for explosives testing. Additionally, surface water intermittently occurs throughout the AOC, within constructed drainage ditches or natural conveyances, as storm water runoff. The surface water drainage generally follows the topography of the AOC, draining north to south. At the southern boundary of the AOC, surface runoff that follows the constructed drainage ditches feeds into a natural drainage channel immediately east of the Former Test Pond. This natural drainage channel becomes the downstream perennial headwater streams to the Michael J. Kirwan reservoir. There is no permanent water in the drainage ditches/natural conveyances, and water is expected to accumulate only after rain events. Precipitation data for Camp Ravenna are provided in Section 3.5. The storm frequency is 35 days per year, and precipitation occurs 154 days per year, which is a sufficient amount of precipitation to create and maintain aquatic habitat at Load Line 6, as evidenced by the presence of the wetlands.

Wetlands. Wetlands are important habitats with water-saturated soil or sediment whose plant life can survive saturation. Wetlands are home to many different species and are also chemical sinks that can serve as detoxifiers and natural water purifiers. It is expected that the wetlands at Load Line 6 perform these and other related functions.

Important wetland resources exist at the AOC. There are four planning level survey wetlands at Load Line 6, all of which are located along the periphery of the AOC in an area that was formerly mowed. A jurisdictional determination by USACE would be required to determine the regulatory status of any wetlands at Load Line 6.

An SAIC Professional Wetland Scientist used the Ohio Rapid Assessment Method (ORAM) (Ohio EPA 2001) in May 2010 to assess the condition of any planning level survey wetlands at Load Line 6 and to determine the potential ecological importance of those wetlands (Appendix H, Figures H-1 through H-4). Using the ORAM, wetlands are classified into three categories:

- Category 1 wetlands are described as “limited quality waters.” They are considered to be a resource that has been degraded, has limited potential for restoration, or is of such low functionality that lower standards for avoidance, minimization, and mitigation can be applied. Scores range from 1 to 29.
- Category 2 includes wetlands of moderate quality and wetlands that are degraded but exhibit reasonable potential for restoration. Scores range from 30 to 59.
- Category 3 generally includes wetlands of very high quality and wetlands of concern regionally and/or statewide, such as wetlands that provide habitat for species listed as threatened or endangered. Scores range from 60 to 100.

The field sheets detailing the ORAM at Load Line 6 are presented in Appendix H (Figures H-1 through H-4). Figure 7-1 shows the locations of the wetlands.

Wetland 1 is located along the eastern side of the AOC. It is 0.12 acres in size and is associated with a wet weather conveyance that receives runoff from the eastern side of the AOC. The wetland consists of emergent and forested vegetation in approximately equal proportions. Based on the ORAM, Wetland 1 is classified as Category 2 (with a final score of 31), which indicates moderate wetland quality with some minor impairment of wetland functions and conditions (Appendix H, Figure H-1).

Wetland 2 is located along the east-southeastern boundary of the AOC. It is 0.11 acres in size and receives runoff from the southeastern portion of the AOC. The wetland consists of emergent vegetation. Based on the ORAM, Wetland 2 is classified as Category 2 (with a final score of 31), which indicates moderate wetland quality with some minor impairment of wetland functions and conditions (Appendix H, Figure H-2).

Wetland 3 is located along the southwestern side of the AOC. Most of the wetland is located off-site and is the source of water to a small stream that originates in the wetland. The wetland is larger (1.48 acres) than Wetlands 1 and 2, but only 0.04 acres is within the AOC. The wetland consists of a mix of scrub-shrub and emergent vegetation within the AOC and forested habitat outside the AOC. Based on the ORAM, Wetland 3 is classified as Category 2 (with a final score of 56), which indicates moderate wetland quality with some minor impairment of wetland functions and conditions (Appendix H, Figure H-3).

Wetland 4 is located along the western boundary of Load Line 6. The wetland appears to be isolated, with no surface hydrologic connection to any streams or other wetlands. The wetland is 0.25 acres in size, but only 0.13 acres is inside the AOC. The wetland is dominated by emergent vegetation, with a small component of forest vegetation. Based on the ORAM, Wetland 4 is classified as Category 1 (with a final score of 29), which indicates impaired wetland functions and conditions (Appendix H, Figure H-4).

Threatened and Endangered and Other Rare Species. The northern long-eared bat (*Myotis septentrionalis*; federally threatened) exists at Camp Ravenna. There are no other federally listed species and no critical habitat on Camp Ravenna. Load Line 6 has not been previously surveyed for rare, threatened, or endangered species; however, there have been no documented sightings of rare, threatened, or endangered species at the AOC (OHARNG 2014).

Other Aquatic Resources. While there are no other known aquatic resources at or near Load Line 6 (e.g., aquatic vegetation, animals), the existing populations interact in their ecosystems and support nutrient cycling and energy flow. The nearest biological and water quality station is approximately 2,500 ft away, and there is no connecting stream to the AOC. Aside from the vegetation map in the INRMP as shown in Figure 7-1, there are no other reported surveys of habitats and wildlife at Load Line 6.

Ecosystem and Landscape Roles and Relationships. There are four spatial areas to evaluate to assess the ecosystem and landscape roles and relationships at Load Line 6: the actual AOC, the vicinity of the AOC, the entire Camp Ravenna, and the ecoregion of northeastern Ohio. Information about the AOC (as a spatial area) is provided in previous sections about terrestrial and aquatic resources.

Vicinity of the AOC. Four vegetation communities border Load Line 6 (Figure 7-1) and include a variety of forest, herbaceous field, and shrubland communities. There are no apparent differences in habitat quality of these plant communities inside or outside of the AOC. For example, the dominant forest alliance in the southwestern portion of the habitat area [green ash (*Fraxinus pennsylvanica),* American elm (*Ulmus americana*), and hackberry (*Celtis occidentalis* and *laevigata*)] extends at least 1,000 ft beyond the southwestern boundary of the AOC. To the east and south occur other forest types: the American beech (*Fagus grandifolia*)/pin oak (*Quercus palustris*)/swamp white oak (*Quercus bicolor*) forest alliance; and the mixed, cold-deciduous, successional forest. The dry, early-successional herbaceous field that occupies much of the AOC borders the habitat area in many directions along small portions of the boundary. Across Fuze & Booster Road to the northwest, shrublands similar to the new habitat type emerging at the AOC occur. The types and qualities of habitat are not unique and can be found at many other areas at Camp Ravenna.

Figure 7-1 shows the Former Test Pond and four small wetlands inside the AOC. Other small wetlands are located near the northeastern, southeastern, and southwestern boundaries of the habitat area. Perennial surface water features exist to the southwest [within a planning level wetland (Wetland 3)] and to the south/southeast (as two small unnamed headwater streams that eventually drain to the Michael J. Kirwan Reservoir) of the AOC boundary (Figure 7-1).

The closest recorded rare species [lurking leskea (*Plagiothecium latebricola*)] is located approximately 200 ft southwest of the AOC (Figure 7-1 and Table 7-10). It is a state-threatened species. The next closest rare species [Eastern box turtle (*Terrapene carolina*)] is located about 1,700 ft north of the AOC. It is a state species of concern.

Table 7-10 summarizes the geographical relationships of various ecological resources in the vicinity of the AOC. Only wetlands are found at or in the vicinity of the AOC; the majority of the nearest resources are more than 1,400 ft away.

The Entire Camp Ravenna. Load Line 6 is considered a medium-sized (approximately 43 acres) AOC, which represents 0.20% of the total area of Camp Ravenna. There is approximately 3,940 acres of forest types FL1 (green ash/American elm/hackberry alliance) and FU5 [cold-deciduous (e.g., white ash and red maple) forest] at RVAAP, based on the INRMP map (OHARNG 2014); this represents about 18% of the habitat types at Camp Ravenna. There is approximately 1,980 acres of herbaceous field, representing about 9% of the habitat types at RVAAP (OHARNG 2014). There is approximately 1,970 acres of wetlands at Camp Ravenna, representing about 9% of the habitat types at Camp Ravenna (OHARNG 2014). Thus, these types of resources are abundant and are not unique at the Load Line 6 and Camp Ravenna.

Ecoregion. In the area surrounding Camp Ravenna, forests occupy a high percentage of the terrain. For example, Ohio's forests cover approximately 8,000,000 acres or 30% of the state (USDA 2009). The Erie/Ontario Drift and Lake Plain ecoregion (USGS 1988) is located in the northeastern part of Ohio that contains the communities of forest alliance [green ash (*Fraxinus pennsyvlvanica*)/American elm (*Ulmus americana*)/hackberry (*Celtis occidentalis* and *laevigata*)] and cold-deciduous [e.g., white ash (*Fraxinus americana*) and red maple (*Acer rubrum*)] forest. This ecoregion is made up of rolling to level terrain and low lime drift and lacustrine deposits. Lakes, wetlands, and swampy streams occur where stream networks converge or where the land is flat and clayey (USGS 1988). The U.S. Forest Service has a Forest Inventory Data Online tool that was queried for the forest types in the surrounding counties in or near RVAAP (USFS 2011). In 2009, approximately 143,000 acres of forest types FL1 and FU5 were found throughout northwestern Ohio in Cuyahoga, Geauga, Mahoning, Portage, Stark, Summit, and Trumbull counties that surround Camp Ravenna. The herbaceous field [e.g., goldenrod (*Solidago* spp.)] was not individually found in this query but is assumed to be common across the ecoregion due to favorable temperatures and terrain. Wetlands across the ecoregion make up 207,800 acres. Thus, the vegetation communities and wetlands at Load Line 6 are also found in the surrounding counties in the ecoregion of northeastern Ohio.

In summary, the forest types of green ash (*Fraxinus pennsylvania*)/American elm (*Ulmus americana*)/hackberry (*Celtis occidentalis* and *laevigata*) and white ash (*Fraxinus americana*)/red maple (*Acer rubrum*) are found in the vicinity of Load Line 6. These forest types, herbaceous fields, and shrublands are in abundance at Camp Ravenna and the larger surrounding local ecoregion. There is no known unique resource at Load Line 6 that cannot be found in the immediate vicinity of the AOC, Camp Ravenna, and in the large part of the ecoregion of northeastern Ohio.

7.3.2.4 Evaluation of Historical Chemical Contamination and Ecological Significance

Based on the historical ESV screening, 33 soil, 7 sediment, and 9 surface water COPECs were identified at Load Line 6. These COPECs are listed in Table 7-9.

The Army and Ohio EPA provide a checklist of important ecological places and resources to determine if such ecological resources are present in (or nearby) an AOC. There are four wetlands and one pond (Former Text Pond) at the AOC. Environmental management goals and objectives of OHARNG are applicable to Load Line 6, including Goal 1 requiring management of natural resources to be compatible with military mission and Goal 5 requiring the Army to sustain usable training grounds and natural resources.

Load Line 6 is made up of approximately 43 acres of herbaceous field, shrubland, and forest communities. Forest communities consist of green ash/American elm/hackberry and white ash/red maple. Four small wetlands are found at the AOC. The vegetation types and wetlands at Load Line 6 are found nearby, at Camp Ravenna, and in the ecoregion.

Because there is contamination at Load Line 6 and important or significant resources (i.e., four small wetlands and the Former Test Pond) are present, this ERA will continue to a Level II Screening Level ERA.

7.3.3 Level II: Screening Level Ecological Risk Assessment

The Level II method follows the guidance documents listed in Section 7.3.1. The Level II method identifies evaluation procedures used for problem formulation and ecological effects evaluation to determine AOC-related COPECs. This work includes defining habitats/environmental setting, suspected contaminants, possible pathways, and mechanisms for ecotoxicity and contaminant transport. Level II also includes establishing screening values.

In addition, technical and refinement factors can be used to assess outcomes of the above procedures. The factors include use of mean exposure concentrations, discussion of approved ESVs, wetland quality at the AOC, and other topics that evaluate and refine the COPECs from the Level II Screening ERA. This type of assessment is Step 3A in the ERA process (USEPA 1997).

7.3.3.1 Generic Ecological Conceptual Exposure Model

The Conceptual Site Exposure Model (CSEM) identifies the interconnections of contaminant sources and transport mechanisms for contaminant migration through the environment to the receptors. The CSEM provides an understanding of the relationships of all sources, release and transport pathways, potential exposure media, and receptors. The CSEM includes:

- ***Source Media.*** Based on historical AOC information, operations associated with various former buildings at Load Line 6 are the contaminant source. The operations contributed chemicals to the surrounding soil, sediment, and surface water.
- ***Transport Mechanisms.*** Material in soil and/or groundwater can migrate via erosion and leaching. Migration to sediment and surface water via erosion is controlled by the amount of precipitation, type of ground cover, and topography of the AOC. Little erosion is expected to occur at the AOC because, although parts of the land are relatively sloped, the slopes have a high percentage of vegetative ground cover that will further help to increase infiltration and decrease erosion. This extensive vegetative cover includes forests, shrublands, and herbaceous fields. While much of the precipitation landing on this area is expected to leach or infiltrate the soil, some rainfall will leave the AOC as runoff. For example, there are shallow drainages that provide a likely flow pathway from the location of the former buildings to one or more of the small wetlands and the Former Test Pond.
- ***Exposure Media.*** These are media where contaminants are available for exposure to ecological receptors. Potential exposure media at Load Line 6 are soil, sediment, surface water, vegetation, and animals. While groundwater may be discharging and mixing with surface water in the Former Test Pond, it is not a separate exposure medium, as explained in Section 7.3.2.2.
- ***Exposure Pathways.*** A main exposure pathway is ingestion of contaminated food. Other pathways may include ingestion of soil, sediment, and water and dermal contact by receptors with soil, sediment, or water.
- ***Ecological Receptors.*** A variety of ecological receptors, such as terrestrial birds and mammals, are present in the area. Receptors associated with various published toxicological

endpoints (e.g., reproduction, physiology) are assumed to represent these various plants and animals.

7.3.3.2 Habitats and Species (Including Generic Receptors)

Habitats and species were defined in the Level I ERA (Section 7.3.2). For example, three types of habitats were described. Habitats, species, and other resources were analyzed, and it was determined that important or significant ecological resources are present at Load Line 6. Four small wetlands and one pond are located at Load Line 6. Because contamination is present, a Level II analysis is needed. Level II assumes ecological receptors are sensitive to various chemicals based on a variety of toxicological data from field-observed effects and laboratory tests. The ESV is utilized as a toxicity metric representing multiple generic receptors, including plants, microorganisms, and animals.

7.3.3.3 Procedure to Identify COPECs

The screening level approach to evaluate sample results from the PBA08 RI followed a similar approach used in the historical ERA. Section 5.0 details chemical concentration data. The PBA08 RI included collecting discrete surface soil (0-1 ft bgs), deep surface soil (1-4 ft bgs), sediment, and surface water samples. Some locations were different from the historical sample locations, and some were co-located with previous samples (Figures 5-2 through 5-8).

As discussed in Section 5.1.1, the soil data within the geographic area of Load Line 6 were subdivided into two EUs: FPA and NPA. The FPA includes the area inside the perimeter road and all former buildings and operational areas. The NPA includes the area outside the production area to the fence line and the area just northwest of the AOC near Building 1101 at Fuze and Booster Road. The FPA contains all known or potential primary contaminant sources, such as the former operational buildings. The former buildings located within the NPA were limited to administrative and storage functions. The sediment and surface water samples were divided into two EUs: Former Test Pond and Drainage Ditches. This ERA uses updated SRVs (Appendix H, Table H-6) and ESVs that follow the revised *Ecological Risk Assessment Guidance* (Ohio EPA 2008), as provided in Appendix H, Tables H-7 through H-9.

The hierarchy of ESVs is based on the information found in the Ohio EPA risk assessment guidance (Ohio EPA 2008) and FWERWP (USACE 2003a). The MDC of each chemical is compared to its respective facility-wide background concentration. Sediment concentrations are also compared to the SRV. Chemicals are not considered site-related if the MDC is below the background concentration. For all chemicals detected above background concentrations, the MDC is compared to the chemical-specific ESV. In addition to the ESV comparison, it was determined if the chemical is a PBT compound. A chemical is retained as a COPEC if it exceeds its background concentration (and SRV for sediment) and the ESV, if the chemical exceeds its background concentration (and SRV for sediment) and had no toxicity information, or if the chemical is considered a PBT compound. MDC to ESV ratios are used to determine the integrated COPECs that result from the combined current and historical data sets. A ratio greater than one suggests a possible environmental consequence. Any chemicals with ratios greater than one are identified as integrated COPECs.

Based on comment resolution with Ohio EPA in July 2014, the selection of integrated COPECs for surface water was modified to include two screens. Along with comparing the MDC to the ESV, Ohio EPA requested the average concentration also be compared to the ESV. In the former, the preferred ESV is the Ohio EPA Outside Mixing Zone Maximum (OMZM) when available, whereas in the latter, the preferred ESV is the Ohio EPA Outside Mixing Zone Average (OMZA; Appendix H, Table H-9). However, there is only one surface water sample for the Former Test Pond at Load Line 6, so average concentrations are not available to compare against the OMZA. As a result, for the Former Test Pond at Load Line 6, the MDC was compared against both the OMZA and the OMZM.

Maximum and Average Detected Concentrations. The MDCs were compared to the background concentrations and ESVs (Appendix H, Tables H-10 through H-17) for detected chemicals. These comparisons are provided for soil in the FPA (Appendix H, Table H-10), soil in the NPA (Appendix H, Table H-11), sediment in the Former Test Pond (Appendix H, Table H-12), sediment in the Drainage Ditches (Appendix H, Table H-13), surface water in the Former Test Pond (Appendix H, Table H-14 and Table H-16), and surface water in the Drainage Ditches (Appendix H, Table H-15 and Table H-17). For potential use in Step 3a, average concentrations were compared to the background concentrations and ESVs (Appendix H, Tables H-18 through H-22) for detected chemicals. These comparisons are provided for soil in the FPA (Appendix H, Table H-18), soil in the NPA (Appendix H, Table H-19), sediment in the Drainage Ditches (Appendix H, Table H-20), surface water in the Former Test Pond (Appendix H, Table H-21), and surface water in the Drainage Ditches (Appendix H, Table H-22). As noted above, the average comparison in surface water also was used to identify integrated COPECs.

Ecological Screening Values. Although the historical ERA used ESVs from the 2003 version of the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2003), this ERA uses updated ESVs from the 2008 version of this guidance document. The hierarchy for soil is Ecological Soil Screening Levels (EcoSSLs), PRGs, and Ecological Screening Levels (ESLs). The hierarchy for sediment is the Sediment Quality Guidelines, followed by ESLs. The hierarchy for surface water is the Ohio EPA Water Quality Criteria (WQC), National Recommended Water Quality Criteria, and ESLs. Appendix H provides for values and sources for ESVs in Tables H-7, H-8, and H-9.

7.3.3.4 Integrated COPECs for Soil (0-4 ft bgs)

As discussed in Section 5.1.1, the soil data within the geographic area of Load Line 6 were subdivided into two EUs: FPA and NPA. A summary of the integrated COPECs identified in soil at the FPA and NPA is as follows.

Integrated COPECs for Soil (0-4 ft) at the Former Production Area. During the PBA08 RI, 49 chemicals were detected in deep surface soil at the FPA. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. A total of 15 inorganic chemicals and 24 organic chemicals were determined to be SRCs because they exceeded background concentrations or did not have an associated background concentration for comparison. Two organic chemicals (fluorene and naphthalene) did not have an associated background concentration for comparison were eliminated as SRCs because they were detected in less than 5% of the samples. Of the

39 SRCs, 11 inorganic chemicals (arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, and zinc) exceeded the ESVs and are identified as integrated COPECs (Table 7-11). In addition, six organic chemicals (HMX, nitrocellulose, carbazole, dibenzofuran, PCB-1254, and PCB-1260), were selected as integrated COPECs because they do not have an ESV. One PBT compound (4,4′-DDE) was identified as an integrated COPEC even though it did not exceed its ESV. Three of the other integrated COPECs (mercury, PCB-1254, and PCB-1260) were also PBT compounds. Table 7-11 shows the calculated ratio of MDC to ESV for each integrated COPEC. Appendix H, Table H-10 presents the details of the ESV comparisons for deep surface soil at the FPA.

Most of the inorganic COPECs reported in the historical ERA (Table 7-9) for soil in the FPA are also identified in this ERA. The historical ERA (MKM 2007) identified three inorganic chemical COPECs (aluminum, iron, and vanadium) that are not integrated COPECs for the FPA. Aluminum and vanadium at the FPA were below their background concentrations (Appendix H, Table H-10), and iron was considered an essential nutrient in the new data set. Seven organic chemicals were identified as integrated COPECs in this ERA. Two new integrated COPECs (4,4′-DDE and PCB-1260) were identified due to detections of these two organic chemicals in samples collected during the PBA08 RI. Based on the presence of integrated COPECs, this ERA predicts the potential for ecological risk in soil at the FPA.

Integrated COPECs for Soil (0-4 ft) at the Non-Production Area. During the PBA08 RI, 34 chemicals were detected in deep surface soil at the NPA. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. A total of 16 inorganic chemicals and 11 organic chemicals were determined to be SRCs because they either exceeded their background concentrations or did not have an associated background concentration for comparison. Of the 27 SRCs, 11 inorganic chemicals (aluminum, arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, selenium, and zinc) exceeded the ESVs and are identified as integrated COPECs (Table 7-12). Mercury is also a PBT compound. No organic chemicals exceeded their associated ESVs, nor were any of the organic chemicals PBT compounds; therefore, no organic chemicals were identified as integrated COPECs for the NPA. Table 7-12 shows the calculated ratio of MDC to ESV for each integrated COPEC. Appendix H, Table H-11 presents the details of the ESV comparisons for deep surface soil at the NPA.

Most of the inorganic COPECs reported in the historical ERA (Table 7-9) for soil in the NPA are also identified in this ERA. The historical ERA (MKM 2007) identified three inorganic COPECs (iron, nickel, and vanadium) that are not integrated COPECs for the NPA. Iron was considered an essential nutrient in the new data set (Appendix H, Table H-11), nickel was below the new ESV (Ohio EPA 2008), and vanadium was below its background concentration. No organic chemicals were identified as integrated COPECs for soil at the NPA. Five organic chemicals identified as historical COPECs were not detected in soil at the NPA during the PBA08 RI. Based on the presence of integrated COPECs, this ERA predicts the potential for ecological risk in soil at the NPA.

7.3.3.5 Integrated COPECs for Sediment

As discussed in Section 5.1.2, the sediment data within the geographic area of Load Line 6 were subdivided into two EUs: Former Test Pond and Drainage Ditches. A summary of the integrated COPECs identified in sediment at the Former Test Pond and Drainage Ditches is presented below.

Integrated COPECs for Sediment at the Former Test Pond. During the PBA08 RI, 22 chemicals were detected in sediment at the Former Test Pond. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. A total of five inorganic chemicals and one organic chemical were determined to be SRCs because they either exceeded their background concentrations or did not have an associated background concentration for comparison. Of the six SRCs, three inorganic chemicals (antimony, copper, and lead) exceeded the ESVs and are identified as integrated COPECs (Table 7-13). In addition, one organic chemical (tetryl) was selected as an integrated COPEC because it does not have an ESV. No PBT compounds were identified in the Former Test Pond sediment. Table 7-13 shows the calculated ratio of MDC to ESV for each integrated COPEC. Appendix H, Table H-12 presents the details of the ESV comparisons for sediment at the Former Test Pond.

Two of the inorganic COPECs (copper and lead) reported in the historical ERA (Table 7-9) for sediment are also identified in this ERA for the Former Test Pond. The historical ERA (MKM 2007) identified four inorganic COPECs (arsenic, beryllium, cadmium, and mercury) and one organic COPEC (nitrocellulose) that are not integrated COPECs for the Former Test Pond. Arsenic and beryllium were below their background concentrations or the SRV (Appendix H, Table H-12), and cadmium was below its ESV in the new data set. Mercury and nitrocellulose were not detected in the PBA08 RI data set. Two new integrated COPECs (antimony and tetryl) are identified in the PBA08 RI. The addition of antimony was due to a detection above its background concentration. The addition of tetryl is due to a detection of this organic chemical in samples collected during the PBA08 RI. Based on the presence of integrated COPECs, this ERA predicts the potential for ecological risk in sediment at the Former Test Pond.

Integrated COPECs for Sediment at the Drainage Ditches. During the PBA08 RI, 21 chemicals were detected in sediment at the Drainage Ditches. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. Two inorganic chemicals were determined to be SRCs because they exceeded their background concentrations or were identified as PBT compounds. Of the two SRCs, only mercury is identified as an integrated COPEC (Table 7-14). Table 7-14 shows the calculated ratio of MDC to ESV for mercury. Appendix H, Table H-13 presents the details of the ESV comparisons for sediment at the Drainage Ditches.

The historical ERA (MKM 2007) identified six inorganic COPECs (arsenic, beryllium, cadmium, copper, lead, and mercury) and one organic COPEC (nitrocellulose) that are not integrated COPECs for the Drainage Ditches. Arsenic, beryllium, copper, and lead were below their background concentrations or their SRVs (Appendix H, Table H-13) in the PBA08 RI data set. Cadmium and nitrocellulose were not detected in the PBA08 RI data set. Mercury was identified as a COPEC in the historical ERA (Table 7-9) for sediment and is also identified as an integrated COPEC.

Based on the presence of integrated COPECs, this ERA predicts the potential for ecological risk in sediment at the Drainage Ditches.

7.3.3.6 Integrated COPECs for Surface Water

As discussed in Section 5.1.2, the surface water data within the geographic area of Load Line 6 were subdivided into two EUs: Former Test Pond and Drainage Ditches. A summary of the integrated COPECs identified in surface water at the Former Test Pond and Drainage Ditches is presented below.

Integrated COPECs for Surface Water at the Former Test Pond. During the PBA08 RI, 15 chemicals were detected in surface water at the Former Test Pond. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. Three inorganic chemicals and two organic chemicals were determined to be SRCs because they exceeded their background concentrations or did not have an associated background concentration for comparison. Of the five SRCs, only beta-BHC is identified as an integrated COPEC (Table 7-15) because it is a PBT compound. Table 7-15 shows the calculated ratio of MDC to ESV for beta-BHC. Appendix H, Table H-14 presents the details of the MDC to OMZM ESV comparisons and Table H-16 presents the details of the MDC to OMZA ESV comparisons for surface water at the Former Test Pond. These comparisons used the OMZM and OMZA from the Ohio EPA WQC, when available, as the ESV; when the OMZM or OMZA were not available, the hierarchy of preferred sources was followed, as presented in Section 7.3.3.3.

For the average comparison, of the five SRCs, only beta-BHC was identified as an integrated COPEC because it is a PBT compound (Table 7-16). Table 7-16 shows the calculated ratio of the average detected concentration to the ESV for beta-BHC. Appendix H, Table H-21 presents the details of the ESV comparisons for surface water at the Former Test Pond based on the average detected concentration.

The historical ERA (MKM 2007) identified seven inorganic COPECs (aluminum, copper, iron, lead, manganese, selenium, and zinc) and two organic COPECs (acetone and nitrocellulose) that are not integrated COPECs for surface water in the Former Test Pond. Aluminum, copper, and manganese were below their background concentrations (Appendix H, Table H-14); lead was below its ESV; selenium, zinc, acetone, and nitrocellulose were not detected; and iron was considered an essential nutrient in the new data set.

One new integrated COPEC (beta-BHC) was detected during the PBA08 RI. Based on the presence of an integrated COPEC, this ERA predicts the potential for ecological risk in surface water at the Former Test Pond.

Integrated COPECs for Surface Water at the Drainage Ditches. During the PBA08 RI, 24 chemicals were detected in surface water at the Drainage Ditches. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. Fourteen inorganic chemicals and four organic chemicals were determined to be SRCs because they exceeded their background concentrations, or they did not have an associated background concentration for comparison. Of the 18 SRCs, 2 inorganic chemicals (aluminum and manganese) exceeded ESVs, and 2 additional inorganic chemicals (copper and lead) did not exceed OMZMs but did exceed OMZAs and are identified as integrated COPECs (Table 7-17). In addition, one organic chemical (nitrocellulose) was selected as an integrated COPEC because it does not have an ESV. Table 7-17 shows the calculated ratio of MDCs to ESVs for each integrated COPEC. Appendix H, Table H-15 presents the details of the MDC to OMZM ESV comparisons and Table H-17 presents the details of the MDC to OMZA ESV comparisons for surface water at the Drainage Ditches based on the MDC. These comparisons used the OMZM and OMZA from the Ohio EPA WQC, when available, as the ESV; when the OMZM or OMZA were not available, the hierarchy of preferred sources was followed, as presented in Section 7.3.3.3.

For the average comparison, of the 18 SRCs, 3 inorganic chemicals (aluminum, lead, and manganese) exceeded the ESVs and are identified as integrated COPECs (Table 7-18). In addition, one organic chemical (nitrocellulose) was selected as an integrated COPEC because it does not have an ESV. Table 7-18 shows the calculated ratio of the average detected concentrations to the ESVs. Appendix H, Table H-22 presents the details of the ESV comparisons for surface water at the Drainage Ditches based on the average detected concentrations.

Three of the inorganic COPECs (aluminum, lead and manganese) and one of the organic COPECs (nitrocellulose) reported in the historical ERA (Table 7-9) for surface water are also identified in this ERA for the Drainage Ditches based on MDC and average comparisons. One of the inorganic COPECs (copper) reported in the historical ERA (Table 7-9) for surface water is also identified in this ERA for the Drainage Ditches based on MDC comparisons. The historical ERA (MKM 2007) identified three inorganic COPECs (iron, selenium, and zinc) and one organic COPEC (acetone) that are not integrated COPECs for surface water in the Drainage Ditches. Selenium, zinc, and acetone were below their ESVs, and iron was considered an essential nutrient in the new data set; therefore, these chemicals are not considered integrated COPECs for surface water in the Drainage Ditches.

Based on the presence of integrated COPECs (aluminum, copper, lead, manganese, and nitrocellulose), this ERA predicts the potential for ecological risk in surface water at the Drainage Ditches.

7.3.3.7 Step 3A: Refinement of Integrated COPECs

Step 3A refines the list of integrated COPECs to determine if: (1) there are final COPECs requiring further evaluation in Level III or remediation to protect ecological receptors; or (2) integrated COPECs can be eliminated from further consideration. This section applies and evaluates refinement factors to the integrated COPECs for the AOC. This evaluation is an important part of Level II and is adapted from USEPA Step 3A, outlined in *Ecological Risk Assessment Guidance for Superfund:*

Process for Designing and Conducting Ecological Risk Assessments (USEPA 1997) and *Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE 2010b). The purpose of Step 3A is stated as follows by the Army (BTAG 2005):

> "The results of Step 3A will be used to determine if threats to ecological receptors are negligible and an appropriate risk management decision may be made to end the ERA process, or potential threats are still indicated and a Baseline Ecological Risk Assessment should be initiated."

The evaluation and refinement factors used in Step 3A are as follows:

- Comparison of average or mean concentration to ESV,
- Comparison of mean concentration to background concentration,
- Comparison of background concentration to ESV,
- Frequency of chemical occurrence relative to ESV,
- Magnitude of ESV exceedance (ratio of ESV to chemical concentrations),
- Discussion of Ohio EPA approved and preferred ESVs,
- Qualitative relationship of exposure area to general home range,
- Category of wetland quality inside the AOC,
- Geographical relationship of on-site wetlands to AOC exceedance area,
- Information about on-site migration of chemicals to on-site wetlands, and
- Evaluation of off-site migration of chemicals at biological/water quality stations.

Deep surface soil at Load Line 6 is divided into two EUs: FPA and NPA. For the FPA, there are 18 integrated COPECs. Arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, and zinc are the integrated COPECs that exceeded their background concentrations and ESVs. 4,4′-DDE has a ratio below 1 but is an integrated COPEC at the FPA because it is a PBT compound. PCB-1254 and PCB-1260 are integrated COPECs because they do not have an ESV and are also identified as PBT compounds. At the FPA, six chemicals (HMX, nitrocellulose, carbazole, dibenzofuran, PCB-1254, and PCB-1260) are integrated COPECs at the FPA because they do not have an ESV. For the NPA, aluminum, arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, selenium, and zinc are the 11 integrated COPECs, all with concentrations exceeding their background concentrations and ESVs.

Sediment at Load Line 6 is divided into two EUs: Former Test Pond and Drainage Ditches. In the Former Test Pond, antimony, copper, lead, and tetryl are integrated COPECs. Copper and lead are based on maximum exposure, as the MDC for both chemicals exceeded their ESVs. Antimony and tetryl were integrated sediment COPECs because they do not have an ESV. For sediment in the Drainage Ditches, mercury did not exceed its ESV but was an integrated COPEC because it is a PBT compound.

Surface water at Load Line 6 is divided into two EUs: Former Test Pond and Drainage Ditches. Surface water is present year round at Load Line 6 at the Former Test Pond. Beta-BHC does not exceed its ESV but is an integrated COPEC due to being a PBT compound. For surface water in the intermittent water of the Drainage Ditches, aluminum, lead, manganese, and nitrocellulose are integrated COPECs. Aluminum and manganese exceeded their background concentrations and ESVs (based on both the maximum and average comparisons). Lead exceeded its background concentration and ESV (based on average comparisons). Nitrocellulose is an integrated COPEC because it does not have an ESV.

Chemicals with no ESVs are discussed later in Step 3A and in the uncertainty section (Section 7.3.3.9). PBT compounds are discussed later in Step 3A. All integrated COPECs that have an MDC to ESV ratio greater than 1 are evaluated based on a series of evaluation or refinement factors. The first four evaluation and refinement factors are organized to compare key quantitative information. These factors are:

- Comparison of average or mean concentration to ESV,
- Comparison of mean concentration to background concentration,
- Comparison of background concentration to ESV, and
- Frequency of chemical occurrence relative to ESV.

Multiple evaluation factors can be used to define whether an integrated COPEC should be retained or eliminated from further consideration. There are two types of comparisons and associated decisions in the first steps of the refinement process (Table 7-19).

Comparison of background concentration to ESV is also an important consideration in this part of the evaluation. Additionally, frequency of detection is provided. The evaluations are presented by type of decision on a COPEC-by-COPEC basis. These evaluations are followed by the application of additional evaluation and refinement factors, when necessary.

The COPECs for each soil EU are defined separately.

Former Production Area – Comparison of Mean Concentration to ESV. Six integrated COPECs (arsenic, cadmium, chromium, cobalt, nickel, and selenium) in soil are eliminated in this step because the mean concentration is smaller than the ESV (Appendix H, Table H-18). Each eliminated integrated COPEC is discussed relative to the mean concentration being smaller than the ESV and the related evaluation and refinement factors. Table 7-20 shows the principal data and various comparisons.

Arsenic. Arsenic was detected in all 73 discrete samples in the FPA. Only four samples had detections above the background concentration, and only three samples had arsenic concentrations exceeding the ESV (Table 7-20). Although the MDC for arsenic in deep surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and background concentration. Therefore, arsenic is eliminated from further consideration and will not be a final COPEC.

Cadmium. Cadmium was detected in 18 of 73 discrete samples in the FPA. Nine of these samples had cadmium concentrations exceeding the ESV (Table 7-20). Although the MDC for cadmium in deep surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV. Therefore, cadmium is eliminated from further consideration and will not be a final COPEC.

Chromium. Chromium was detected in all 73 discrete samples in the FPA. Thirteen samples had detections above the background concentration, but only one sample had chromium concentrations exceeding the ESV (Table 7-20). Although the MDC for chromium in deep surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and background concentration. Therefore, chromium is eliminated from further consideration and will not be a final COPEC.

Cobalt. Cobalt was detected in all 73 discrete samples in the FPA. Eleven samples had detections above the background concentration, and only six of these samples had cobalt concentrations exceeding the ESV (Table 7-20). Although the MDC for cobalt in deep surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and background concentration. Therefore, cobalt is eliminated from further consideration and will not be a final COPEC.

Nickel. Nickel was detected in all 73 discrete samples in the FPA. Only 14 samples had detections above the background concentration, and only 1 sample had a nickel concentration exceeding the ESV (Table 7-20). Although the MDC for nickel in deep surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and the background concentration. Therefore, nickel is eliminated from further consideration and will not be a final COPEC.

Selenium. Selenium was detected in 30 of 73 discrete samples in the FPA. Only 4 samples had detections above the background concentration, and 24 samples had a selenium concentration exceeding the ESV (Table 7-20). Although the MDC for selenium in deep surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and only slightly higher than the background concentration. Therefore, selenium is eliminated from further consideration and will not be a final COPEC.

Of the 11 integrated COPECs in the FPA with MDCs exceeding the ESV, arsenic, cadmium, chromium, cobalt, nickel, and selenium were eliminated from further consideration. Five remaining integrated COPECs with MDCs greater than the ESV (copper, lead, manganese, mercury, and zinc) in deep surface soil in the FPA have mean concentrations larger than the ESV.

Non-Production Area – Comparison of Mean Concentration to ESV. Five integrated COPECs (arsenic, cadmium, chromium, cobalt, and copper) in deep surface soil in the NPA are eliminated in this step because the mean concentration is smaller than the ESV (Appendix H, Table H-19). Each eliminated integrated COPEC is discussed relative to the mean concentration being smaller than the ESV and the related evaluation and refinement factors. Table 7-21 shows the principal data and various comparisons.

Arsenic. Arsenic was detected in all 23 discrete samples in the NPA, but only 1 sample had chromium concentrations exceeding the background concentration and ESV (Table 7-21). Although the MDC for arsenic in deep surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and background concentration. Therefore, arsenic is eliminated from further consideration and will not be a final COPEC.

Cadmium. Cadmium was detected in 4 of 23 discrete samples in the NPA, but only 1 sample had a cadmium concentration exceeding the ESV (Table 7-21). Although the MDC for cadmium in deep surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV. Therefore, cadmium is eliminated from further consideration and will not be a final COPEC.

Chromium. Chromium was detected in all 23 discrete samples in the NPA. Only five samples exceeded background concentration, and only one sample had a chromium concentration exceeding the ESV (Table 7-21). Although the MDC for chromium in deep surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and background concentration. Therefore, chromium is eliminated from further consideration and will not be a final COPEC.

Cobalt. Cobalt was detected in all 23 discrete samples in the NPA. Only three samples were above the background concentration, and only one of these samples had a cobalt concentration exceeding the ESV (Table 7-21). Although the MDC for cobalt in deep surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and background concentration. Therefore, cobalt is eliminated from further consideration and will not be a final COPEC.

Copper. Copper was detected in all 23 discrete samples in the NPA. Only four samples were above the background concentration, and only one sample had a copper concentration exceeding the ESV (Table 7-21). Although the MDC for copper in deep surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and background concentration. Therefore, copper is eliminated from further consideration and will not be a final COPEC.

In summary, arsenic, cadmium, chromium, cobalt, and copper were eliminated from further consideration. Six remaining integrated COPECs (aluminum, lead, manganese, mercury, selenium, and zinc) in deep surface soil at the NPA have mean concentrations larger than the ESV.

Former Production Area – Comparison of Mean Concentration Above ESV to Background Concentration. One COPEC (manganese) in deep surface soil at the FPA is eliminated in this step because the mean concentration is larger than the ESV but smaller than the background concentration. Manganese is discussed relative to the various evaluation and refinement factors.

Manganese. Manganese in deep surface soil in the FPA has a mean concentration less than the background concentration, and the background concentration is more than six times greater than the ESV (Table 7-21). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Manganese was detected in 67 of 73 discrete samples at concentrations above the ESV; however, only 1 sample exceeded the background concentration. Although the MDC for manganese in deep surface soil exceeds the background concentration and the ESV, the mean concentration is below the background concentration and the ESV is conservative. Therefore, manganese is eliminated from further consideration and will not be a final COPEC.

Non-Production Area – Comparison of Mean Concentration Above ESV to Background Concentration. Five COPECs (aluminum, lead, manganese, mercury, and selenium) in deep surface soil in the NPA are eliminated in this step because the mean concentration is larger than the ESV but smaller than the background concentration. Each COPEC is discussed relative to the various evaluation and refinement factors.

Aluminum. Aluminum in deep surface soil in the NPA has a mean concentration less than the background concentration (Table 7-21). The background concentration is 390 times greater than the ESV, so the ESV can be considered conservative. Although aluminum was detected in all 23 discrete samples at concentrations above the ESV, only 2 samples had detections exceeding the background concentration. Having only two samples exceed the background concentration suggests the concentration of aluminum in deep surface soil is not a likely concern. Additionally, aluminum is not a concern because the soil pH is too high to dissociate the chemical. A typical soil pH is 6-7 at one of the nearby load lines at RVAAP (USACE 2004). Regarding aluminum chemistry and ecological risk in soil, USEPA stated, “Aluminum is identified as a COPC only for soil with a pH less than 5.5” (USEPA 2003a). Therefore, because (1) the mean concentration is less than the background concentration, (2) the ESV is rather conservative, and (3) the soil pH at RVAAP is higher than the USEPA dissociation limit, aluminum is eliminated from further consideration and will not be a final COPEC.

Lead. Lead in deep surface soil in the NPA has a mean concentration less than the background concentration, and the background concentration is more than twice the ESV (Table 7-21). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Lead was detected in 19 of 23 discrete samples at concentrations above the ESV; however, only 1 sample had a detection exceeding the background concentration. Although the MDC for lead in deep surface soil exceeds the background concentration and the ESV, the mean concentration is below the background concentration, and the ESV is conservative. Therefore, lead is eliminated from further consideration and will not be a final COPEC.

Manganese. Manganese in deep surface soil in the NPA has a mean concentration less than the background concentration, and the background concentration is more than six times greater than the ESV (Table 7-21). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Manganese was detected in 19 of 23 discrete samples at concentrations above the ESV; however, only 1 sample had a detection exceeding the background concentration. Although the MDC for manganese in deep surface soil exceeds the background concentration and the ESV, the mean concentration is below background, and the ESV is conservative. Therefore, manganese is eliminated from further consideration and will not be a final COPEC.

Mercury. Mercury in deep surface soil in the NPA has a mean concentration less than the background concentration, and the background concentration is 70 times greater than the ESV (Table 7-21). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Mercury was detected in 19 of 19 discrete samples at concentrations above the ESV; however, only 3 samples had detections exceeding the background concentration. Although the MDC for mercury in deep surface soil exceeds the background concentration and the ESV, the mean concentration is below the background concentration, and the ESV is conservative. Therefore, mercury is eliminated from further consideration and will not be a final COPEC.

Selenium. Selenium in deep surface soil in the NPA has a mean concentration less than the background concentration. The background concentration is approximately three times greater than the ESV. Because the ESV is lower than the background concentration, the ESV can be considered conservative. Selenium was detected in 16 of 23 discrete samples at concentrations above the ESV; 8 of these samples had detections exceeding the background concentration (Table 7-21). Although the MDC for selenium in deep surface soil exceeds the background concentration and the ESV, the mean concentration is below background and the ESV is conservative. Therefore, selenium is eliminated from further consideration and will not be a final COPEC.

Former Production Area – Continued Evaluations. The remaining four integrated COPECs at the FPA (copper, lead, mercury, and zinc) in soil have mean concentrations greater than the ESV and the background concentration. Each remaining integrated COPEC is presented below and discussed relative to the first four and related evaluation and refinement factors.

Copper. Copper in deep surface soil in the FPA has a mean concentration greater than the background concentration and ESV. Copper was detected in all 73 discrete samples at Load Line 6, but only 7 of these samples had copper concentrations exceeding the ESV (Table 7-20). The fact that the mean copper concentration exceeds the ESV and background concentration in deep surface soil indicates that copper requires further evaluation as a COPEC.

Lead. Lead in deep surface soil in the FPA has a mean concentration greater than the background concentration and ESV. It was detected above the background concentration in 26 of 73 discrete samples. Lead was detected in 65 of 73 discrete samples at concentrations above the ESV. The ESV is lower than the background concentration, which indicates the ESV for lead may be conservative. Although the ESV may be conservative, the mean concentration for lead in deep surface soil exceeds both the background concentration and ESV. Lead requires further evaluation as a COPEC.

Mercury. Mercury in deep surface soil in the FPA has a mean concentration greater than the background concentration and ESV. Although mercury in deep surface soil in the FPA has a mean concentration slightly greater than the background concentration, the background concentration is 70 times greater than the ESV, suggesting the ESV may be very conservative. Mercury, a PBT compound, was detected above the background concentration in 16 of 66 discrete deep surface soil samples (Table 7-20). Although mercury has a very conservative ESV, the mean concentration for mercury exceeds both the background concentration and ESV. Mercury requires further evaluation as a COPEC.

Zinc. Zinc in deep surface soil in the FPA has a mean concentration greater than the background concentration and ESV. In addition, the background concentration is greater than the ESV, which indicates the ESV may be conservative. Zinc was detected above the ESV in 66 of 73 discrete samples and above the background concentration in 28 of 73 samples (Table 7-20). Because, the mean concentration in deep surface soil exceeds both the background concentration and the ESV, zinc requires further evaluation as a COPEC.

Non-Production Area – Continued Evaluations. The remaining COPEC (zinc) in deep surface soil at the NPA has a mean concentration greater than the ESV and background concentration. The integrated COPEC is presented below and discussed relative to the first four and related evaluation and refinement factors.

Zinc. Zinc in deep surface soil in the NPA has a mean concentration greater than the background concentration, and the background concentration is greater than the ESV. Zinc was detected above the ESV in 17 of 23 discrete samples and above the background concentration in 3 of 23 samples (Table 7-21). The ESV is lower than background concentration, which indicates the ESV may be conservative. Although very few of the samples exceeded the background concentration, the mean concentration in deep surface soil exceeds both the background concentration and the ESV. Zinc requires further evaluation as a COPEC.

Additional Aspects of Continued Evaluations. The second refinement factor comparing the mean concentration to background concentration evaluates how much higher the mean soil concentration is compared to the background concentration. Five COPECs (copper, lead, mercury, and zinc at the FPA and zinc at the NPA) have mean concentrations higher than their background concentrations. If the degree of difference between the mean concentration and the background concentration is small, the integrated COPEC can be eliminated from further consideration and will not be considered a final COPEC. Table 7-22 shows that while the mean concentration exceeds the background concentration, the exceedance is often relatively small. For example, the mean concentration for lead at the FPA is 30 mg/kg, while the background concentration is 26.1 mg/kg.

Additional Technical and Refinement Factors. The next three evaluation and refinement factors include:

- Magnitude of ESV exceedance (ratio of ESV to chemical concentrations),
- Discussion of Ohio EPA approved and preferred ESVs, and
- Qualitative relationship of exposure area to general home range.

Former Production Area – Magnitude of ESV Exceedance. Although the mean concentration to ESV ratios for copper (1.1), lead (2.7), mercury (91.6), and zinc (1.5) in the FPA indicate a possibility of risk, most of the ratios are relatively small (Appendix H, Table H-18). The small ratios for copper, lead, and zinc indicate that the potential for toxicity is relatively low, and they may not become final COPECs. The Guidance for Conducting Ecological Risk Assessments (Ohio EPA 2008) states:

> "If only minor exceedances are detected and other evidence can substantiate, a claim may be made that some or all of the site-associated soils have not been impacted and no additional ecological investigation of the soils is warranted."

Non-Production Area – Magnitude of ESV Exceedance. Although the mean concentration to ESV ratio for zinc (1.7) indicates a possibility of risk, the ratio is relatively small (Appendix H, Table H-19). The small ratio for zinc indicates the potential for toxicity is relatively low, and it may not become a final COPEC.

Comparison of Ohio EPA Approved and Preferred ESVs. The *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008) gives specific guidance on selection of media screening values (ESVs) for Level II evaluation. For soil, three possible sources of ESV values are listed in order of preference: (1) USEPA EcoSSLs, (2) *Preliminary Remediation Goals for Ecological Endpoints* (DOE 1997), and (3) *Region 5 Ecological Screening Levels* (USEPA 2003b). However, it is important to note the preferred source (EcoSSLs) can have up to four values per chemical, one for each receptor type (plants, soil invertebrates, birds, and mammals). Ohio EPA does not provide guidance on which value to select of these four, so the most conservative (lowest) value was chosen for this ERA. However, since all of these sources are approved in the guidance, and the EcoSSL value to be used in Level II is not specified, it is possible that the chosen ESV is too conservative. Alternative ESVs are presented below for the remaining four integrated COPECs at the FPA and one integrated COPEC at the NPA.

The Ohio EPA approved and preferred copper ESV used in this ERA is 28 mg/kg. This value is from the USEPA EcoSSL for copper (USEPA 2007a), which is the ESV source most preferred for soil by the Ohio EPA (Appendix H, Table H-7). The copper ESV used in this ERA is the most conservative ESV of the USEPA EcoSSLs. Other EcoSSLs for copper include 49, 70, and 80 mg/kg. The ESV of 28 mg/kg is also more than twice as low as the ESV (60 mg/kg) from the next source of ESVs preferred by Ohio EPA (Appendix H, Table H-7) (DOE 1997). The preferred copper ESV (28 mg/kg) is close to the background concentration (17.7 mg/kg) and the mean concentration (29.5 mg/kg) for copper. All of the other EcoSSLs and the alternative ESV are above the mean concentration. This information indicates the Ohio EPA approved and preferred ESV for copper is conservative; thus, the selection of copper as a COPEC is conservative.

The Ohio EPA approved and preferred lead ESV used in this ERA is 11 mg/kg. This ESV is also from the USEPA EcoSSLs (Appendix H, Table H-7). The lead ESV used in this ERA is the most conservative ESV of the USEPA EcoSSLs. Other EcoSSLs for lead include 56, 120, and 1,700 mg/kg (USEPA 2005). The ESV of 11 mg/kg is about four times lower than the ESV (40.5 mg/kg) from the next source of ESVs preferred by Ohio EPA (Appendix H, Table H-7) (DOE 1997). The preferred ESV used for lead is also lower than the background concentration of 26.1 mg/kg (Appendix H, Table H-10), while all of the other EcoSSLs and the alternate ESV are above the background concentration. This information indicates the Ohio EPA approved and preferred ESV for lead, and thus, the selection of lead as a COPEC is very conservative.

The Ohio EPA approved and preferred mercury ESV used in this ERA is 0.0005 mg/kg (Appendix H, Table H-7). The ESV is lower than other ESVs for mercury (0.1 mg/kg), the ESV for methylmercury (0.0016 mg/kg) (USEPA 2000, 2001, and 2003b) (Appendix H, Table H-7), and the background concentration (0.036 mg/kg) (Appendix H, Table H-10). The *Preliminary Remediation Goals for Ecological Endpoints* labels the form of mercury as an “inorganic chemical” and notes that the ESV for mercury is “so low that it may often be within background soil concentrations” (DOE 1997). Although mercury can bioaccumulate in food chains as a PBT compound, the Ohio EPA approved and preferred ESV is very low; thus, the selection of mercury as a COPEC is very conservative.

The Ohio EPA approved and preferred zinc ESV used in this ERA is 46 mg/kg. This value is from the USEPA EcoSSLs (Appendix H, Table H-7) (USEPA 2007b). The zinc ESV used in this ERA is the most conservative ESV of the USEPA EcoSSLs. Other EcoSSLs for zinc include 79, 120, and 160 mg/kg (USEPA 2007b). The ESV of 46 mg/kg is about five times greater than the ESV (8.5 mg/kg) from the next source of ESVs preferred by Ohio EPA (Appendix H, Table H-7) (DOE 1997). The preferred ESV used for zinc is also lower than the background concentration of 61.8 mg/kg (Appendix H, Table H-10), while all of the other EcoSSLs are above the background concentration. These factors indicate the Ohio EPA approved and preferred ESV for zinc is somewhat conservative; thus, the selection of zinc as a COPEC is somewhat conservative.

The above information about alternative ESVs shows there are less conservative ESVs that could be chosen in the Level II work. Table 7-23 shows the ratio of ESV to mean concentration for the preferred ESV and an alternative ESV. This alternative ESV is the ESV with the closest concentration to the preferred ESV that is above the background concentration. For the four remaining integrated COPECs at the FPA, use of the alternative ESV would decrease all ratios to less than 1. For NPA, the single remaining integrated COPEC (zinc) has a ratio below 1 with this alternative ESV. Thus, if the alternative ESVs were used, all the ratios would fall to or below 1, and the COPECs would be eliminated from further consideration and would not be final COPECs.

In summary, copper, lead, mercury, and zinc have alternative ESVs approved by Ohio EPA that are less conservative than the preferred ESVs used in this ERA. Use of these alternative ESVs would reduce the ratios of mean concentrations to ESVs to below 1 and support elimination of these chemicals from consideration as final COPECs.

Qualitative Relationship of Exposure Area to General Home Range. Wildlife receptors, especially those with smaller 1-acre home ranges (e.g., small birds and mammals such as robins and field mice), could be exposed to the highest detected concentrations of copper, lead, mercury, or zinc at the FPA and zinc at the NPA. However, an examination of the number of concentrations detected above the alternative ESVs (discussed in the previous section) indicates receptor exposures would be limited to these elevated concentrations. Specifically, only 3 of the 73 copper detections are above the alternative ESV (Table 7-23). Lead (8 of 73 detections), mercury (5 of 66 detections), and zinc (15 of 73 detections) at the FPA and zinc (1 of 23 detections) at the NPA also have relatively limited exceedances compared to the overall number of detections. These integrated COPECs are not widely distributed at the most elevated concentrations. For example, the highest concentrations of copper, lead, and zinc are located in the north-northeast portion of the FPA, in relatively small areas. The two highest concentrations of mercury are co-located in the south-central portion of the FPA in a relatively small area. At the NPA, the two highest zinc detections are located in the northern and southern portions in a relatively small area. Qualitatively, this suggests the exposure areas with elevated concentrations would be limited in comparison to the small home ranges of small receptors and even large receptors (deer or turkey) that roam over hundreds of acres. Thus, COPEC exposure to mobile wildlife species would be relatively small, which suggests the four remaining integrated COPECs can be eliminated from further consideration and would not be final COPECs.

Regarding the previous three refinement factors, ratios of ESV to mean concentration are relatively small for copper (1.1), lead (2.7), and zinc (1.5) in the FPA. Mercury has a ratio of 91.6 in the FPA. If alternative ESVs were used, all ratios would decrease to less than 1. The maximum concentrations of all four inorganic chemicals are found in small areas relative to the size of both small and large home ranges. In addition, the frequency of detection indicates limited exposure to wildlife. Together, these factors, as well as the previous factors, support the view that none of these inorganic chemicals are final COPECs.

Wetland Quality, Geographical Information, and On-site Migration of Chemicals. The next three evaluation and refinement factors deal with various aspects of wetlands. The three factors are:

- Category of wetland quality inside the AOC,
- Geographical relationship of on-site wetlands to AOC exceedance area, and
- Information about on-site migration of chemicals to on-site wetlands.

If the wetland quality is low, it is distant from the high concentration area, or on-site migration is poor, it increases the likelihood that the remaining integrated COPECs (copper, lead, mercury, and zinc) will not be of ecological concern and do not need to be evaluated as final COPECs.

One wetland at this AOC is classified as a Category 1 wetland (with an ORAM score of 29), and three wetlands are classified as Category 2 wetlands (with ORAM scores of 31, 31, and 56). Category 1 indicates impaired wetland conditions and functions, and Category 2 indicates moderate wetland quality with some minor impairment of wetland functions and conditions (Section 7.3.2.3).

The four wetlands are small in size, with only 0.4 acres of 1.96 total acres of the wetlands inside the AOC. RVAAP has about 1,970 acres of wetlands, and the 0.4 acres of wetlands inside the habitat boundary at Load Line 6 represent about 0.02% of the total wetland area of RVAAP (OHARNG 2014). The low ORAM score, relatively small areas, and availability of many more wetland acres at RVAAP lowers the importance of the wetlands at Load Line 6.

All four wetlands are located on the eastern, western, and southwestern edges of the AOC. The edges of the AOC are the maximum distant possible from the center of the FPA and the northern and southern portions of the NPA, where the maximum COPEC concentrations are located (Figure 7-1). Thus, the wetlands are relatively distant from the highest COPEC concentrations.

Over a period of years, contaminants from the former buildings may have flowed into the Former Test Pond. Soluble contaminants are likely to be discharged via overflow. Insoluble (immobile) chemicals would be retained. The Drainage Ditches and Former Test Pond are considered an ecosystem sink for the chemicals during most seasons of the year. There is a low likelihood for off-site migration of contaminants. The above limitations (low scores, small areas, and availability), along with limited on-site and off-site migration of chemicals, provide information to further reduce the concern about the remaining integrated COPECs.

Evaluation of Biological and Water Quality Sampling Stations. The last evaluation and refinement factor considers findings at the nearest biological/water quality sampling stations:

- Evaluation of off-site migration of chemicals at biological/water quality stations.

These studies were published in the *Facility-wide Biological and Water Quality Study* (USACE 2005b). These monitoring stations are positioned in streams and ponds downgradient from several AOCs. Various biological measurements of macroinvertebrates and fish, as well as chemical and physical measurements of surface water and sediment, were taken and assessed for evidence of upgradient contamination. For Load Line 6, the nearest stream sampling station is 4,600 ft north, and the nearest pond sampling station is 2,500 ft west (Table 7-10). There are no known connections of Load Line 6 to these stream and ponds. Therefore, this particular factor cannot be applied.

Evaluation of Integrated COPECs in Sediment and Surface Water. Integrated COPECs in sediment and surface water were subjected to the same evaluation and refinement factors applied to integrated COPECs for deep surface soil. Some factors, such as those concerning wetlands and off-site migration, apply to the whole AOC and have already been discussed. The evaluation of sediment and surface water includes chemical-specific evaluation and refinement factors and the qualitative relationship of exposure area to general home range.

Former Test Pond Sediment – Evaluation and Refinement Factors. The four integrated COPECs in sediment at the Former Test Pond are antimony, copper, lead, and tetryl (Table 7-13). Antimony and tetryl were conservatively identified as integrated COPECs because they did not have ESVs and are discussed later in Step 3A and in the uncertainty section (Section 7.3.3.9).

There was only one sediment sample taken at the Former Test Pond; therefore, the comparison of the mean concentration to the ESV is not applicable to copper and lead. Both COPECs were detected above their background concentrations. Although the MDC to ESV ratio for copper (2.9) and lead (1.5) at the Former Test Pond indicate a possibility of risk, the ratios are relatively small (Appendix H, Table H-12). The small ratios indicate toxicity is relatively low and these two chemicals may not become final COPECs; however, they will undergo further evaluation.

Drainage Ditches Sediment – Evaluation and Refinement Factors. In the Drainage Ditches sediment, mercury was identified as an integrated COPEC because it is a PBT compound. PBT compounds are discussed in Step 3A. Mercury is eliminated from further consideration and will not be a final COPEC.

Former Test Pond Surface Water – Evaluation and Refinement Factors. For surface water in the Former Test Pond, beta-BHC was identified as an integrated COPEC because it is a PBT compound. PBT compounds are discussed in Step 3A. Beta-BHC is eliminated from further consideration and will not be a final COPEC.

Drainage Ditches Surface Water – Evaluation and Refinement Factors. In the Drainage Ditches, the integrated COPECs in surface water are aluminum, copper, lead, manganese, and nitrocellulose. Nitrocellulose was identified as integrated COPEC because it did not have an ESV and is discussed later in Step 3A and in the uncertainty section (Section 7.3.3.9).

Aluminum was detected in all three samples taken in the Drainage Ditches, but only one sample had a detection above its background concentration. Aluminum had a mean concentration (2.6 mg/L) lower than the background concentration (3.4 mg/L) (Appendix H, Table H-22). As a result, aluminum is eliminated from further consideration and will not be a final COPEC.

Copper was detected in all three samples taken in the Drainage Ditches, but only one sample had a detection above its background concentration and OMZA screening value. Copper had a mean concentration (0.0066 mg/L) lower than the background concentration (0.0079 mg/L) (Appendix H, Table H-22). As a result, copper was eliminated from further consideration and will not be a final COPEC.

Lead was detected in all three samples collected in the Drainage Ditches. Although all three of the detected concentrations were below the OMZM ESV, the mean concentration of lead (0.00665 mg/L) slightly exceeded the OMZA ESV (0.0051 mg/L) (Appendix H, Table H-22). The ratio of the mean concentration to OMZA ESV for lead (1.04) at the Drainage Ditches indicates a small possibility of risk; however, the MDC of lead was below the OMZM ESV (Appendix H, Table H-15) and lead was below the SRV in the sediment of the Drainage Ditches (Appendix H, Table H-20). This information suggests there is limited source material for the elevated detected in surface water, and this chemical may not become a final COPEC; however, lead will undergo further evaluation.

Manganese was detected above its background concentration and the ESV in two of three detected surface water samples in the Drainage Ditches. Manganese had a mean concentration (0.93 mg/L) greater than the ESV (0.12 mg/L) and the background concentration (0.39 mg/L). Although the MDC and mean concentrations to ESV ratios for manganese (18.3 and 7.8, respectively) at the Drainage Ditches indicate a possibility of risk, manganese was detected within background in the sediment of the Drainage Ditches (Appendix H, Table H-20), and mean concentrations in both soil EUs were below the background concentration. This information suggests limited source material for the elevated detections in the surface water, and this chemical may not become a final COPECs; however, manganese will undergo further evaluation.

Summary. In summary, copper and lead in Former Test Pond sediment and lead and manganese in Drainage Ditches surface water were retained for further evaluation.

Comparison of Ohio EPA Approved and Preferred ESVs. There are no other ESVs available from the sources preferred by Ohio EPA (Appendix H, Tables H-8 and H-9). Therefore, this ERA will not provide an evaluation of Ohio EPA approved and preferred ESVs for the remaining integrated COPECs in sediment and surface water.

Qualitative Relationship of Exposure Area to General Home Range. The Former Test Pond is located near the southern border of the AOC. It is approximately 0.03 acres in size, which is a very small portion of the 1-acre home range of a small bird or mammal (USEPA 1993). A larger receptor that uses this area as a small part of its home range would have even lower exposure to COPECs in the Former Test Pond. As an aquatic habitat, it is small and lacks aquatic plants and other attractive attributes (Photograph 7-2). The size of the Former Test Pond greatly reduces concern for the integrated COPECs found in the single sample because only a limited number of receptors would be exposed to any of the COPECs.

The Drainage Ditches contain only intermittent surface water. Because of their man-made purpose, size/shape, and locations near roads and buildings, they are not ecological habitat. Any ecological receptor that uses Load Line 6 as part of its home range would have only incidental contact with the Drainage Ditches. This greatly reduces concern for the integrated COPECs there (though only lead and manganese are retained for further evaluation). The historical ERA reached the same conclusion, and no further action was recommended for the AOC (MKM 2007).

In summary, the Former Test Pond and Drainage Ditches are a small part of any receptor home range and are unlikely to be used by more than a limited number of receptors. The ditches are ephemeral and would not be reliable aquatic habitat. These and previous factors lead to the conclusion that none of the remaining integrated COPECs found in sediment (copper and lead) and surface water (lead and manganese) are final COPECs.

Evaluation of PBT Compounds and COPECs Without ESVs. As discussed in Level II, there are six chemicals that are PBT compounds and nine chemicals that are integrated COPECs because they did not have ESVs in deep surface soil, sediment, or surface water at Load Line 6. These chemicals are briefly evaluated below.

PBT Compounds. The *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008) includes a PBT compound screen in the Level II ERA. This screen is necessary because not all ESVs account for bioaccumulation; instead, they are derived based primarily on toxicity to endpoint receptors exposed by direct contact (plants, soil-dwelling invertebrates) or ingestion of soil or water (e.g., mammals, birds). For AOCs that move to a Level III baseline ERA, PBT compounds are evaluated in the wildlife food chains. Ohio EPA allows PBTs to be screened out in Level II if the "method used to derive the screening value considered exposure to higher trophic level organisms in the development of the screening value" (Ohio EPA 2008).

For the first two sources of soil ESVs preferred by Ohio EPA (EcoSSLs and PRGs), bioaccumulation in higher trophic levels is considered in development of the ESV. According to the EcoSSL guidance, "wildlife receptors may be exposed to contaminants in soil by two main pathways: incidental ingestion of soil while feeding, and ingestion of food items that have become contaminated due to uptake from soil" (USEPA 2007c). Derivation of EcoSSL values includes uptake equations that account for both direct ingestion and food chain bioaccumulation (USEPA 2007c). The same is true of PRGs: "the 90th percentile of the soil-to-biota uptake factor was used as a conservative estimate of the chemical concentrations in wildlife food types (earthworms, plants, or small mammals)," and "the model accounts for the ingestion of soil as well as food" (DOE 1997). It is also important to note that both sources often derive values for multiple receptors, and the most conservative (lowest) value is chosen. Thus, for soil ESVs from these two sources, PBT compounds that have ratios less than 1 can be dismissed as final COPECs.

The USEPA Region 5 ESLs (USEPA 2003b) are an Ohio EPA-approved source for soil, sediment, and surface water ESVs (see Appendix H, Tables H-7 to H-9 for hierarchies). It is a source of screening values for some PBT compounds not covered in the EcoSSLs or PRGs, such as beta-BHC in surface water. The ESLs also account for bioaccumulation in the food chain, as "development of ESLs focused on mammalian or avian species and identified those chemicals that have the potential for significant bioaccumulation or biomagnification" (USEPA 1999). Thus, development of ESLs included bioaccumulation in higher tropic levels as a standard component in the equations, and PBT compounds with ESVs in soil, sediment, and surface water from this source that have ratios less than one can be dismissed as final COPECs.

For some of the PBT compounds, there are no ESVs. As a result, a limited evaluation was conducted for each medium, focusing on the derivation of the ESV, frequency of detection, relationship to the background concentration, and other chemical-specific refinement factors.

Regarding deep surface soil in the FPA, 4,4′-DDE, PCB-1254, PCB-1260, and mercury are integrated COPECs because they are PBT compounds. In addition, mercury is an integrated COPEC at the NPA because it is a PBT compound. Mercury in both deep surface soil EUs was previously evaluated in Step 3A because it exceeded its ESV.

4,4′-DDE, PCB-1254, and PCB-1260 were detected in only 1 of 14 FPA soil samples; these chemicals were not detected in soil in the NPA. None of these chemicals were detected in soil greater than 1 ft bgs, nor were they detected in Drainage Ditch sediment or surface water. While pesticides/PCBs were not analyzed in sediment in the Former Test Pond, they were analyzed in surface water and were not detected. Most importantly, the detected concentration of 4,4′DDE was below the ESV, which accounted for bioaccumulation (USEPA 2007c); therefore, this chemical will not be selected as a final COPEC.

There are no Ohio EPA accepted ESVs for PCB-1254 and PCB-1260. Because only one sample from all three media contained these two PCBs, exposure to these PBT compounds would be limited. This suggests bioaccumulation would not occur to toxic levels in receptors (predators and prey). As a result, PCB-1254 and PCB-1260 are eliminated from further consideration and will not be final COPECs.

Mercury was detected in both soil EUs above the ESV, which accounts for bioaccumulation (DOE 1997). These exceedances are not surprising because the background concentration is 70 times greater than the ESV. At the NPA, the mean concentration of mercury (0.0351 mg/kg) is below the background concentration (0.036 mg/kg) (Table 7-21), so mercury is eliminated from further consideration and will not be a final COPEC at NPA. While the mean concentration of mercury (0.047 mg/kg) at the FPA is slightly above the background concentration (0.036 mg/kg), the similarity between the concentrations suggests exposures to mercury at Load Line 6 are no different from background conditions. Thus, mercury at the FPA is eliminated from further consideration and will not be a final COPEC.

In the Drainage Ditches, mercury is the only chemical in the sediment identified as an integrated COPEC because it is a PBT compound. While both the mean concentration and MDC are below the ESV, the ESV may or may not account for bioaccumulation. However, the MDC (0.052 mg/kg) is below the background concentration (0.059 mg/kg) (Appendix H, Table H-13); therefore, mercury is eliminated from further consideration and will not be a final COPEC.

For surface water in the Former Test Pond, beta-BHC is an integrated COPEC because it is a PBT compound. Beta-BHC was detected in the one surface water sample collected from the Former Test Pond at a concentration below its ESV, which accounted for bioaccumulation (USEPA 2003b). As a result, beta-BHC is eliminated from further consideration and will not be a final COPEC.

COPECs without ESVs. The *Guidance for Conducting Ecological Risk Assessments* specifies that chemicals without screening benchmark values should be retained as COPECs (Ohio EPA 2008). While Ohio EPA allows the use of additional screening benchmark values, such values need to be approved prior to submitting the report. For Load Line 6, a search for (and subsequent approval of) additional values was not deemed necessary. Rather, to mitigate concern for the uncertainties associated with COPECs that lack ESVs, a limited additional evaluation was conducted for each medium, focusing on frequency of detection, relationship to background concentration, and other chemical-specific refinement factors.

For soil at the FPA, the integrated COPECs without ESVs are HMX, nitrocellulose, carbazole, dibenzofuran, PCB-1254, and PCB-1260. Four COPECs (carbazole, dibenzofuran, PCB-1254, and PCB-1260) were detected in 1 of 14 samples. HMX was detected in 1 of 27 samples. Thus, exposure to these chemicals would be limited. While nitrocellulose was detected in 11 of 14 samples, it is essentially non-toxic (USEPA 1987), and this chemical also is not expected to be an ecological concern. Soil at the NPA did not have integrated COPECs without ESVs.

For sediment in the Former Test Pond, antimony and tetryl were identified integrated COPECs without ESVs. Both antimony and tetryl were detected in the only sediment sample from the Former Test Pond. The concentration for antimony (1.7 mg/kg) is essentially the same as the SRV (1.3 mg/kg), and antimony is not considered an ecological concern in sediment. There are no other detections of tetryl in either soil EU, the Drainage Ditches sediment EU, or the two surface water EUs. As a result, there will be little to no exposure to this explosive, and potential for ecological risk is limited. Sediment at the Drainage Ditches did not have integrated COPECs without ESVs.

For surface water in the Drainage Ditches, nitrocellulose is the only integrated COPEC without an ESV. Nitrocellulose is essentially non-toxic, and there are no concerns associated with the detection of this COPEC in the surface water of the Drainage Ditches (USEPA 1987). For the Former Test Pond, there were no COPECs without ESVs identified.

Summary of Findings in Step 3A. Of the 19 integrated COPECs in deep surface soil in the combined FPA and NPA, 4 were eliminated as COPECs because they did not have ESVs, had low frequency of detection, or little to no toxicity. Two PBT compounds (PCB-1254 and PCB-1260) with no ESVs were also eliminated because they had low frequency of detection and were not found in other media. One PBT compound (4,4′-DDE) was eliminated because it had a ratio less than 1, low frequency of detection, and was not found in other media. Additional integrated COPECs were eliminated from further consideration because the mean concentration is smaller than the ESV (arsenic, cadmium, chromium, cobalt, nickel, and selenium); other integrated COPECs (aluminum and manganese) were eliminated from further consideration because the mean concentration is smaller than the background concentration. The remaining four integrated COPECs in soil (copper, lead, mercury, and zinc) have a combination of factors that together eliminated them from further consideration. These factors are presented below:

1. The mean concentrations are only slightly higher than background concentrations.
2. Most mean concentration-to-ESV ratios of exceedance are near 1.
3. Ohio EPA guidance allows alternative ESVs that are less conservative than the ESVs used in this ERA. These alternate ESVs (unlike the preferred ESV) are above background concentrations. If these alternate ESVs were used in lieu of the current ones, all ratios would be below 1.
4. The small and large wildlife receptors are exposed to rather low frequencies of detections above the alternative ESVs, and highly elevated concentrations are limited to relatively small areas.
5. The quality of the wetlands is low, the wetlands are relatively distant from the small high concentration areas, and on-site migration is poor.

No final COPECs in deep surface soil were identified for Load Line 6.

Of the four integrated COPECs in sediment at the Former Test Pond, antimony and tetryl have no ESV. Antimony was eliminated as a COPEC because the detection is similar to the SRV. Tetryl was eliminated because it was not found in other media. Copper and lead have relatively low concentrations and are found in a very small body of water (0.03 acres). A limited number of receptors would be exposed to these relatively low concentrations. In the Drainage Ditches, the only COPEC (mercury) was eliminated because the maximum concentration was lower than the ESV and the background concentration.

The only integrated COPEC in surface water of the Former Test Pond (beta-BHC) was eliminated because the maximum concentration was lower than the ESV (which accounts for bioaccumulation), and it was not detected in other media at Load Line 6. Of the five integrated COPECs in the Drainage Ditches: nitrocellulose was eliminated because it had no ESV and is not toxic; aluminum and copper were eliminated because the mean concentrations are lower than background concentrations; lead and manganese were eliminated because of the ephemeral nature of the ditches (i.e., there is no ecological habitat). No final COPECs in sediment and surface water were identified for Load Line 6.

7.3.3.8 Consideration of Human Health Driven Remediation

The HHRA does not identify any COCs and recommends no further action for soil, sediment, or surface water at Load Line 6. Thus, there would be no remediation implemented to further protect human health that would also protect ecological resources at Load Line 6.

7.3.3.9 Uncertainties and Mitigations

Uncertainties or unknowns are present in both exposure data and effects data. To mitigate uncertainty in exposure data, the MDCs of all available and appropriate data were used in Level I. In Level II, the MDC and mean COPEC concentrations were used to mitigate uncertainty about exposure data for receptors in the AOC. To mitigate uncertainty in effects information, a site visit for habitat condition was conducted, and the latest INRMP of rare species sightings and planning level survey wetlands was used (OHARNG 2014). The ORAM was applied to the small wetlands. Conservative ESVs, which are typically based on concentrations observed to have no effect on test species in laboratory studies, were used in Level II to mitigate uncertainty about effects on receptors in the AOC. There are some COPECs because the chemicals do not have ESVs. The COPECs are assumed to have limited toxicity given the lack of cause-effect laboratory tests and field-observed effects in the scientific literature.

In Level II, to mitigate uncertainty about effects on receptors in the AOC, the ESVs for COPECs are compared to background concentrations. Use of ESVs that are lower than background concentrations provides an indication of the conservative nature of the evaluation. Conservative ESVs are appropriate for use as screening thresholds in Level I and II (i.e., soil constituents with an MDC below the ESV need no further consideration in Level II).

7.3.3.10 Summary and Recommendations of Screening Level Ecological Risk Assessment

Integrated COPECs were identified in deep surface soil, sediment, and surface water at Load Line 6. The two EUs for each medium are summarized jointly. Some of the COPECs identified in the historical ERA were also identified during screening of PBA08 RI data. In soil, several historical COPECs (especially organic chemicals) were not identified during the PBA08 RI, and a few new COPECs were identified due to additional sampling data. In sediment, few of the historical COPECs were retained as COPECs in the PBA08 RI. There were also fewer COPECs for surface water identified during the PBA08 RI, as compared to historical COPECs. Those chemicals retained after screening of historical and PBA08 RI data were termed integrated COPECs.

Nineteen integrated soil COPECs, five integrated sediment COPECs, and five integrated surface water COPECs were further evaluated in Step 3A with technical and refinement factors. All integrated soil, sediment, and surface water COPECs were determined to be of no ecological concern. None require remediation or further evaluation. Consequently, the ERA for Load Line 6 can conclude with a Level II ERA that no further action is necessary to be protective of important ecological receptors. This recommendation is consistent with the recommendation made in the Phase I RI Report

(MKM 2007) which concluded that ecological risks were unlikely at Load Line 6; site-related risks are not great enough to proceed past the SERA.

7.3.4 Conclusions

There is chemical contamination present in deep surface soil, sediment, and surface water at Load Line 6. This contamination was identified using historical and PBA08 RI data. Fields, shrubland, and green ash (*Fraxinus pennsylvanica*)/American elm (*Ulmus americana*)/hackberry (*Celtis occidentalis* and *laevigata*) forest were observed on the 43 acres of the AOC. There are important and significant ecological resources in the AOC. Specifically, wetlands and surface water (e.g., a small test pond) are present and near contamination. These findings invoked a requirement of a Level II assessment.

The Level II assessment evaluated soil, sediment, and surface water COPECs using historical and PBA08 RI data, identified integrated COPECs, and evaluated the integrated COPECs using technical and refinement factors in Step 3A. The factors in Step 3A showed there is no further evaluation necessary for integrated COPECs, and there is no ecological concern requiring remediation. Consequently, the ERA for Load Line 6 can conclude with Level II ERA that no further action is necessary to be protective of important ecological receptors. This recommendation is consistent with the recommendation made in the Phase I RI Report (MKM 2007) which concluded that ecological risks are unlikely at Load Line 6; site-related risks were not great enough to proceed past the SERA.

Table 7-1. Risk Assessment Data Set for Surface Soil (0-1 ft bgs) Discrete Samples

Location	Sample ID	Date	Depth (ft bgs)
Former Production Area			
LL6ss-001	LL6ss-001-0001-SO	3/12/2002	0-1
LL6ss-002	LL6ss-002-0001-SO	3/12/2002	0-1
LL6ss-003	LL6ss-003-0001-SO	3/12/2002	0-1
LL6ss-004	LL6ss-004-0001-SO	11/25/2003	0-1
LL6sd-005	LL6sd-005-0001-SD	12/1/2003	0-0.5
LL6ss-005	LL6ss-005-0001-SO	11/19/2003	0-1
LL6ss-006	LL6ss-006-0001-SO	11/21/2003	0-1
LL6ss-007	LL6ss-007-0001-SO	11/14/2003	0-1
LL6ss-008	LL6ss-008-0001-SO	11/14/2003	0-1
LL6ss-009	LL6ss-009-0001-SO	11/20/2003	0-1
LL6sd-010	LL6sd-010-0001-SD	12/1/2003	0-0.5
LL6ss-010	LL6ss-010-0001-SO	12/2/2003	0-1
LL6ss-010	LL6ss-010-0002-SO	1/14/2004	0-1
LL6sd-011	LL6sd-011-0001-SD	12/2/2003	0-1
LL6ss-011	LL6ss-011-0001-SO	12/3/2003	0-1
LL6sd-012	LL6sd-012-0001-SD	12/2/2003	0-1
LL6ss-012	LL6ss-012-0001-SO	11/25/2003	0-1
LL6sd-013	LL6sd-013-0001-SD	12/2/2003	0-1.5
LL6ss-013	LL6ss-013-0001-SO	11/21/2003	0-1
LL6sd-014	LL6sd-014-0001-SD	12/2/2003	0-0.5
LL6ss-014	LL6ss-014-0001-SO	11/25/2003	0-1
LL6sd-015	LL6sd-015-0001-SD	12/2/2003	0-0.5
LL6ss-015	LL6ss-015-0001-SO	11/25/2003	0-1
LL6ss-016	LL6ss-016-0001-SO	11/21/2003	0-1
LL6ss-017	LL6ss-017-0001-SO	11/19/2003	0-1

Table 7-1. Risk Assessment Data Set for Surface Soil (0-1 ft bgs) Discrete Samples (continued)

Location	Sample ID	Date	Depth (ft bgs)
LL6ss-018	LL6ss-018-0001-SO	12/2/2003	0-1
LL6ss-019	LL6ss-019-0001-SO	11/19/2003	0-1
LL6ss-020	LL6ss-020-0001-SO	12/2/2003	0-1
LL6ss-021	LL6ss-021-0001-SO	11/19/2003	0-1
LL6ss-022	LL6ss-022-0001-SO	11/14/2003	0-1
LL6ss-023	LL6ss-023-0001-SO	11/19/2003	0-1
LL6ss-024	LL6ss-024-0001-SO	11/25/2003	0-1
LL6ss-033	LL6ss-033-0001-SO	11/18/2003	0-1
LL6ss-034	LL6ss-034-0001-SO	11/14/2003	0-1
LL6ss-035	LL6ss-035-0001-SO	11/13/2003	0-1
LL6ss-038	LL6ss-038-0001-SO	11/5/2003	0-1
LL6ss-039	LL6ss-039-0001-SO	11/5/2003	0-1
LL6sb-069	LL6sb-069-5219-SO	2/25/2010	0-1
LL6sb-070	LL6sb-070-5223-SO	3/1/2010	0-1
LL6sb-071	LL6sb-071-5227-SO	3/1/2010	0-1
LL6ss-073	LL6ss-073-5237-SO	2/22/2010	0-1
LL6ss-074	LL6ss-074-5238-SO	2/22/2010	0-1
LL6ss-076	LL6ss-076-5239-SO	2/22/2010	0-1
LL6ss-078	LL6ss-078-5240-SO	2/22/2010	0-1
LL6ss-079	LL6ss-079-5241-SO	2/22/2010	0-1
LL6ss-075a	LL6ss-075-5246-SO	2/22/2010	0-1
LL6ss-080a	LL6ss-080-5248-SO	2/22/2010	0-1
Non-Production Area			
LL6ss-025	LL6ss-025-0001-SO	11/14/2003	0-1
LL6ss-026	LL6ss-026-0001-SO	11/20/2003	0-1
LL6ss-027	LL6ss-027-0001-SO	11/20/2003	0-1
LL6ss-028	LL6ss-028-0001-SO	11/18/2003	0-1
LL6ss-029	LL6ss-029-0001-SO	11/25/2003	0-1
LL6ss-030	LL6ss-030-0001-SO	11/18/2003	0-1
LL6ss-031	LL6ss-031-0001-SO	11/13/2003	0-1
LL6ss-032	LL6ss-032-0001-SO	11/13/2003	0-1
LL6ss-036	LL6ss-036-0001-SO	11/13/2003	0-1
LL6ss-037	LL6ss-037-0001-SO	11/13/2003	0-1
LL6ss-040	LL6ss-040-0001-SO	11/5/2003	0-1
LL6ss-056	LL6ss-056-0001-SO	11/18/2003	0-1
LL6sb-068	LL6sb-068-5215-SO	3/1/2010	0-1
LL6sd-081	LL6sd-081-5243-SD	2/18/2010	0-0.5
LL6sb-083	LL6sb-083-5233-SO	2/25/2010	0-1
LL6ss-077[a]	LL6ss-077-5247-SO	2/25/2010	0-1

[a] Chromium speciation samples used to evaluate the presence of hexavalent chromium.
bgs = Below ground surface.
ID = Identification.

Table 7-2. Risk Assessment Data Set for Subsurface Soil (1-13 ft bgs) Discrete Samples

Location	Sample ID	Date	Depth^{a} (ft bgs)
Former Production Area			
LL6sb-001	LL6sb-001-0001-SO	12/3/2003	1-3
LL6sb-002	LL6sb-002-0001-SO	12/3/2003	1-3
LL6sb-003	LL6sb-003-0001-SO	12/3/2003	1-3
LL6sb-004	LL6sb-004-0001-SO	11/25/2003	1-3
LL6sb-005	LL6sb-005-0001-SO	11/19/2003	1-3
LL6sb-006	LL6sb-006-0001-SO	11/21/2003	1-3
LL6sb-007	LL6sb-007-0001-SO	11/14/2003	1-3
LL6sb-008	LL6sb-008-0001-SO	11/14/2003	1-3
LL6sb-009	LL6sb-009-0001-SO	11/20/2003	1-3
LL6sb-010	LL6sb-010-0001-SO	12/2/2003	1-3
LL6sb-011	LL6sb-011-0001-SO	12/3/2003	1-3
LL6sb-012	LL6sb-012-0001-SO	11/25/2003	1-3
LL6sb-013	LL6sb-013-0001-SO	11/21/2003	1-3
LL6sb-014	LL6sb-014-0001-SO	11/25/2003	1-3
LL6sb-015	LL6sb-015-0001-SO	11/25/2003	1-3
LL6sb-016	LL6sb-016-0001-SO	11/21/2003	1-3
LL6sb-017	LL6sb-017-0001-SO	11/19/2003	1-3
LL6sb-018	LL6sb-018-0001-SO	12/2/2003	1-3
LL6sb-019	LL6sb-019-0001-SO	11/19/2003	1-3
LL6sb-020	LL6sb-020-0001-SO	12/2/2003	1-3
LL6sb-021	LL6sb-021-0001-SO	11/19/2003	1-3
LL6sb-023	LL6sb-023-0001-SO	11/19/2003	1-3
LL6sb-024	LL6sb-024-0001-SO	11/25/2003	1-3
LL6sb-042	LL6sb-042-0001-SO	12/3/2003	1-3
LL6sb-044	LL6sb-044-0001-SO	12/2/2003	1-3
LL6sb-045	LL6sb-045-0001-SO	12/2/2003	1-3
LL6sb-069	LL6sb-069-5220-SO	2/25/2010	1-4
LL6sb-070	LL6sb-070-5224-SO	3/1/2010	1-4
LL6sb-071	LL6sb-071-5228-SO	3/1/2010	1-4
LL6sb-069	LL6sb-069-5221-SO	2/25/2010	4-7
LL6sb-070	LL6sb-070-5225-SO	3/1/2010	4-7
LL6sb-071	LL6sb-071-5229-SO	3/1/2010	4-7
LL6sb-033	LL6sb-033-0001-SO	11/18/2003	6-8
LL6sb-041	LL6sb-041-0001-SO	10/27/2003	7-7
LL6sb-069	LL6sb-069-5222-SO	2/25/2010	7-13
LL6sb-038	LL6sb-038-0001-SO	11/5/2003	8-10
LL6sb-039	LL6sb-039-0001-SO	11/5/2003	8-10
LL6sb-035	LL6sb-035-0001-SO	11/14/2003	11-13
Non-Production Area			
LL6sb-025	LL6sb-025-0001-SO	11/14/2003	1-3
LL6sb-026	LL6sb-026-0001-SO	11/20/2003	1-3
LL6sb-027	LL6sb-027-0001-SO	11/20/2003	1-3
LL6sb-028	LL6sb-028-0001-SO	11/18/2003	1-3
LL6sb-030	LL6sb-030-0001-SO	11/18/2003	1-3
LL6sb-056	LL6sb-056-0001-SO	11/18/2003	1-3
LL6sb-068	LL6sb-068-5216-SO	3/1/2010	1-4
LL6sb-083	LL6sb-083-5234-SO	2/25/2010	1-4
LL6sb-055	LL6sb-055-0001-SO	11/4/2003	3-5
LL6sb-040	LL6sb-040-0001-SO	11/5/2003	4-6
LL6sb-049	LL6sb-049-0001-SO	11/4/2003	4-6
LL6sb-068	LL6sb-068-5217-SO	3/1/2010	4-7

Table 7–2. Risk Assessment Data Set for Subsurface Soil (1-13 ft bgs) Discrete Samples (continued)

Location	Sample ID	Date	Depth[a] (ft bgs)
LL6sb-083	LL6sb-083-5235-SO	2/25/2010	4-5.5
LL6sb-031	LL6sb-031-0001-SO	11/18/2003	6-8
LL6sb-036	LL6sb-036-0001-SO	11/18/2003	6-8
LL6sb-050	LL6sb-050-0001-SO	11/4/2003	6-8
LL6sb-051	LL6sb-051-0001-SO	11/4/2003	6-8
LL6sb-037	LL6sb-037-0001-SO	11/14/2003	12-14

[a] Samples were assigned to depth intervals based on starting depth.
bgs = Below ground surface.
ID = Identification.

Table 7-3. Risk Assessment Data Set for Surface Water

Location	Sample ID	Date
Drainage Ditches		
LL6sw-002	LL6sw-002-0001-SW	12/1/2003
LL6sw-081	LL6sw-081-5242-SW	3/2/2010
LL6sw-082	LL6sw-082-5244-SW	2/17/2010
Former Test Pond		
LL6sw-084	LL6sw-084-5794-SW	4/1/2010

bgs = Below ground surface.
ID = Identification.

Table 7-4. Risk Assessment Data Set for Sediment

Location	Sample ID	Date	Depth (ft bgs)
Drainage Ditches			
LL6sd-002	LL6sd-002-0001-SD	12/1/2003	0-0.5
LL6sd-082	LL6sd-082-5245-SD	2/17/2010	0-0.5
Former Test Pond			
LL6sd-084	LL6sd-084-5795-SD	4/1/2010	0-0.5

bgs = Below ground surface.
ID = Identification.

Table 7-5. Summary of SRCs

SRC	Surface Soil (0-1 ft bgs)		Subsurface Soil (1-13 ft bgs)		Sediment		Surface Water	
	FPA	NPA	FPA	NPA	Ditch	Pond	Ditch	Pond
Inorganic chemicals								
Aluminum	--	X	--	--	--	--	X	--
Antimony	--	--	--	--	X	X	X	X
Arsenic	X	X	X	--	--	--	--	--
Barium	X	X	--	X	--	--	X	--
Beryllium	X	X	X	X	X	X	X	--
Cadmium	X	X	X	X	--	X	X	-
Chromium	X	X	X	--	--	--	X	--
Cobalt	X	X	X	--	X	X	X	X
Copper	X	X	X	--		X	X	--
Lead	X	X	X	--	X	X	X	X
Manganese	X	X	--	--	--	--	X	--
Mercury	X	X	X	--	--	--	--	--
Nickel	X	X	--	--	X	X	X	--
Selenium	X	X	X	X	--	--	X	--
Silver	--	X	X	X	--	X	--	--
Thallium	X	X	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	X	--
Zinc	X	X	X	--	--	--	X	--
Explosives								
HMX	X	--	--	--	--	--	X	X
Nitrocellulose	X	--	X	--	--	--	X	--
Tetryl	--	--	--	--	--	X	--	--
SVOCs								
2-Methylnaphthalene	X	--	X	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	--	X	--
Acenaphthene	X	--	X	--	--	--	--	--
Anthracene	X	X	X	--	--	--	--	--
Benz(a)anthracene	X	X	X	--	--	--	--	--
Benzo(a)pyrene	X	X	X	--	--	--	--	--
Benzo(b)fluoranthene	X	X	X	--	--	--	--	--
Benzo(ghi)perylene	X	X	X	--	--	--	--	--
Benzo(k)fluoranthene	X	X	X	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	X	--	X	--	--	--	--	--
Carbazole	--	--	X	--	--	--	--	--
Chrysene	X	X	X	--	--	--	--	-
Dibenz(a,h)anthracene	X	--	X	--	--	--	--	--
Dibenzofuran	--	--	X	--	--	--	--	-
Di-n-octylphthalate	--	--	--	X	--	--	--	--
Fluoranthene	X	X	X	--	--	--	--	--
Fluorene	--	--	X	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	X	X	X	--	--	--	--	--
Naphthalene	--	--	X	--	--	--	-	-
Phenanthrene	X	X	X	--	--	--	--	--
Pyrene	X	X	X	--	--	--	--	--
Pesticides/PCBs								
beta-BHC	--	--	--	--	--	--	--	X
4,4'-DDE	X	--	--	-	--	--	-	--

Table 7 5. Summary of SRCs (continued)

SRC	Surface Soil (0-1 ft bgs)		Subsurface Soil (1-13 ft bgs)		Sediment		Surface Water	
	FPA	NPA	FPA	NPA	Ditch	Pond	Ditch	Pond
PCB-1254	X	--	--	--	--	--	-	--
PCB-1260	X	--	--	--	--	--	--	--
VOCs								
Acetone	--	--	X	--	--	--	X	--
Methylene chloride	X	--	--	--	--	--	--	--
Toluene	X	--	X	--	--	-	--	--

bgs = Below ground surface.
DDE = Dichlorodiphenyldichloroethylene.
FPA = Former production area.
HMX = Octahydro-1,3,5,7-tetranitroi-1,3,5,7-tetrazocane.
NPA = Non-production area.
PCB = Polychlorinated biphenyl.
Pond = Former test pond.
SRC = Site-related contaminant.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.
X = Chemical is an SRC at this EU or depth interval.
-- = Chemical is not an SRC at this EU or depth interval.

Table 7-6. Summary of COPCs

COPC	Surface Soil (0-1 ft bgs)		Subsurface Soil (1-13 ft bgs)		Sediment		Surface Water	
	FPA	NPA	FPA	NPA	Ditch	Pond	Ditch	Pond
Aluminum	--	X	--	--	--	--	--	--
Arsenic	X	X	X	--	--	--	--	--
Cadmium	X	--	--	--	--	--	--	--
Cobalt	X	X	X	--	X	X	X	--
Copper	X	--	--	--	--	--	--	--
Manganese	X	X	--	--	--	--	X	--
Benz(a)anthracene	--	--	X	--	--	--	--	--
Benzo(a)pyrene	X	X	X	--	--	--	--	--
Benzo(b)fluoranthene	--	--	X	--	--	--	--	--
Dibenz(a,h)anthracene	X	--	X	--	--	--	--	--

[a] No samples were collected from this depth interval at the NPA.
-- = chemical is not a COPC in this medium or depth interval.
bgs = Below ground surface. NPA = Non-Production Area.
COPC = Chemical of potential concern.
FPA = Former Production Area.
X = Chemical is a COPC in this medium.

Table 7-7. FWCUGs Corresponding to an HQ of 1 and Target Risk of 1E-05 for COPCs in Soil and/or Sediment

COPC	Critical Effect or Target Organ	Resident Receptor FWCUG[a] (mg/kg)	
		HQ=1	TR=1E-05
Aluminum	Neurotoxicity in offspring	73798	--
Arsenic	Skin	20.2	4.25[b]
Cadmium	Proteinuria	64.1	12491
Cobalt	NS	1313	8030
Copper	GI, kidney, liver	3106	--
Manganese	CNS	2927	--
Benz(a)anthracene	NA	--	2.21
Benzo(a)pyrene	NA	--	0.221
Benzo(b)fluoranthene	NA	--	2.21
Dibenz(a,h)anthracene	NA	--	0.221

[a] Resident Receptor FWCUGs are the smaller of the Adult or Child values for each COPC and endpoint (non-cancer and cancer).

[b] Risk-based FWCUG is less than the background screening values for arsenic in surface soil (15.4 mg/kg), subsurface soil (19.8 mg/kg) and sediment (19.5 mg/kg) and for manganese in subsurface soil (3030 mg/kg).

-- = No value available.
CNS = Central nervous system.
COPC = Chemical of potential concern.
FWCUG = Facility-wide cleanup goal.
GI = Gastrointestinal.
HQ = Hazard quotient.
mg/kg = Milligrams per kilogram.
NA = Not applicable.
NS = Not specified.
TR = Target risk.

Table 7-8. FWCUGs Corresponding to an HQ of 1 and Target Risk of 1E-05 for COPCs in Surface Water

COPC	Critical Effect or Target Organ	Resident Receptor[a] (mg/L	
		HQ = 1	TR = 1E-05
Cobalt	NS	0.006[b]	--
Manganese	CNS	6.326	--

[a] Resident Receptor FWCUGs are the smaller of the Adult or Child values for each COPC.

[b] No FWCUG is available for cobalt. Value is the USEPA tap water RSL.

-- = No value available.
CNS = Central nervous system.
COPC = Chemical of potential concern.
FWCUG = Facility-wide cleanup goal.
HQ = Hazard quotient.
NS = Not specified.
RSL = Regional screening level.
TR = Target risk.
USEPA = U.S. Environmental Protection Agency

Table 7-9. Summary of Historical COPECs per the Phase I RI

Group	COPEC	Shallow Soil	Sediment	Surface Water
Inorganic chemicals	Aluminum	X	--	X
	Arsenic	X	X	--
	Beryllium	--	X	--
	Cadmium	X	X	--
	Chromium	X	--	--
	Cobalt	X	--	--
	Copper	X	X	X
	Iron	X	--	X
	Lead	X	X	X
	Manganese	X	--	X
	Mercury	X	X	--
	Nickel	X	--	--
	Selenium	X	--	X
	Vanadium	X	--	--
	Zinc	X	--	X
Pesticides and PCBs	PCB-1254	X	--	--
VOCs	Acetone	--	--	X
SVOCs	Carbazole	X	--	--
	Dibenzofuran	X	--	--
Explosives	HMX	X	--	--
Propellants	Nitrocellulose	X	X	X

Adapted from the Final Report for the Phase I Remedial Investigation at Load Line 6 (RVAAP 33) (MKM 2007)
-- = Chemical not identified as a COPEC in this data set
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
HMX = Octahydro-1,3,5,7-tetranitroi-1,3,5,7-tetrazocane.
PBT = Persistent, bioaccumulative, and toxic.
PCB = Polychlorinated biphenyl.
RI = Remedial Investigation.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.
X = Quantitative COPEC, exceeds ESV, does not have an ESV, or is a PBT compound.

Table 7-10. Survey of Proximity to the AOC of Various Ecological Resources

Natural Resource	Natural Resources Inside Habitat Area	Proximity Within or Near the AOC	Distances to Nearest Resource of the AOC[a]
Wetlands (Planning Level Survey)	Three small medium-quality (Category 2) wetlands	At or near east, east-southeast, and southwest boundaries	Others wetlands are in vicinity of AOC (Figure 7-1)
	One small poor-quality (Category 1) wetland	At the western boundary	
	One small pond (Former Test Pond)	Near southern boundary	
Rare species	No known sightings	Identified 200 ft southwest of AOC (see text for species names)	1,700 ft N (see text for species names)
Beaver dams	None	None	1,400 ft N and 2,600 ft N
100-year floodplain	None	None	4,200 ft SW
Stream sampling[b]	None	None	Approximately 4,600 ft N
Pond sampling[b]	None	None	Approximately 2,500 ft W (Fuze and Booster Quarry Landfill Ponds)

[a] Measurements of distance and direction are taken from the nearest boundary of the AOC to the resource being measured.

[b] Stream and pond sampling refers to *Facility-wide Biological and Water Quality Study 2003* (USACE 2005b).

AOC = Area of concern.

Table 7-11. Summary of Integrated COPECs for Deep Surface Soil at the Former Production Area

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Arsenic	41	18	2.3	None
Cadmium	6.8	0.36	18.9	None
Chromium	29	26	1.1	None
Cobalt	33	13	2.5	None
Copper	627	28	22.4	Second highest ratio at about 22 X
Lead	180	11	16.4	None
Manganese	1,820	220	8.3	None
Mercury	0.6	0.00051	1,176	Highest ratio at about 1175 X
Nickel	46.6	38	1.2	None
Selenium	1.8	0.52	3.5	None
Zinc	200	46	4.4	None
HMX	0.19	No ESV	--	None
Nitrocellulose	10.1	No ESV	--	None
Carbazole	0.14	No ESV	--	None
Dibenzofuran	0.045	No ESV	--	None
4,4′-DDE	0.0024	0.021	0.11	PBT compound
PCB-1254	0.033	No ESV	--	PBT compound
PCB-1260	0.0096	No ESV	--	PBT compound

Table excludes nutrients.
-- = Not applicable, no ESV is available for comparison.
COPEC = Chemical of potential ecological concern.
DDE = Dichlorodiphenyldichloroethylene.
ESV = Ecological screening value.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
MDC = Maximum detected concentration.
mg/kg = Milligrams per kilogram.
PBT = Persistent, bioaccumulative, and toxic.
PCB = Polychlorinated biphenyl.
X = Multiplier.

Table 7-12. Summary of Integrated COPECs for Deep Surface Soil at the Non-Production Area

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Aluminum	19,000	50	380	Highest ratio at about 380 X
Arsenic	31.1	18	1.7	None
Cadmium	2.4	0.36	6.7	None
Chromium	26.7	26	1.03	None
Cobalt	17.5	13	1.4	None
Copper	85.4	28	3.1	None
Lead	117	11	10.6	None
Manganese	1,800	220	8.2	None
Mercury	0.14	0.00051	274.5	Second highest ratio at about 275 X
Selenium	2.5	0.52	4.8	None
Zinc	641	46	13.9	None

Table excludes nutrients.
-- = Not applicable, no ESV is available for comparison.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
mg/kg = Milligrams per kilogram.
X = Multiplier.

Table 7-13. Summary of Integrated COPECs in Sediment at the Former Test Pond

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of Maximum to ESV	Comments
Antimony	1.7	No ESV	--	None
Copper	91.7	31.6	2.9	Highest ratio at about 3 X
Lead	55.2	35.8	1.5	Second highest ratio at 1.5 X
Tetryl	0.031	No ESV	--	None

Table excludes nutrients.
-- = Not applicable, no ESV available.
X = Multiplier.
ESV = Ecological screening value.
COPEC = Chemical of potential ecological concern.
MDC = Maximum detected concentration.
mg/kg = Milligrams per kilogram.

Table 7-14. Summary of Integrated COPECs in Sediment at the Drainage Ditches

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of Maximum to ESV	Comments
Mercury	0.052	0.18	0.29	PBT compound

Table excludes nutrients.
-- = Not applicable, no ESV available.
ESV = Ecological screening value.
COPEC = Chemical of potential ecological concern.
MDC = Maximum detected concentration.
mg/kg = Milligrams per kilogram.
PBT = Persistent, bioaccumulative, and toxic.

Table 7-15. Summary of Integrated COPECs Based on MDCs in Surface Water at the Former Test Pond

COPEC	MDC (mg/L)	ESV (mg/L)	Ratio of Maximum to ESV	Comments
Beta-BHC	0.000044	0.000495[a]	0.09	PBT compound

[a] No Ohio EPA Administrative Code ESV (OMZM or OMZA) is available; ESV is next available in hierarchy of sources (USEPA Region 5).
Table excludes nutrients.
ESV = Ecological screening value.
COPEC = Chemical of potential ecological concern.
MDC = Maximum detected concentration.
OMZA = Ohio mixing zone average.
OMZM = Ohio mixing zone maximum.
mg/L = Milligrams per liter.
PBT = Persistent, bioaccumulative, and toxic.

Table 7-16. Summary of Integrated COPECs in Based on Average Concentrations for Surface Water at the Former Test Pond

COPEC	Average Detected Concentration* (mg/L)	ESV (mg/L)	Ratio of Average Detected Concentration to ESV	Comments
Beta-BHC	0.000044	0.000495[a]	0.09	PBT compound

[a] No Ohio EPA Administrative Code ESV (OMZM or OMZA) is available; ESV is next available in hierarchy of sources (USEPA Region 5).
Table excludes nutrients.
*Note: As only one water sample was collected from the Former Test Pond, the MDC was used as the average concentration.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
COPEC = Chemical of potential ecological concern.
mg/L = Milligrams per liter.
OMZA = Ohio mixing zone average.
OMZM = Ohio mixing zone maximum.
PBT = Persistent, bioaccumulative, and toxic.

Table 7-17. Summary of Integrated COPECs Based on MDCs for Surface Water at the Drainage Ditches

COPEC	Maximum Concentration (mg/L)	ESV (mg/L)	Ratio of Maximum to ESV	Comments
Aluminum	6.04	0.087[a]	69.4	ESV is NAWQC
Copper	0.0123	0.0093[b]	1.3	Ratio is MDC/OMZA (OMZM<1)
Lead	0.0107	0.0064[b]	1.7	Ratio is MDC/OMZA (OMZM<1)
Manganese	2.2	0.12[a]	18.3	ESV is Tier II Chronic
Nitrocellulose	0.24	No ESV	--	None

[a] No Ohio EPA Administrative Code ESV (OMZM or OMZA) is available; ESV is next available in hierarchy of sources.
[b] ESV shown is OMZA. The analyte is not a COPEC when screened against OMZM (MDC<OMZM). See Appendix H, Table H-15 for OMZM screening of this analyte.
Table excludes nutrients.
-- = Not applicable, no ESV available.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
mg/L = Milligrams per liter.
NAWQC = National ambient water quality criteria.
OMZA = Outside mixing zone average.
OMZM = Outside mixing zone maximum.

Table 7-18. Summary of Integrated COPECs Based on Average Concentrations for Surface Water at the Drainage Ditches

COPEC	Average Detected Concentration[a] (mg/L)	ESV (mg/L)	Ratio of Average Detected Concentration to ESV	Comments
Aluminum	2.64	0.087[b]	30.3	ESV is NAWQC
Lead	0.00665	0.0064	1.04	ESV is OMZA
Manganese	0.932	0.12[b]	7.8	ESV is Tier II Chronic
Nitrocellulose	0.247	No ESV	--	None

[a] Average detected concentration is the arithmetic mean of one sample from each of three locations since 30-day averages from single locations are not available.

[b] No Ohio EPA Administrative Code ESV (OMZM or OMZA) is available; ESV is next available in hierarchy of sources.

Table excludes nutrients.

-- = Not applicable, no ESV available.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
mg/L = Milligrams per liter.
NAWQC = National ambient water quality criteria.
OMZA = Outside mixing zone average.
OMZM = Outside mixing zone maximum.

Table 7-19. Application and Decisions of Selected Evaluation Factors to Integrated COPECs for Deep Surface Soil from Level II

Action	Condition for Decision to Dismiss or Retain COPEC	Outcome
Compare mean concentration to ESV	(A) Mean concentration smaller than or equal to the ESV	COPEC is not a candidate to be a final COPEC. Evaluation ceased.
	(B) Mean concentration larger than the ESV	Continue evaluation of chemical.
Compare mean concentration above ESV to background concentration	(A) Mean concentration smaller than the background concentration	COPEC is not a candidate to be a final COPEC. Evaluation ceased.
	(B) Mean concentration larger than background concentration	Continue evaluation of chemical.

COPEC = Chemical of potential ecological concern.

Table 7-20. Summary of Data for Step 3A Refinement of Integrated COPECs in Deep Surface Soil at Former Production Area

COPEC	Mean Concentration (mg/kg)	ESV (mg/kg)	Mean Concentration > ESV? (Yes/No)	Background Concentration[a] (mg/kg)	Mean Concentration > Background Concentration? (Yes/No)	ESV > Background Concentration? (Yes/No)	Frequency of Detections[b] > ESV	Frequency of Detections[b] > Background Concentration	Further Evaluation in Level II Required? (Yes/No)
COPEC with Mean Concentration < ESV									
Arsenic	12.1	18	No	15.4	No	Yes	3/73	4/73	No
Cadmium	0.235	0.36	No	0	Yes	Yes	9/18	18/18	No
Chromium	16.6	26	No	27.2	No	No	1/73	13/73	No
Cobalt	9.75	13	No	23.2	No	No	6/73	11/73	No
Nickel	21.3	38	No	60.7	No	No	1/73	14/73	No
Selenium	0.503	0.52	No	1.5	No	No	24/30	4/30	No
COPEC with Mean Concentration > ESV and Mean Concentration < Background Concentration									
Manganese	427	220	Yes	1450	No	No	67/73	1/73	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration									
Copper	29.5	28	Yes	17.7	Yes	Yes	7/73	27/73	Yes
Lead	30	11	Yes	26.1	Yes	No	65/73	26/73	Yes
Mercury	0.0467	0.00051	Yes	0.036	Yes	No	66/66	16/66	Yes
Zinc	70.4	46	Yes	61.8	Yes	No	66/73	28/73	Yes

[a] For deep surface soil, background concentration is either surface or subsurface and is determined by the depth of the maximum concentration.

[b] Frequency of detection refers to the subset of detections relative to ESV or background concentration as opposed to the standard frequency of detections of total samples taken.

COPEC = Chemical of potential ecological concern.

ESV = Ecological screening value.

mg/kg = Milligrams per kilogram.

Table 7-21. Summary of Data for Step 3A Refinement of Integrated COPECs in Deep Surface Soil at Non-Production Area

COPEC	Mean Concentration (mg/kg)	ESV (mg/kg)	Mean Concentration > ESV? (Yes/No)	Background Concentration[a] (mg/kg)	Mean Concentration > Background Concentration? (Yes/No)	ESV > Background Concentration? (Yes/No)	Frequency of Detections[b]> ESV	Frequency of Detections[b] > Background Concentration	Further Evaluation in Level II Required? (Yes/No)
COPEC with Mean Concentration < ESV									
Arsenic	11.5	18	No	15.4	No	Yes	1/23	1/23	No
Cadmium	0.157	0.36	No	0	Yes	Yes	1/4	4/4	No
Chromium	17.3	26	No	17.4	No	Yes	1/23	5/23	No
Cobalt	8.4	13	No	23.2	No	No	1/23	3/23	No
Copper	17	28	No	17.7	No	Yes	1/23	4/23	No
COPEC with Mean Concentration > ESV and Mean Concentration < Background Concentration									
Aluminum	14000	50	Yes	19500	No	No	23/23	2/23	No
Lead	19.9	11	Yes	26.1	No	No	19/23	1/23	No
Manganese	519	220	Yes	1450	No	No	19/23	1/23	No
Mercury	0.0351	0.00051	Yes	0.036	No	No	19/19	3/19	No
Selenium	1.04	0.52	Yes	1.5	No	No	16/16	8/16	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration									
Zinc	78.8	46	Yes	61.8	Yes	No	17/23	3/23	Yes

[a] For deep surface soil, background concentration is either surface or subsurface, and is determined by the depth of the maximum concentration.

[b] Frequency of detection refers to the subset of detections relative to ESV or background concentration as opposed to the standard frequency of detections of total samples taken.

COPEC = Chemical of potential ecological concern.

ESV = Ecological screening value.

mg/kg = Milligrams per kilogram.

Table 7-22. Summary of Mean Concentrations and Background Concentrations of Remaining Integrated COPECs in the Refinement Factors

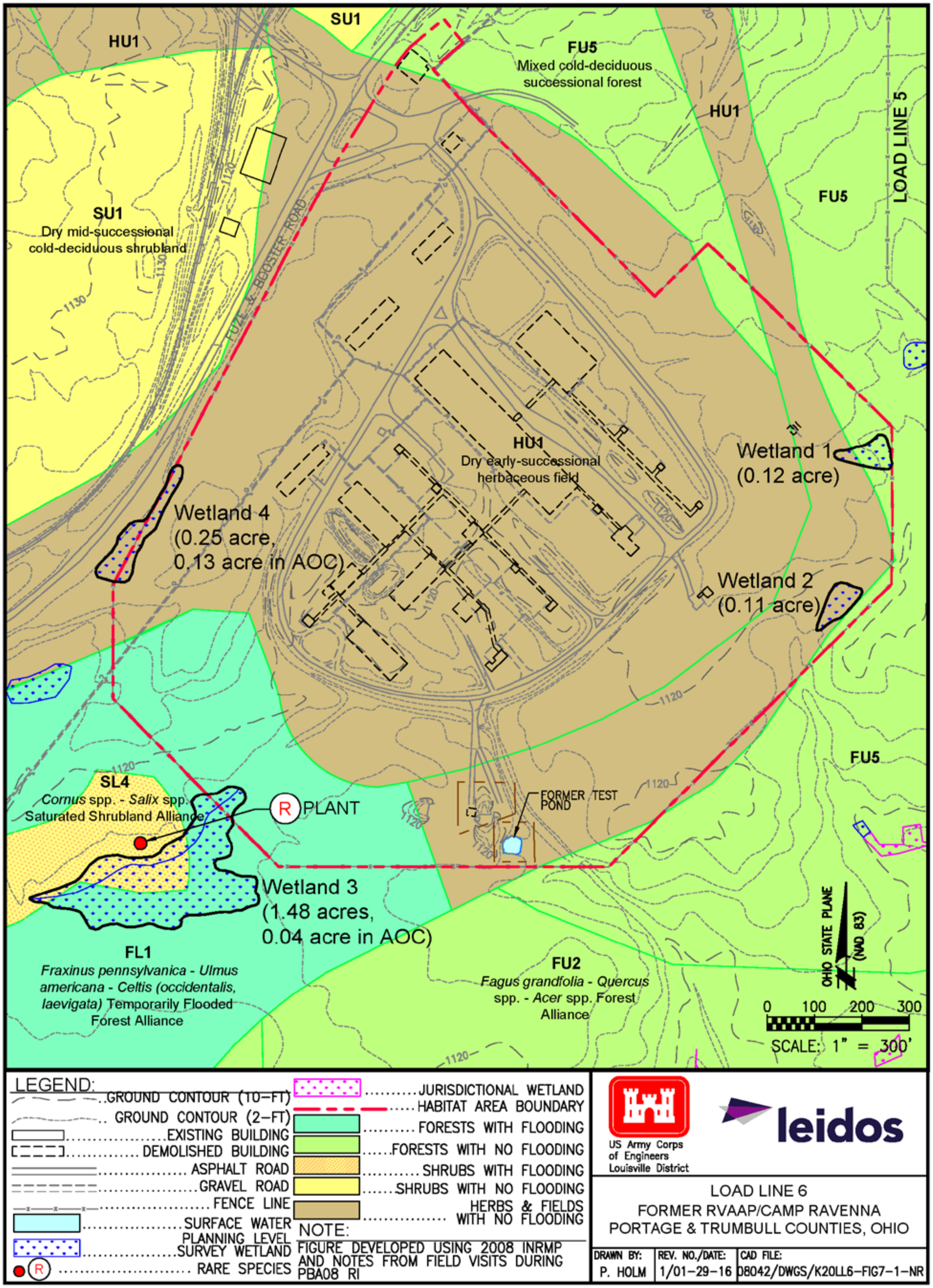
COPEC	Mean Concentration (mg/kg)	Background Concentration (mg/kg)	Ratio of Mean Concentration to Background Concentration	Qualitative Assessment of Mean to Background Concentration
Former Production Area				
Copper	29.5	17.7	1.7	Concentrations are somewhat similar
Lead	30	26.1	1.15	Concentrations are similar
Mercury	0.047	0.036	1.3	Concentrations are somewhat similar
Zinc	70.4	61.8	1.14	Concentrations are similar
Non-Production Area				
Zinc	78.8	61.8	1.3	Concentrations are somewhat similar

COPEC = Chemical of potential ecological concern.
mg/kg = Milligrams per kilogram.

Table 7-23. Comparison of Alternative ESV to Mean Concentration for Remaining Integrated COPECs

COPEC	Background Concentration (mg/kg)	Preferred ESV (mg/kg)	Alternative ESV[a] (mg/kg)	Ratio of Preferred ESV to Mean Concentration	Ratio of Alternative ESV to Mean Concentration
Former Production Area					
Copper	17.7	28	49	1.1	0.6
Lead	26.1	11	56	2.7	0.5
Mercury	0.036	0.00051	0.1[a]	91.6	0.5
Zinc	61.8	46	79	1.5	0.9
Non-Production Area					
Zinc	61.8	46	79	1.7	0.99

[a] The Alternative ESV is the ESV with the closest concentration to the preferred ESV that is above the background concentration.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
mg/kg = Milligrams per kilogram.



NOTE:
FIGURE DEVELOPED USING 2008 INRMP AND NOTES FROM FIELD VISITS DURING PBA08 RI

LOAD LINE 6
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
P. HOLM	1/01-29-16	08042/DWGS/K20LL6-FIG7-1-NR

Figure 7-1. Natural Resources Inside and Near Habitat Area at Load Line 6

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8.0 REMEDIAL INVESTIGATION CONCLUSIONS AND RECOMMENDATIONS

8.1 INTRODUCTION

This RI Report for Load Line 6 presents a detailed analysis of historical and newly acquired environmental data. The following sections summarize the major findings of the nature and extent of contamination, modeling of contaminant fate and transport, HHRA, and ERA. A CSM incorporating all available information is also presented to integrate results of prior investigations and the PBA08 RI. The CSM denotes, based on available data, where source areas occur, the mechanisms for contaminant migration from source areas to receptor media (e.g., surface water and groundwater), exit pathways from the AOC, and whether COCs occur that may require further evaluation in an FS. This section presents the need for any further characterization of the media evaluated under the RI phase of work and whether to proceed to the FS phase of the CERCLA RI/FS process.

8.2 SUMMARY OF DATA USED IN THE REMEDIAL INVESTIGATION

Quality-assured sample data from the 2002 lead azide screening, 2003 Phase I RI, 2010 PBA08 RI, and 2011/2012 Former Test Pond investigations were used to evaluate nature and extent of contamination at Load Line 6. These investigations used discrete sampling methods.

All available sample data collected at the locations were evaluated to determine suitability for use in various key RI data screens and evaluations (i.e., nature and extent, fate and transport, risk assessment). Evaluating the data’s suitability for use in the PBA08 RI involved two primary considerations: (1) whether the data represented current AOC conditions, and (2) sample collection methods (e.g., discrete vs. ISM).

Samples from the 2002 lead azide screening and 2003 Phase I RI were evaluated to determine if conditions had changed substantively between earlier characterization efforts and the 2010 PBA08 RI. In May 2002, thermal decontamination and 5X certification of all buildings at Load Line 6 took place, with the exception of Buildings 2F-4, 2F-7, 2F-8, and 2F-9 (MKM 2007). These four buildings were demolished conventionally in July 2005 and the footers and floor slabs were removed in 2006 and 2007 after the Phase I RI field activities. Samples potentially affected by these demolition activities were surface and subsurface soil locations LL6ss-006, LL6ss-013, LL6ss-016; surface soil sample LL6ss-018; and subsurface sample LL6ss-039. The surface and subsurface samples in proximity to the buildings that were later demolished were not omitted from the SRC screen and were classified as part of the FPA. Therefore, these data sets were considered representative of current conditions within and surrounding the footprints of the former buildings at Load Line 6.

Data collected in 2010 as part of the PBA08 RI focused on delineating the extent of contaminants identified in surface soil (0–1 ft bgs), subsurface soil (1-13 ft bgs), sediment, and surface water. The PBA08 RI sampled locations with the greatest likelihood of contamination (e.g., adjacent to production buildings or within sediment accumulation areas, such as ditches) and analyzed for chemicals identified in historical investigations.

8.3 SUMMARY OF NATURE AND EXTENT

8.3.1 Soil

Data from the 2002 lead azide screening, 2003 Phase I RI, and 2010 PBA08 RI were used to identify SRCs at Load Line 6, and data from samples collected in 2011 and 2012 were used to provide additional assessment of the Former Test Pond. Collectively, this data set effectively characterizes the nature and extent of the contamination at the AOC. To support the evaluation of nature and extent of contamination, SRC concentrations were compared to SLs corresponding to the lowest FWCUG for the Resident Receptor (Adult and Child) and National Guard Trainee at a target HQ of 0.1 or TR of 1E-06, as presented in the FWCUG Report. If there was no FWCUG for a chemical, the USEPA RSL was used as the SL. Based on the information provided earlier in this section and the summary below, it can be concluded that the vertical and horizontal extent of contamination is defined, and no further sampling is needed to evaluate Load Line 6.

Locations where explosives were identified as potential contaminants from previous use were thoroughly evaluated, including around former process buildings and across each EU. The maximum concentrations of explosives and propellants were all below their respective SLs and were not considered COPCs. In addition, the 2002 lead azide screening had field tests conducted for TNT and RDX using the Jenkins method. No explosives were detected above SLs in any of the surface soil, sediment, or surface water samples.

As identified in the Phase I RI Report, concentrations of contaminants are generally low. No apparent spatial trend in the distribution of inorganic chemicals throughout the AOC is evident. Inorganic chemicals, specifically arsenic and manganese concentrations, detected across the entire AOC were generally higher in samples taken from the FPA.

Seven inorganic chemicals (antimony, arsenic, barium, cadmium, chromium, lead, and mercury) were identified as potential inorganic SRCs and as potentially related to previous AOC operations. When evaluating these chemicals against their SLs (using the trivalent chromium FWCUG for chromium and the RSL of 400 mg/kg for lead), antimony, barium, chromium, lead, and mercury concentrations were all below their SLs; therefore, these chemicals were not considered COPCs for the FPA or NPA. Arsenic and cadmium are the only inorganic chemicals potentially related to previous AOC operations that are considered COPCs in surface soil at the FPA and NPA.

Arsenic is considered a COPC in surface soil at the FPA and NPA, with an MDC of 41 mg/kg at sample location LL6sb-007. However, subsurface soil was below the SL at this location. Arsenic was detected above its background concentration (19.8 mg/kg) in 2 of 38 subsurface samples, with an MDC of 26 mg/kg observed at 6–8 ft bgs at sample location LL6sb-033, which is adjacent to former Building 2F-11. This boring, installed in 2003, did not have a deeper sample; therefore, an additional boring (LL6sb-071) was installed in 2010 to fill this data gap. The arsenic concentration in the 4-7 ft bgs sample interval from sample location LL6sb-071 was 10.2 mg/kg, which is well below the subsurface background concentration.

Cadmium was not identified as a COPC in the NPA. Cadmium had one detection above the FWCUG at a TR of 1E-06, HQ of 0.1 (6.41 mg/kg) in 1 of 44 samples collected in the FPA, with an MDC of 6.8 mg/kg at sample location LL6sb-002. However, subsurface soil was below the SL at this location and throughout the FPA and NPA.

Manganese had a single detection above the background concentration of 1,450 mg/kg, with an MDC of 1,820 mg/kg at sample location LL96ss-078. This sample location is in the southern portion of the FPA along the road, which exceeded the National Guard Trainee FWCUG at a TR of 1E-05, HQ of 1 (351 mg/kg). Another isolated exceedance at a similar concentration was observed in the NPA at sample location LL6sb-032, the suspected test range. However, manganese was detected below the SL in subsurface soil at this location.

None of the detected concentrations of SVOCs, VOCs, pesticides, or PCBs in surface or subsurface soil were above the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Building 2F-35 was the only building at Load Line 6 whose purpose was solvent storage. The sample associated with former Building 2F-35 (LL6sb-014) had no detectable concentrations of VOCs in soil. A Suspect VOC Disposal Pit to the east of this building was assessed during the Phase I RI. Of the 10 borings installed to assess this area, none of the borings had VOCs detected during the field screening. Also, of the four samples sent to the analytical laboratory, none had detections of TPH (DRO and GRO) or VOCs. The only SVOC detected was at LL6sb-049 with an estimated concentration of 0.02J mg/kg of di-n-octylphthalate. Thus, no evidence of VOC contamination is present from the Suspect VOC Disposal Pit.

8.3.2 Sediment and Surface Water

The Drainage Ditches EU was evaluated with two sediment and three surface water samples. No explosives or propellants were detected in the Drainage Ditches sediment samples. Nitrocellulose and HMX were detected at low, estimated concentrations at sample location LL6sw-082 in the Drainage Ditches surface water. Both concentrations were below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. No sediment or surface water concentrations for metals in the Drainage Ditches samples exceeded the RSL at a TR of 1E-05, HQ of 1 except for the surface water concentration for cobalt at LL6sw-082. No SVOCs were identified as SRCs in the Drainage Ditches sediment samples, and only one SVOC (4-methylphenol) was identified as an SRC in surface water samples at the Drainage Ditches. 4-Methylphenol had a concentration below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1. No VOCs, pesticides, or PCBs were identified as SRCs in the Drainage Ditches sediment samples, and only one VOC (acetone) was identified as an SRC in surface water samples at the Drainage Ditches. The concentration of acetone was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1.

The Former Test Pond was assessed with one co-located sediment and surface water sample (LL6sd/sw-084) collected during the 2010 PBA08 RI, two sediment samples (FTFsd-002-SD and FTFsd-003-SD) and one surface water sample (FTFsw-001-0001-SW) collected in August 2011 during the MMRP RI, and one sediment sample (LL6sd-096-5870-SD) and surface water sample

(LL6sw-096-5871-SW) collected in August 2012. One explosive (tetryl) was detected in sediment at sample location LLsd-084 at an estimated concentration of 0.031J mg/kg. This detection was below the RSL at a TR of 1E-06, HQ of 0.1, and is, therefore, not considered a COPC. One explosive (HMX) was detected in surface water at sample location LLsw-084 at an estimated concentration of 0.000062J mg/L collected from the Former Test Pond. This detection was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1, and is, therefore, not considered a COPC. None of the samples collected in 2011 or 2012 had detections of explosives or propellants. No sediment or surface water concentration for metals at the Former Test Pond exceeded the RSL at a TR of 1E-05, HQ of 1.

Surface water and wet sediment samples were collected at potential exit points from the Fuze and Booster Hill area (which includes Load Lines 5 through 11) and near the southern boundary of RVAAP/Camp Ravenna to determine nature and extent. Four surface water and co-located composite wet sediment samples were collected from these areas in order to characterize current conditions and assess potential exit pathways from the area. This report provides an evaluation of two of these samples (FWSsd/sw-101 and FWSsd/sw-103) that are south and southeast of Load Line 6. No explosives or propellants were detected in these sediment samples. HMX was detected in both surface water samples and RDX was detected at FWSsw-103 at concentrations well below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-06, HQ of 0.1. No sediment or surface water concentration for metals at FWSsd/sw-101 and FWSsd/sw-103 exceeded the RSL at a TR of 1E-05, HQ of 1. No PCBs were detected in sediment or surface water samples and only low, estimated concentrations of toluene at 0.00041J mg/kg in sediment at FWS-103 and gamma-chlordane at 0.000048J mg/L at FWS-101 were detected. All other SVOCs, VOCs and pesticides had non-detectable concentrations.

8.4 SUMMARY OF CONTAMINANT FATE AND TRANSPORT

All SRCs identified in surface soil, subsurface soil, and sediment at Load Line 6 were evaluated through the stepwise contaminant fate and transport evaluation. The evaluation included analyzing leaching and migration from soil and sediment to groundwater, and determining whether contamination is present in soil and sediment may potentially impact groundwater quality at the site.

Maximum concentrations of SRCs identified in surface and subsurface soil were evaluated using a series of generic screening steps to identify initial CMCOPCs. Initial CMCOPCs for soil were further evaluated using SESOIL to predict leaching concentrations and identify final CMCOPCs based on RVAAP facility-wide background concentrations and the lowest risk-based screening criteria among USEPA MCLs, USEPA tap water RSLs, or RVAAP groundwater FWCUGs for the Resident Receptor (Adult). A sediment screening analysis was performed for sediment samples at the AOC. Chemical-specific DAFs were calculated using co-located surface water and sediment concentrations for identified sediment SRCs. These DAFs were used in the sediment screening analysis to identify the final CMCOPCs based on RVAAP facility-wide background concentrations and the lowest risk-based screening criteria. Final CMCOPCs were evaluated using AT123D to predict groundwater concentrations beneath source areas and at the nearest downgradient groundwater receptor to the AOC (e.g., stream).

Evaluation of modeling results with respect to current AOC groundwater data and model limitations identified the following CMCOPCs:

- Selenium and naphthalene among the soil CMCOPCs were predicted to exceed the screening criteria in groundwater beneath the source area. Neither of these CMCOPCs was predicted to be above their criteria at the downgradient receptor location.
- No final sediment CMCOPCs were identified.

A qualitative assessment of the sample results and considerations of the limitations and assumptions of the models were performed to identify if any CMCOCs are present in soil and sediment at Load Line 6 that may impact the groundwater beneath the source or at the downstream receptor location. This qualitative assessment concluded that there were no CMCOCs present in soil and sediment that may impact the groundwater beneath the source or at the downstream receptor location. No further action is required of soil and sediment at Load Line 6 for the protection of groundwater.

8.5 SUMMARY AND CONCLUSIONS OF THE HUMAN HEALTH RISK ASSESSMENT

The HHRA did not identify any COCs that pose unacceptable risk to the Resident Receptor (Adult and Child). Because there is no unacceptable risk to the Resident Receptor, it can be concluded that there is no unacceptable risk to the National Guard Trainee and Industrial Receptor.

Media of concern at Load Line 6 are surface soil, subsurface soil, surface water, and sediment. Soil data associated with Load Line 6 were aggregated into surface and subsurface soil at the FPA and NPA. Sediment and surface water data were aggregated and evaluated separately at the Drainage Ditches and the Former Test Pond.

No COCs were identified for the Resident Receptor (Adult and Child) in any of the media of concern; therefore, no other receptors were evaluated, and no further action is recommended from a human health risk perspective.

8.6 SUMMARY AND CONCLUSIONS OF THE ECOLOGICAL RISK ASSESSMENT

The ERA Level I presents important ecological resources on or near the AOC and evaluates the potential for current contamination to impact ecological resources. There is chemical contamination present in soil, sediment, and surface water at Load Line 6. This contamination was identified using historical and PBA08 RI data. Various forest and other ecological resources were observed on the 43 acres of the AOC. There are important and significant ecological resources in the AOC. Specifically, wetlands and surface water (e.g., a small test pond) are present and near contamination. These findings invoked a requirement of a Level II ERA.

The Level II ERA evaluated soil, sediment, and surface water COPECs. A total of 19 integrated COPECs were identified for soil. Five integrated COPECs were identified for sediment. Five integrated COPECs were identified for surface water. The integrated soil, sediment, and surface water COPECs were further evaluated with technical and refinement factors in Step 3A. The factors in Step

3A showed there are no integrated COPECs that are of ecological concern requiring remediation or further evaluation. Consequently, the Level II Screening ERA concluded that no further action is necessary to be protective of ecological resources.

8.7 UPDATED CONCEPTUAL SITE MODEL

An initial CSM was provided in the Phase I RI Report (MKM 2007). This CSM is updated in this section to incorporate results of the PBA08 RI and any new determinations made in this report. Elements of this updated CSM include:

- Primary and secondary contaminant sources and release mechanisms.
- Contaminant migration pathways and discharge or exit points.
- Potential receptors with unacceptable risk. and
- Data gaps and uncertainties.

The following sections describe each of the above elements of the CSM for Load Line 6; the CSM is presented on Figure 8-1. In addition, figures contained in earlier sections of the report that illustrate AOC features, topography, groundwater and surface water flow directions, and the nature and extent of SRCs are cited to assist in visualizing key summary points of the revised CSM.

8.7.1 Primary and Secondary Contaminant Sources and Release Mechanisms

No primary contaminant sources (e.g., operational facilities or retention basins) remain at Load Line 6, with the exception of the Former Test Pond. Operations to support World War II ceased in 1945, and the Firestone Tire and Rubber Company discontinued use of the site for research in the late 1970s. As of July 2007, all buildings have either been thermally demolished or demolished by conventional practices, and the footers and floor slabs have been removed. Remnant infrastructure at Load Line 6 consists only of the perimeter road that surrounds the FPA, the test chamber foundation and concrete blocks around the small Former Test Pond, and Former Test Pond itself. Remnant contamination in soil is considered a secondary source of contamination.

The Former Test Pond had only one inorganic chemical (cobalt) detected above its background and screening criteria at a concentration of 11.7 mg/kg. This concentration was less than the RSL at a TR of 1E-05, HQ of 1. No surface water COPCs were identified. Only one explosive (tetryl) was detected in sediment at sample location LLsd-084 at an estimated concentration of 0.031J mg/kg. This detection was below the RSL at a TR of 1E-06, HQ of 0.1, and is, therefore, not considered a COPC. None of the samples collected in 2011 or 2012 had detections or explosives or propellants. No explosives or propellants were detected in any surface water samples.

The evaluation of contaminant nature and extent indicated potential secondary sources of contamination in soil at Load Line 6. Locations where explosives were identified as potential contaminants from previous use were thoroughly evaluated, including around former process buildings and across each EU. The maximum concentrations of explosives and propellants were all below their respective SLs and were not considered COPCs. In addition, the 2002 lead azide screening had field tests conducted for TNT and RDX using the Jenkins method.

As identified in the Phase I RI Report, concentrations of contaminants are generally low. No apparent spatial trend in the distribution of inorganic chemicals throughout the AOC is evident. Inorganic chemicals, specifically arsenic and manganese concentrations, detected across the entire AOC were generally higher in samples taken from the FPA. Arsenic is considered a COPC in surface soil at the FPA and NPA, with an MDC of 41 mg/kg at sample location LL6sb-007. However, subsurface soil was below the SL at this location. Arsenic was detected above its background concentration (19.8 mg/kg) in 2 of 38 subsurface samples, with an MDC of 26 mg/kg observed at 6–8 ft bgs at sample location LL6sb-033, which is adjacent to former Building 2F-11.

Building 2F-35 was the only building at Load Line 6 whose purpose was solvent storage. The sample associated with former Building 2F-35 (LL6sb-014) had no detectable concentrations of VOCs in soil. A Suspect VOC Disposal Pit to the east of this building was assessed during the Phase I RI. Of the 10 borings installed to assess this area, none of the borings had VOCs detected during the field screening. Thus, no evidence of contamination is present from the Suspect VOC Disposal Pit.

The primary mechanisms for release of contaminants from secondary sources at Load Line 6 are:

- Eroding soil matrices with sorbed contaminants and mobilization in overland surface water storm runoff during heavy rainfall conditions,
- Dissolving soluble contaminants and transport in intermittent surface water runoff, and
- Leaching contaminants to groundwater.

8.7.2 Contaminant Migration Pathways and Exit Points

8.7.2.1 Surface Water Pathways

Surface water at Load Line 6 occurs intermittently as storm water runoff within natural and constructed drainage ditches or conveyances. Migration of contaminants from soil sources via surface water occurs primarily by: (1) movement of the particle-bound contaminants in surface water runoff, and (2) transport of dissolved constituents in surface water. In the case of particle-bound contaminant migration, contaminants will be mobilized during periods of high flow (e.g., rain events). Upon reaching portions of surface water conveyances where flow velocities decrease, they will settle out as sediment accumulation. Sediment-bound contaminants may become re-suspended and migrate during storm events or may partition to a dissolved phase in surface water.

In the case of particle-bound contaminant migration, contaminants will be mobilized during periods of high flow (e.g., rain events). Upon reaching the lowest elevation of the AOC where temporary ponding of water may occur, the particulates will settle out as sediment accumulation. Re-suspension and migration of sediment-bound contaminants from the low points in the AOC would not occur.

Dissolved phase contaminant migration in surface water is relevant with respect to leaching processes to groundwater at the Former Test Pond. Also, temporary ponding of surface water runoff in the lowest points of the AOC is likely during heavy rainfall events or periods of snowmelt; however, visual observations during various investigations have not indicated evidence of long-term standing water. Infiltration rates and evapotranspiration processes appear sufficiently high to prevent long-term water retention.

8.7.2.2 Groundwater Pathways

The estimated direction of groundwater flow at the AOC is to the east and southeast. This reflects the January 2010 facility-wide potentiometric data presented in the *Facility-wide Groundwater Monitoring Program Report on the January 2010 Sampling Event* (EQM 2010). Water level elevations at the AOC range from 1105.36–1107.58 ft amsl, with the highest elevation occurring at LL6mw-006. Potentiometric data indicate the groundwater table occurs within the unconsolidated zone throughout the AOC. Groundwater discharge to surface water features (e.g., via base flow to streams or springs) does not occur within the AOC boundary. Rather, the closest potential groundwater discharge locations are an unnamed tributary to the Mahoning River approximately 1,100 ft to the southeast.

The FWGWMP was initiated in 2005 and involves quarterly sampling of selected wells within the former RVAAP. Between 2009 and 2014, several different sampling events under the FWGWMP collected groundwater data at Load Line 6.

Contaminant leaching pathways from soil to the water table are through silt clay loam to clay loam tills with interbedded sands scattered throughout, with an overall hydraulic conductivity average of 4.47E-03 cm/s. Conservative transport modeling indicates two chemicals (i.e., selenium and naphthalene) may leach from soil and migrate to the groundwater table at concentrations exceeding MCLs/RSLs beneath their respective sources; however, neither chemical is predicted to migrate laterally and reach the nearest surface water receptor (i.e., unnamed tributary to the Mahoning River at a distance ranging between 1,100–2,000 ft) at concentrations exceeding MCLs/RSLs. These chemicals were not detected in AOC groundwater samples collected from 2009–2010; therefore, this evaluation concludes that the model-predicted concentrations are conservative. A qualitative assessment of the sample results was performed and the limitations and assumptions of the models were considered to identify if any CMCOCs are present in soil at Load Line 6 that may potentially impact groundwater at Load Line 6. This qualitative assessment concluded that CMCOCs are not adversely impacting groundwater quality based on current data and are not predicted to have future impacts. No further action is required of soil to be protective of groundwater.

8.7.2.3 Sewer System

The sewers within the perimeter of Load Line 6 are being investigated and assessed as part of the Facility-wide Sewers AOC (RVAAP-67). Storm sewers are not present at Load Line 6. While cracks and joint separations within the sanitary sewer system have been observed due to the advanced age of the system, the pipes are generally intact, which limits vertical migration from sewer sediment to the exterior of the piping system.

The compiled data provided effective characterization of the nature and extent of the contamination at the Load Line 6 FA, and no further sampling was recommended. All SRCs found in the subsurface sewer media samples within the Load Line 6 FA were evaluated through the stepwise fate and transport screening evaluation and were eliminated as posing future impacts to groundwater. The HHRA did not identify COCs at the Load Line 6 FA for the National Guard Trainee or Resident Receptor (Adult and Child). Since the Load Line 6 FA has no sewer outfalls, no further action was recommended from an ecological perspective (USACE 2012a).

8.7.3 Potential Receptors

In February 2014, the Army and Ohio EPA amended the risk assessment process to address changes in the RVAAP restoration program. The Technical Memorandum identified three Categorical Land Uses and Representative Receptors to be considered during the RI phase of the CERCLA process. These three Land Uses and Representative Receptors are presented below.

1. Unrestricted (Residential) Land Use – Resident Receptor (Adult and Child) (formerly called Resident Farmer).
2. Military Training Land Use – National Guard Trainee.
3. Commercial/Industrial Land Use – Industrial Receptor (USEPA Composite Worker).

Unrestricted (Residential) Land Use is considered protective for all three Land Uses at Camp Ravenna. Therefore, if an AOC meets the requirements for Unrestricted (Residential) Land Use, the AOC is also considered to have met the requirements of the other Land Uses (i.e., Commercial/Industrial and Military Training), and the other Land Uses do not require evaluation. The HHRA identified did not identify Resident Receptor COCs to be carried forward for potential remediation; therefore, Load Line 6 is considered protective for all potential human health receptors.

Camp Ravenna has a diverse range of vegetation and habitat resources. Habitats present within the facility include large tracts of closed-canopy hardwood forest, scrub/shrub open areas, grasslands, wetlands, open-water ponds and lakes, and semi-improved administration areas. An abundance of wildlife is present on the facility: 35 species of land mammals, 214 species of birds, 41 species of fish, and 34 species of amphibians and reptiles have been identified. The ERA Level I presents important ecological resources on or near the AOC and evaluates the potential for current contamination to impact ecological resources. There is chemical contamination present in soil, sediment, and surface water at Load Line 6, and there are important and significant ecological resources in the AOC. The Level II ERA and the factors in Step 3A showed there are no integrated COPECs that are of ecological concern requiring remediation or further evaluation. Consequently, the Level II Screening ERA concluded that no further action is necessary to be protective of ecological resources.

8.7.4 Uncertainties

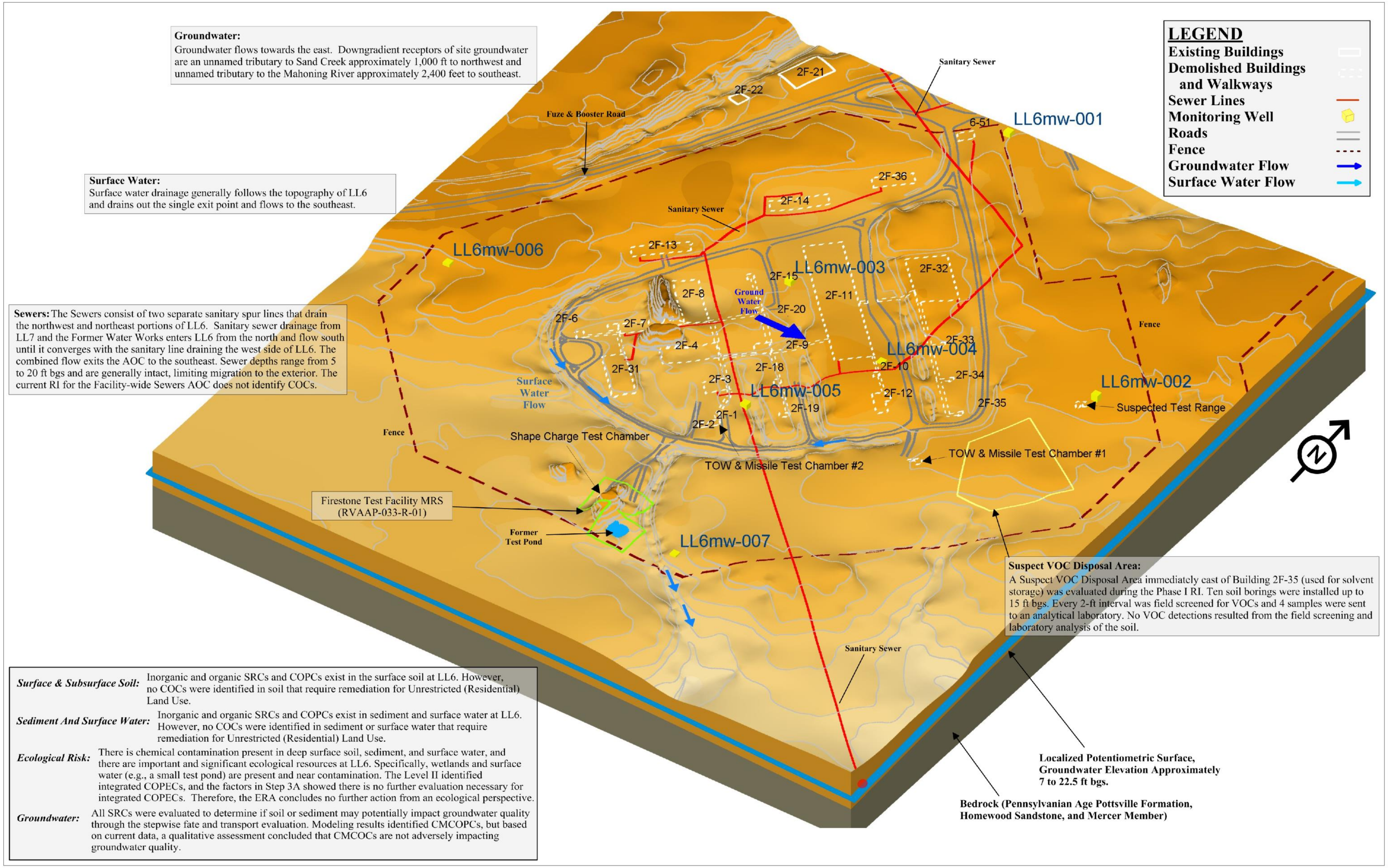
Uncertainties are inherent in the CSM depending on the density and availability of data. The CSM for Load Line 6 is overall well defined using existing data, and major data gaps do not remain to be resolved. However, some uncertainties for the CSM for the Load Line 6 include:

- Surface water characterization within the drainage ditches on the AOC is subject to some uncertainty due to the intermittent occurrence of surface water originating within the AOC during precipitation events. Discharge of surface water from the AOC is generally via ditches at the AOC.
- Removing primary contaminant sources (e.g., buildings), grading, and continuing vegetation succession within those areas likely have resulted in a lower overall degree of soil erosion and contaminant migration from the former operations area.
- While this RI addresses soil, sediment, and surface water, additional ongoing investigations are being conducted for the Facility-wide Groundwater and Facility-wide Sewers AOCs.

8.8 RECOMMENDATION OF THE REMEDIAL INVESTIGATION

Based on the investigation results, Load Line 6 has been adequately characterized and the recommended path forward is no further action for soil, sediment, and surface water to attain Unrestricted (Residential) Land Use. Further investigation is not warranted at this AOC for the following reasons: (1) the nature and extent of impacted media has been sufficiently characterized; (2) the fate and transport modeling did not identify soil CMCOCs requiring further evaluation or remediation to protect groundwater; (3) there are no CERCLA release-related human health COCs identified in soil, sediment, or surface water requiring further evaluation in an FS or remediation; and (4) remedial actions to protect ecological resources are not warranted.

The next step in the CERCLA process is to prepare a PP to solicit public input with respect to no further action for soil, sediment, and surface water. The PP will briefly summarize the history, characteristics, risks, and the basis for no further action. Comments on the PP received from state and federal agencies and the public will be considered in preparation of a ROD to document the final remedy. The ROD will also include a responsiveness summary addressing comments received on the PP.



Groundwater:
Groundwater flows towards the east. Downgradient receptors of site groundwater are an unnamed tributary to Sand Creek approximately 1,000 ft to northwest and unnamed tributary to the Mahoning River approximately 2,400 feet to southeast.

Surface Water:
Surface water drainage generally follows the topography of LL6 and drains out the single exit point and flows to the southeast.

Sewers: The Sewers consist of two separate sanitary spur lines that drain the northwest and northeast portions of LL6. Sanitary sewer drainage from LL7 and the Former Water Works enters LL6 from the north and flow south until it converges with the sanitary line draining the west side of LL6. The combined flow exits the AOC to the southeast. Sewer depths range from 5 to 20 ft bgs and are generally intact, limiting migration to the exterior. The current RI for the Facility-wide Sewers AOC does not identify COCs.

Suspect VOC Disposal Area:
A Suspect VOC Disposal Area immediately east of Building 2F-35 (used for solvent storage) was evaluated during the Phase I RI. Ten soil borings were installed up to 15 ft bgs. Every 2-ft interval was field screened for VOCs and 4 samples were sent to an analytical laboratory. No VOC detections resulted from the field screening and laboratory analysis of the soil.

Surface & Subsurface Soil: Inorganic and organic SRCs and COPCs exist in the surface soil at LL6. However, no COCs were identified in soil that require remediation for Unrestricted (Residential) Land Use.

Sediment And Surface Water: Inorganic and organic SRCs and COPCs exist in sediment and surface water at LL6. However, no COCs were identified in sediment or surface water that require remediation for Unrestricted (Residential) Land Use.

Ecological Risk: There is chemical contamination present in deep surface soil, sediment, and surface water, and there are important and significant ecological resources at LL6. Specifically, wetlands and surface water (e.g., a small test pond) are present and near contamination. The Level II identified integrated COPECs, and the factors in Step 3A showed there is no further evaluation necessary for integrated COPECs. Therefore, the ERA concludes no further action from an ecological perspective.

Groundwater: All SRCs were evaluated to determine if soil or sediment may potentially impact groundwater quality through the stepwise fate and transport evaluation. Modeling results identified CMCOPCs, but based on current data, a qualitative assessment concluded that CMCOCs are not adversely impacting groundwater quality.

Localized Potentiometric Surface, Groundwater Elevation Approximately 7 to 22.5 ft bgs.

Bedrock (Pennsylvanian Age Pottsville Formation, Homewood Sandstone, and Mercer Member)

Figure 8-1. Load Line 6 CSM

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9.0 AGENCY COORDINATION AND PUBLIC INVOLVEMENT

The Army is the lead agency responsible for executing the CERCLA process and ultimately completing an approved ROD for soil, sediment, and surface water at Load Line 6. This section reviews actions that have been conducted and presents activities that are planned to ensure the regulatory agencies and members of the public have been provided with appropriate opportunities to stay informed of the progress of the Load Line 6 environmental investigation and final selection of a remedy.

9.1 STATE ACCEPTANCE

State acceptance considers comments received from agencies of the state of Ohio on the recommendation for no further action. Ohio EPA is the lead regulatory agency for supporting remedy of soil, sediment, and surface water at Load Line 6. This RI Report has been prepared in consultation with Ohio EPA.

Ohio EPA has provided input during the ongoing investigation and report development to ensure the remedy ultimately selected for Load Line 6 is protective of human health and the environment and fulfills the requirements of the DFFO (Ohio EPA 2004). Ohio EPA will provide comments on this RI Report and the subsequent PP and ROD. The Army will obtain Ohio EPA concurrence prior to the final selection of the remedy for soil, sediment, and surface water at the AOC.

9.2 COMMUNITY ACCEPTANCE

Community acceptance considers comments provided by community members. CERCLA 42 U.S.C. 9617(a) emphasizes early, constant, and responsive community relations. The Army has prepared a *Community Relations Plan for the Ravenna Army Ammunition Plant Restoration Program* (Vista 2015) to facilitate communication between the former RVAAP and the community surrounding Ravenna, Ohio during environmental investigations and potential remedial action. The plan was developed to ensure the public has convenient access to information regarding project progress. The community relations program interacts with the public through news releases, public meetings, public workshops, and Restoration Advisory Board meetings with local officials, interest groups, and the general public.

CERCLA 42 U.S.C. 9617(a) requires an Administrative Record to be established “at or near the facility at issue.” Relevant documents regarding the former RVAAP have been made available to the public for review and comment.

The Administrative Record for this project is available at the following location:

Camp Ravenna
Environmental Office
1438 State Route 534 SW
Newton Falls, OH 44444

Access to Camp Ravenna is restricted but can be obtained by contacting the environmental office at (614) 336-6136. In addition, an Information Repository of current information and final documents is available to any interested reader at the following libraries:

Reed Memorial Library
167 East Main Street
Ravenna, Ohio 44266

Newton Falls Public Library
204 South Canal Street
Newton Falls, Ohio 44444-1694

Additionally, there is an online resource for restoration news and information. This website is available at: www.rvaap.org.

Comments will be received from the community upon issuing the RI Report and PP. As required by the CERCLA regulatory process and the Community Relations Plan (Vista 2015), the Army will hold a public meeting and request public comments on the PP for Load Line 6. These comments will be considered prior to the final selection of a remedy. Responses to these comments will be addressed in the responsiveness summary of the ROD.

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