Revised Draft

Remedial Investigation Report for Soil, Sediment, and Surface Water at RVAAP-41 Load Line 8

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

Contract No. W912QR-15-C-0046

Prepared for:

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U.S. Army Corps of Engineers
Louisville District

Prepared by:

leidos

Leidos
8866 Commons Boulevard, Suite 201
Twinsburg, Ohio 44087

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6. AUTHOR(S)

Sprinzl, Richard, E.
Johnson, Jamie, R.
Khan, Alauddin, PhD
Barta, Michael, L.
Robers, Sharon, K.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Leidos
8866 Commons Boulevard
Suite 201
Twinsburg, Ohio 44087

8. PERFORMING ORGANIZATION REPORT NUMBER

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USACE - Louisville District
U.S. Army Corps of Engineers
600 Martin Luther King Jr., Place
PO Box 59
Louisville, Kentucky 40202-0059

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14. ABSTRACT

This Remedial Investigation Report for Load Line 8 presents physical characteristics, geology, and hydrogeology of Load Line 8; 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 8 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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a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Nathaniel Peters, II
U	U	U	U	31014	**19b. TELEPHONE NUMBER** *(Include area code)* 502.315.2624

CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Leidos has completed the Revised Draft Remedial Investigation Report for Soil, Sediment, and Surface Water at RVAAP-41 Load Line 8 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.

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

5/10/16
Date

Selvam Arunachalam, P.E.
Independent Technical Review Team Leader

5/10/16
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.

Lisa Jones-Bateman
Senior Program Manager

5/10/16
Date

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ARNG = Army National Guard.
CO = Central Office.
DERR = Division of Environmental Response and Revitalization.
ILE = Installation, Logistics, and Environment.
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

amsl	above mean sea level
AOC	Area of Concern
Army	U.S. Department of the Army
AT123D	Analytical Transient 1-,2-,3-Dimensional
bgs	below ground surface
BHC	Hexachlorocyclohexane
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
CSEM	Conceptual Site Exposure Model
CSM	Conceptual Site Model
DAF	Dilution Attenuation Factor
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DERR	Division of Environmental Response and Revitalization
DFFO	Director’s Final Findings and Orders
DNT	Dinitrotoluene
DQO	Data Quality Objective
EcoSSL	Ecological Soil Screening Level
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ERS	Ecological Risk Screening
ESV	Ecological Screening Value
EU	Exposure Unit
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 Assessor Manual
FWSAP	Facility-wide Sampling and Analysis Plan
gpm	gallons per minute
GSSL	Generic Soil Screening Level
HELP	Hydrologic Evaluation of Landfill Performance
HHRA	Human Health Risk Assessment

HHRS	Human Health Risk Screening
HLC	Henry’s Law Constant
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane
HQ	Hazard Quotient
ILCR	Incremental Lifetime Cancer Risk
INRMP	Integrated Natural Resources Management Plan
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
ISM	Incremental Sampling Methodology
K_d	soil/water partitioning coefficient
K_ds	distribution coefficients
K_{oc}	water/organic carbon partition coefficient
K_{ow}	octanol-water partition coefficient
MCL	Maximum Contaminant Level
MDC	Maximum Detected Concentration
MDL	Maximum Detection Limit
MEC	Munitions or Explosives of Concern
MI	Multi-increment
NCP	National Contingency Plan
NPA	Non-production Area
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
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
PRG	Preliminary Remediation Goal
QA	Quality Assurance
QC	Quality Control
R	Retardation Factor
RDA	Recommended Daily Allowance
RDI	Recommended Daily Intake
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
REIMS	Ravenna Environmental Information Management System
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
SESOIL	Seasonal Soil Compartment
SL	Screening Level
SOR	Sum-of-Ratios
SRC	Site-related Contaminant
SRV	Sediment Reference Value
SSL	Soil Screening Level
SSSL	Site-Specific Soil Screening Level
SVOC	Semi-volatile Organic Compound
TAL	Target Analyte List
TNT	2,4,6-Trinitrotoluene
TR	Target Risk
UCL	Upper Confidence Limit
URF	Unit Risk Factor
USACE	U.S. Army Corps of Engineers
USACHPPM	United States Army Center for Health Promotion and Preventive Medicine
USATHAMA	United States Army Toxic and Hazardous Materials Agency
USEPA	U.S. Environmental Protection Agency
USP&FO	U.S. Property and Fiscal Officer
VOC	Volatile Organic Compound
WOE	Weight-of-Evidence

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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 report replaces the *Draft Remedial Investigation Report for Soil, Sediment, and Surface Water at RVAAP-41 Load Line 8*, dated March 15, 2012, originally submitted to Ohio Environmental Protection Agency (Ohio EPA). This Remedial Investigation (RI) Report addresses soil, sediment, and surface water at Load Line 8 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 the Ohio EPA *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 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 8 is designated as AOC RVAAP-41 within the former RVAAP. Load Line 8, formerly known as Booster Line #2, is an approximately 44-acre fenced AOC located south of Fuze and Booster Road, west of Load Line 6, and south of the 40mm Test Area in the south-central portion of Camp Ravenna. Remaining features at Load Line 8 include a one-lane access road that enters the AOC from the northeast and surrounds the locations of the former production buildings along the northern and western sides.

From 1941–1945, Load Line 8 operated at full capacity to produce booster charges for artillery projectiles. Load Line 8 was deactivated at the end of World War II, and the process equipment was removed. Reportedly, Load Line 8 was used again in the 1970s where the site was reactivated for melt pour operations and assembly (USACE 2009a). No historical information exists to indicate Load Line 8 was used for any other processes, other than what is presented above.

ES.1.2 Scope

The scope of this RI Report is to perform a CERCLA evaluation of soil, sediment, and surface water at Load Line 8. The media of concern associated with Load Line 8 are surface soil [0–1 ft below ground surface (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 (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., 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 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 Commercial/Industrial Land Use as an Alternative if it achieves no further action for Unrestricted (Residential) Land Use.

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 2004 Characterization of 14 AOCs (MKM 2007), 2007 Investigation of the Under Slab Surface Soil (USACE 2009a), and 2010 Performance-Based

Acquisition 2008 Remedial Investigation (PBA08 RI) were used to evaluate nature and extent of contamination at Load Line 8. These investigations used incremental sampling methodology (ISM) and 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). 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 vs. ISM).

Samples from the 2004 (Characterization of 14 AOCs) and 2007 (Investigation of Under Slab Surface Soil) data sets were evaluated to determine if conditions had changed substantively between earlier characterization efforts and the 2010 PBA08 RI, as building demolition activities occurred in 2006 after the 2004 sampling. The samples collected in 2004 were collected within ditch lines adjacent to former buildings and in large areas encompassing, but also extending substantially beyond the footprint of the former buildings. The 2007 sampling was conducted within the footprints of the demolished buildings after slab removal. Therefore, both data sets were considered representative of current conditions within and surrounding the footprints of the former buildings at Load Line 8.

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. Since ISM was used for surface soil (0-1 ft bgs) as part of the Characterization of 14 AOCs, ISM was also used for surface soil sampling during the PBA08 RI. 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. Additionally, sediment and surface water samples were collected from drainage ditches exiting the AOC.

ES.2.2 Summary of Nature and Extent of Contamination

Nature and extent of contamination in surface soil (0-1 ft bgs), subsurface soil (greater than 1 ft bgs), sediment, and surface water was evaluated in the RI. Data from the 2004 Characterization of 14 AOCs, 2007 Investigation of Under Slab Surface Soil, and 2010 PBA08 RI provided effective characterization of the nature and extent of the contamination at the AOC. Figure ES-1 shows the sample locations used to conduct this RI. To support the evaluation of nature and extent of contamination, site-related contaminant (SRC) concentrations were compared to screening levels (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) (herein referred to as the FWCUG Report). It can be concluded that the vertical and horizontal extent of contamination is defined, and no further sampling is needed to evaluate Load Line 8.

Sites where explosives were identified as potential contaminants from previous use [2,4,6-trinitrotoluene (TNT), hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane (HMX), and tetryl] were thoroughly evaluated, including around former process buildings and across the AOC as a whole. TNT and RDX were not detected in any of the environmental media sampled at Load Line 8 and HMX and tetryl were not detected in subsurface soil or surface water. The maximum concentrations of HMX and tetryl detected in the ISM surface soil samples were below their respective SLs and were not considered chemicals of potential concern (COPCs). In addition, tetryl was detected in one ISM sediment sample below the SL and was not considered a COPC.

Arsenic, chromium, lead, and mercury were identified as potential inorganic SRCs and as potentially related to previous site use. Arsenic was detected below its background concentration in surface soil at Load Line 8. An arsenic concentration (26.9 mg/kg) detected in the subsurface soil interval from 4-7 ft bgs at LL8sb-060 exceeded the subsurface soil background concentration (19.8 mg/kg). The concentration decreased below the background concentration in the 7-13 ft bgs interval at LL8sb-060. Chromium, lead, and mercury had concentrations above their background concentrations, but all concentrations were below their respective SLs in soil and sediment samples. Lastly, all detections of these four inorganic chemicals in surface water were below their respective SLs in the most recent samples of surface water at Load Line 8.

Three other inorganic chemicals (cobalt, manganese, and nickel) exceeded their respective SLs in surface soil. The exceeding concentrations of these inorganic chemicals were below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1 except manganese at three ISM surface soil locations (LL8ss-003M, LL8ss-005M, and LL8ss-009M). No other inorganic chemicals exceeded their respective SLs in the subsurface soil at Load Line 8.

Aluminum exceeded its SL at discrete sediment sample location LL8sd-090; however, the concentration was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Cobalt was detected at concentrations exceeding the SL at LL8sw-091 and LL8sw-092; however, the concentrations were below the regional screening level (RSL) at a TR of 1E-05, HQ of 1.

Polycyclic aromatic hydrocarbons (PAHs) were identified as potential contaminants from previous site use at former Buildings 2B-23 and 2B-24 that were used for heater houses; however, concentrations detected in surface soil and the other environmental media adjacent to or surrounding these former buildings were less than the SLs. PAHs were widely distributed in surface soil throughout the AOC; however, the maximum detections of the five PAHs identified as COPCs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene] were observed at sample location LL8ss-072M, which is in the vicinity of former Building 2B-21. At sample location LL8ss-072M, the detections of benzo(a)pyrene and dibenzo(a,h)anthracene exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Five surface soil locations (LL8ss-071M, LL8ss-072M, LL8ss-073M, LL8ss-076M, and LL8ss-085M) slightly exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1 for benzo(a)pyrene. In addition, benzo(a)pyrene was detected at ISM sediment sample location LL8sd-001M above the SL and is therefore considered a COPC.

Former Building 2B-22 was the only building at Load Line 8 whose purpose was solvent storage. The sample (LL8ss-019) associated with Building 2B-22 had no detectable volatile organic compound (VOC) concentrations in surface soil. One VOC (2-butanone) was identified as an SRC in surface soil, as estimated concentrations were reported from PBA08 RI multi-acre ISM samples LL8ss-074M (0.002J mg/kg) and LL8ss-088M (0.0024J mg/kg). In addition, the VOC acetone was detected in one discrete subsurface sample at a low, estimated concentration. One VOC (toluene) was detected at a low concentration in one discrete sediment sample. All detected VOC concentrations were below their respective SLs.

One polychlorinated biphenyl (PCB) (PCB-1254) and four pesticides [4,4’-dichlorodiphenyldichloroethane (DDD); 4,4’-dichlorodiphenyldichloroethylene (DDE); 4,4’-dichlorodiphenyltrichloroethane (DDT); and beta-hexachlorocyclohexane] were identified as SRCs in surface soil. Three of the four pesticides (4,4’-DDD; 4,4’-DDE; and 4,4’-DDT) were identified as SRCs in surface soil and in sediment. None of the detections exceeded their respective SLs. No pesticides or PCBs were detected in subsurface soil or surface water, and no PCBs were detected in sediment.

ES.3 SUMMARY OF CONTAMINANT FATE AND TRANSPORT

All SRCs identified in the surface soil, subsurface soil, and sediment at Load Line 8 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 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 identify final CMCOPCs based on RVAAP facility-wide background concentrations and the lowest risk-based screening criteria among USEPA maximum contaminant levels (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 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). The evaluation of modeling results with respect to current AOC groundwater data and model limitations identified the following CMCOPCs for soil and sediment:

- Arsenic, selenium, and naphthalene in soil were predicted to exceed the screening criteria in groundwater beneath the source area; however, none of these constituents were predicted to exceed screening criteria at the downgradient receptor location.

- Barium; cadmium; chromium; cobalt; lead; mercury; nickel; selenium; benz(a)anthracene; benzo(b)fluoranthene; naphthalene; and 4,4'-DDE in sediment were predicted to exceed the screening criteria in groundwater beneath the source area; however, none of these constituents were predicted to exceed screening criteria 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 contaminant migration chemicals of concern (CMCOCs) are present in soil and sediment at Load Line 8 that may impact the groundwater at Load Line 8 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 8 for the protection of groundwater.

ES.4 SUMMARY OF THE HUMAN HEALTH RISK ASSESSMENT

The HHRA identified chemicals of concern (COCs) and conducted risk management analysis to determine if COCs pose unacceptable risk to the Resident Receptor. Since the risk management analysis determined there was 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 8 are surface soil, subsurface soil, sediment, and surface water. Soil data associated with Load Line 8 were aggregated into surface and subsurface soil. Sediment was evaluated from ditches within and west of the production area. In addition, sediment and surface water were evaluated from ditches located in the southwest side of Load Line 8 where surface water exits the AOC.

No COCs were identified for the Resident Receptor in subsurface soil or sediment. Five PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] were identified as COCs for the Resident Receptor (Adult and Child) in surface soil. Five ISM sample locations have benzo(a)pyrene concentrations above the Resident Receptor (Adult and Child) FWCUG of 0.221 mg/kg (i.e., ranging from 0.24 to 1.3 mg/kg). The dibenz(a,h)anthracene concentration in LL8ss-072M (0.29 mg/kg) slightly exceeded the Resident Receptor (Adult and Child) FWCUG of 0.221 mg/kg. The sum-of-ratios (SOR) for these samples is greater than one, due primarily to benzo(a)pyrene. Gravel, slag, and crushed building debris were present in the ISM sample areas. The PAH concentrations at Load Line 8 are not indicative of an operations-related point source of PAHs and are indicative of road sources Due to the low concentrations of PAHs reported in these samples collected from areas with no identified source of PAHs other than roads, gravel, and building debris, PAHs were not identified as COCs for potential remediation.

Three COCs (cobalt, iron, and lead) were identified for the Resident Receptor in surface water. Cobalt and lead were identified as exceeding their FWCUGs in surface water only because no FWCUGs are available for these inorganic chemicals. The detected concentration of cobalt (0.0085 mg/L) in the sample collected at LL8sw-090 in March 2010 slightly exceeds the tap water RSL (0.0060 mg/L), corresponding to an HQ of 1. The maximum detected concentration of lead (0.024

mg/L) is 1.6 times the MCL for drinking water (0.015 mg/L) in LL8sw-090 collected in March 2010. Iron was below the FWCUG in surface water, but contributed to an SOR greater than one in LL8sw-090. These metals were not identified as COCs for remediation as (1) concentrations of these metals were significantly lower in a subsequent surface water sample collected from the same location in April 2011, and (2) incidental exposure to surface water in a ditch would be much less than exposure from ingestion of tap water or drinking water, which the conservative comparisons for cobalt and lead were based on.

Based on the risk management analysis, no COCs were identified to be carried forth in an FS for the Resident Receptor 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 THE ECOLOGICAL RISK ASSESSMENT

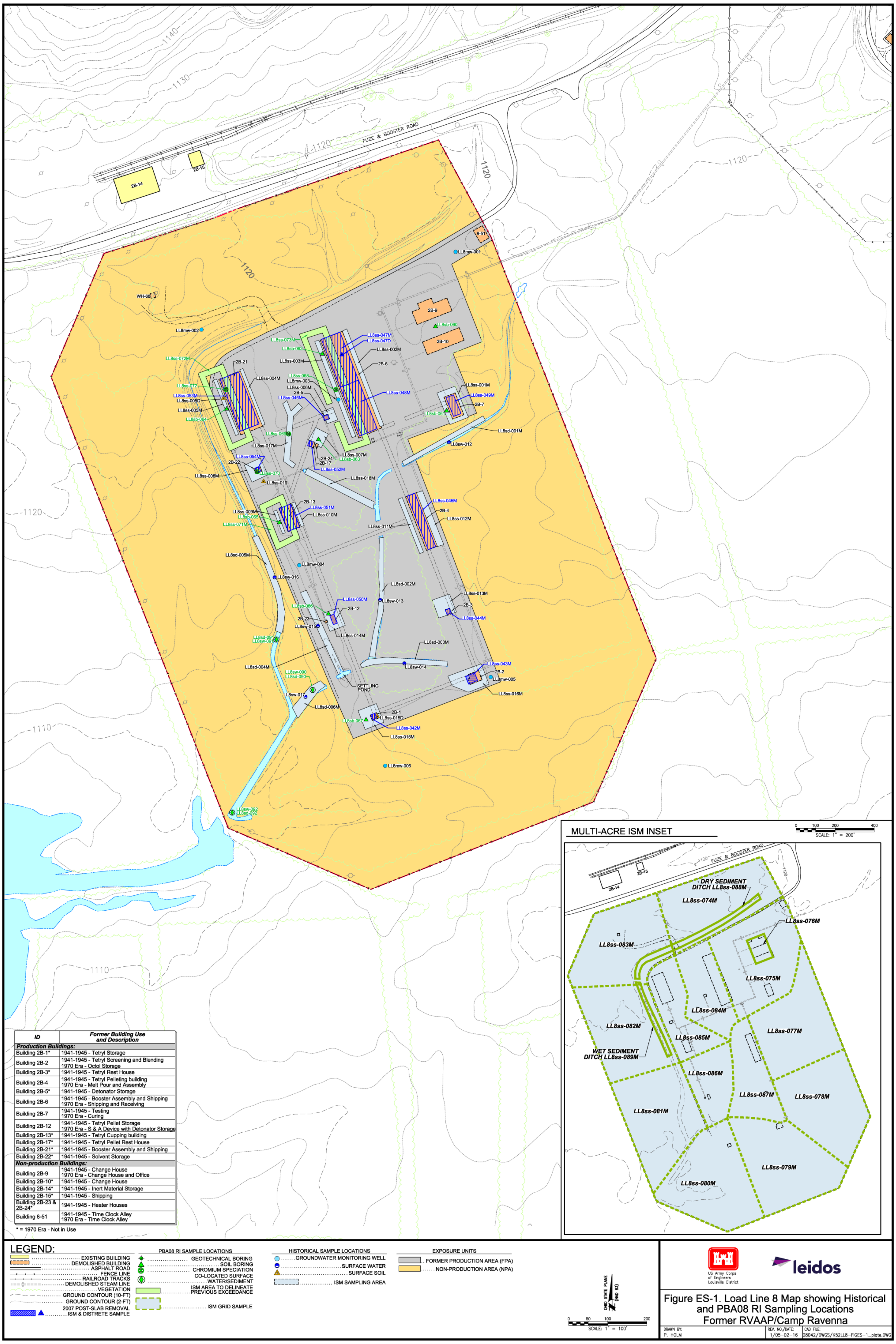
The Level I ERA presents important ecological resources on or near the AOC and evaluates the potential for current contamination to impact ecological resources. There is chemical contamination present in surface soil, sediment, and surface water at Load Line 8. This contamination was identified using historical and PBA08 RI data. Various field, forest, shrubland, and other ecological resources were observed on the 44 acres in the AOC. There are important and significant ecological resources in the AOC. Specifically, wetlands and surface water (i.e., ditches and a stream) 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). Eighteen integrated COPECs were identified for soil. Nine integrated COPECs were identified for sediment. Seven 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 for Load Line 8 concludes with a recommendation that no further action is required to be protective of important ecological resources.

ES.6 CONCLUSIONS OF THE REMEDIAL INVESTIGATION

Based on the investigation results, Load Line 8 has been adequately characterized and the recommended path forward is no further action for soil, sediment, and surface water at Load Line 8 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:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

Figure ES-1. Load Line 8 Map Showing Historical and PBA08 RI Sampling Locations - Former RVAAP/Camp Ravenna

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1.0 INTRODUCTION

This document has been revised by Leidos under 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 8 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 8 is designated as area of concern (AOC) RVAAP-41.

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 the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National 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 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).

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 8.
- 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 of the RI Report.

1.1 PURPOSE

The purpose of this report is to use available RI data to evaluate the nature and extent of contamination; fate and transport of contaminants in the environment; and risk assessments for surface and subsurface soil, sediment, and surface water at Load Line 8. This report also provides a summary of the Performance-based Acquisition 2008 Remedial Investigation (PBA08 RI) at Load Line 8 that was performed to supplement data from previous sampling events. Depending on the results of the evaluations contained in this report, 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 and 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 these 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 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 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 (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 8 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 8; 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, outfall sediment, outfall 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 8. These evaluations recommend no further action with respect to the Facility-wide Sewers within Load Line 8. 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/FS guidance and 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 8, 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 8, including the geology, hydrogeology, climate, and population.
- Section 4.0 summarizes previous assessments and investigations at Load Line 8, as well as the data used to support this RI Report.
- Section 5.0 discusses the occurrence and distribution of contamination at the AOC.
- Section 6.0 presents 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, and
  Appendix I: PBA08 RI Summary.

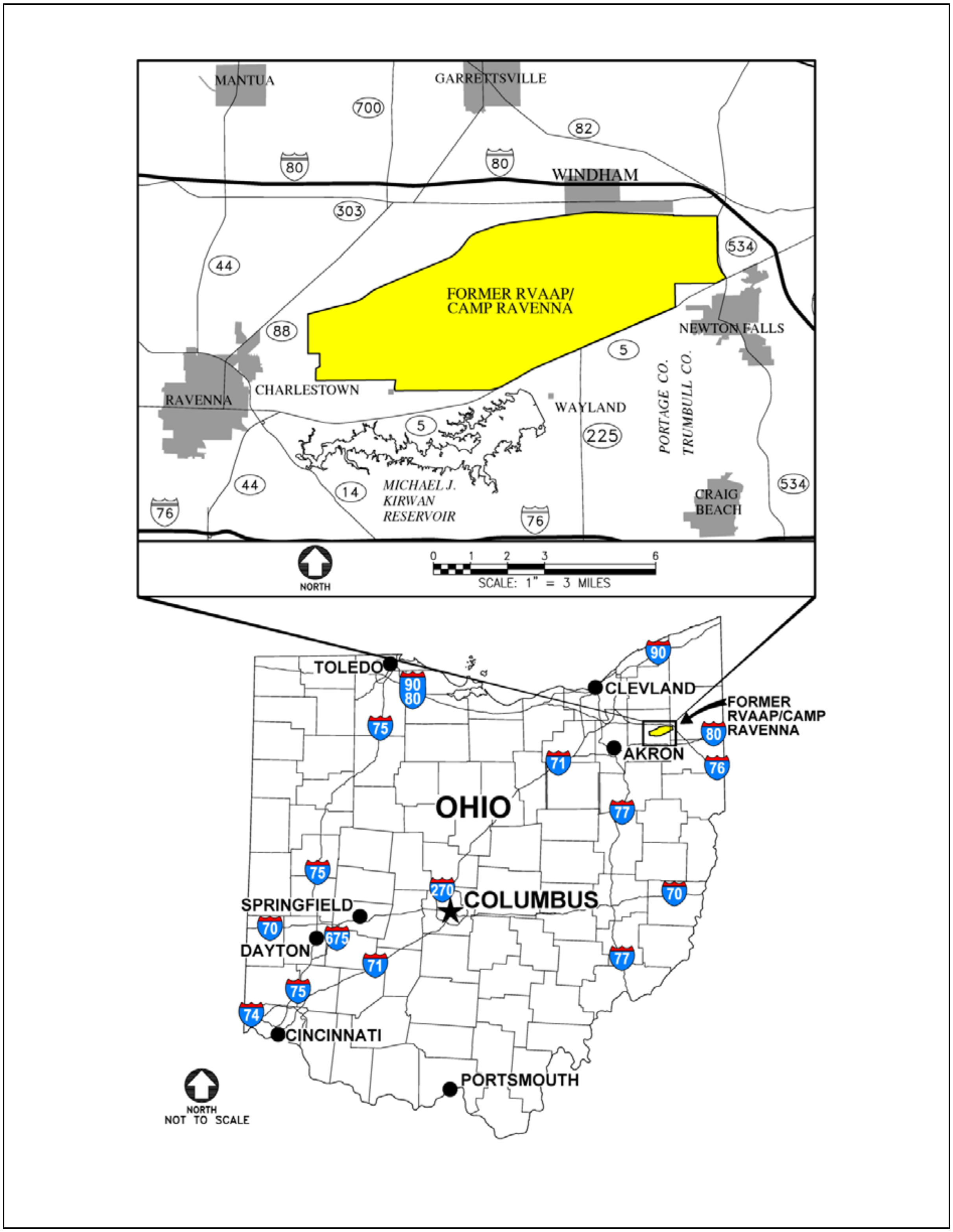
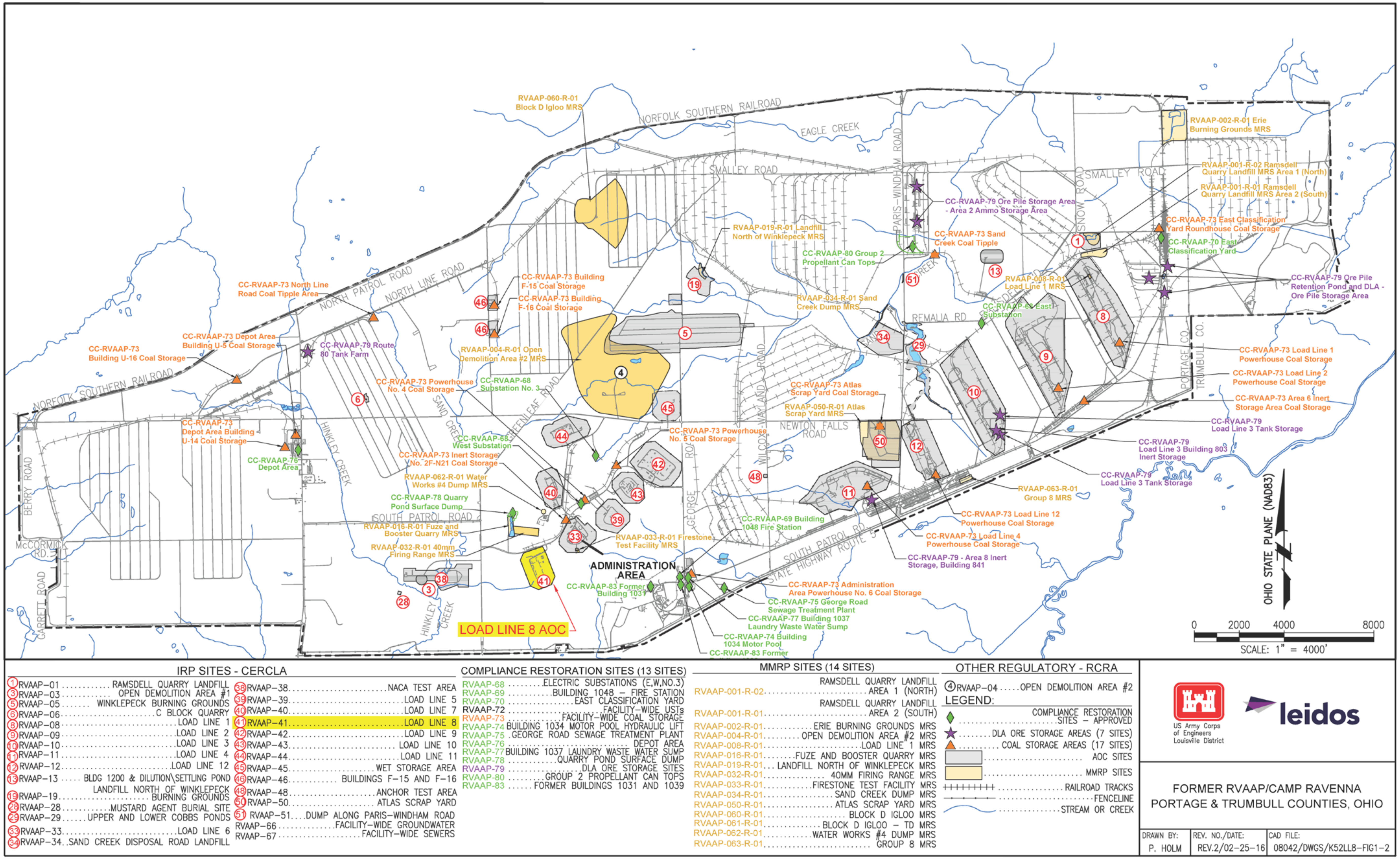


Figure 1-1. General Location and Orientation of Camp Ravenna



IRP SITES - CERCLA

①RVAAP–01	RAMSDELL QUARRY LANDFILL
③RVAAP–03	OPEN DEMOLITION AREA #1
⑤RVAAP–05	WINKLEPECK BURNING GROUNDS
⑥RVAAP–06	C BLOCK QUARRY
⑧RVAAP–08	LOAD LINE 1
⑨RVAAP–09	LOAD LINE 2
⑩RVAAP–10	LOAD LINE 3
⑪RVAAP–11	LOAD LINE 4
⑫RVAAP–12	LOAD LINE 12
⑬RVAAP–13	BLDG 1200 & DILUTION\SETTLING POND
⑲RVAAP–19	LANDFILL NORTH OF WINKLEPECK BURNING GROUNDS
㉘RVAAP–28	MUSTARD AGENT BURIAL SITE
㉙RVAAP–29	UPPER AND LOWER COBBS PONDS
㉝RVAAP–33	LOAD LINE 6
㉞RVAAP–34	SAND CREEK DISPOSAL ROAD LANDFILL
㊳RVAAP–38	NACA TEST AREA
㊴RVAAP–39	LOAD LINE 5
㊵RVAAP–40	LOAD LINE 7
㊶RVAAP–41	LOAD LINE 8
㊷RVAAP–42	LOAD LINE 9
㊸RVAAP–43	LOAD LINE 10
㊹RVAAP–44	LOAD LINE 11
㊺RVAAP–45	WET STORAGE AREA
㊻RVAAP–46	BUILDINGS F–15 AND F–16
㊽RVAAP–48	ANCHOR TEST AREA
㊿RVAAP–50	ATLAS SCRAP YARD
(51) RVAAP–51	DUMP ALONG PARIS–WINDHAM ROAD
RVAAP–66	FACILITY–WIDE GROUNDWATER
RVAAP–67	FACILITY–WIDE SEWERS

COMPLIANCE RESTORATION SITES (13 SITES)

RVAAP-68	ELECTRIC SUBSTATIONS (E,W,NO.3)
RVAAP-69	BUILDING 1048 – FIRE STATION
RVAAP-70	EAST CLASSIFICATION YARD
RVAAP-72	FACILITY–WIDE USTs
RVAAP-73	FACILITY–WIDE COAL STORAGE
RVAAP-74	BUILDING 1034 MOTOR POOL HYDRAULIC LIFT
RVAAP-75	GEORGE ROAD SEWAGE TREATMENT PLANT
RVAAP-76	DEPOT AREA
RVAAP-77	BUILDING 1037 LAUNDRY WASTE WATER SUMP
RVAAP-78	QUARRY POND SURFACE DUMP
RVAAP-79	DLA ORE STORAGE SITES
RVAAP-80	GROUP 2 PROPELLANT CAN TOPS
RVAAP-83	FORMER BUILDINGS 1031 AND 1039

MMRP SITES (14 SITES)

RVAAP-001-R-02	RAMSDELL QUARRY LANDFILL AREA 1 (NORTH)
RVAAP-001-R-01	RAMSDELL QUARRY LANDFILL AREA 2 (SOUTH)
RVAAP-002-R-01	ERIE BURNING GROUNDS MRS
RVAAP-004-R-01	OPEN DEMOLITION AREA #2 MRS
RVAAP-008-R-01	LOAD LINE 1 MRS
RVAAP-016-R-01	FUZE AND BOOSTER QUARRY MRS
RVAAP-019-R-01	LANDFILL NORTH OF WINKLEPECK MRS
RVAAP-032-R-01	40MM FIRING RANGE MRS
RVAAP-033-R-01	FIRESTONE TEST FACILITY MRS
RVAAP-034-R-01	SAND CREEK DUMP MRS
RVAAP-050-R-01	ATLAS SCRAP YARD MRS
RVAAP-060-R-01	BLOCK D IGLOO MRS
RVAAP-061-R-01	BLOCK D IGLOO – TD MRS
RVAAP-062-R-01	WATER WORKS #4 DUMP MRS
RVAAP-063-R-01	GROUP 8 MRS

OTHER REGULATORY - RCRA

④RVAAP–04 ..... OPEN DEMOLITION AREA #2

LEGEND:

◆	COMPLIANCE RESTORATION SITES – APPROVED
★	DLA ORE STORAGE AREAS (7 SITES)
▲	COAL STORAGE AREAS (17 SITES)
▭	AOC SITES
▭	MMRP SITES
┼┼┼┼┼┼┼┼	RAILROAD TRACKS
–·–·–·–	FENCELINE
～	STREAM OR CREEK

FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
P. HOLM	REV.2/02–25–16	08042/DWGS/K52LL8–FIG1–2

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

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2.0 BACKGROUND

This section provides a description of the facility. In addition, it provides a summary of Load Line 8 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 releases 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 Load Line 8; however, finished detonators from Load Line 9 contained lead azide which were used in booster assembly and stored at Load Line 8 (MKM 2007). According to this assessment, from 1941–1945 Load Lines 5–11 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 former RVAAP received bulk 2,4,6-trinitrotoluene (TNT) product during operational activities, but 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 U.S. Department of the Army's (Army) 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 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 is federally owned and is licensed to 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 8 BACKGROUND INFORMATION

2.2.1 Operational History

Load Line 8, formerly known as Booster Line #2, is an approximately 44-acre fenced AOC located on Fuze and Booster Road, west of Load Line 6, and south of the 40mm Test Area in the south-central portion of Camp Ravenna (Figures 1-2 and 2-1). A description of the operational use at Load Line 8 is as follows:

- 1941–1945 – The site operated at full capacity to produce booster charges for artillery projectiles. With the exception of a tetryl booster that was loaded and assembled at Load Line 8, all primary explosive products were delivered to Load Line 8 as sealed, finished sub-assemblies (e.g., lead azide detonators from Load Line 9). At the end of World War II, Load Line 8 was deactivated, and the process equipment was removed.
- 1970 era (estimated 1969–1971) – Per the *Final Investigation of the Under Slab Surface Soils Post Slab and Foundation Removal at RVAAP-39 Load Line 5, RVAAP-40 Load Line 7, RVAAP-41 Load Line –LL8, and RVAAP-43 Load Line 10* (USACE 2009a), the site was reactivated for melt pour operations and assembly in this timeframe.

No fuel storage tanks were present at Load Line 8 during operations. No historical information exists to indicate Load Line 8 was used for any other processes (including fuel storage and use, burning, etc.) other than what is presented above.

All buildings, including slabs and foundations, were removed in 2006. Remaining features at Load Line 8 include a one-lane access road that enters the AOC from the northeast and surrounds the locations of the former production buildings along the northern and western sides. The Load Line 8 perimeter fence is still in place, but it is not currently maintained. Small construction drainage ditches border the access road and through the central portion of the AOC.

2.2.2 Potential Sources

Historical facilities at Load Line 8 included 19 production and support buildings ranging in size from 37–13,158 ft^2. There were 14 production buildings and 5 non-production buildings used at Load Line 8 during World War II. The locations of the former primary operational buildings are shown on Figure 2-1 and in the aerial photograph shown in Figure 2-2.

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

- Building 2B-14 – Utilized for inert material storage (located outside AOC boundary) during the production era.
- Building 2B-15 – Utilized for shipping (located outside AOC boundary) during the production era.
- Building 8-51 – Gate House utilized to clock employees in and out from shifts.
- WH-86 – Well House.
- Drainage ditches.

Table 2-1 summarizes potential sources of contamination at Load Line 8 and 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 to be TNT, composition B [a combination of TNT and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)], sulfates, nitrates, lead styphnate, and lead azide. Additional site-specific contaminants at Load Line 8 include tetryl, Octol [a mixture of TNT and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane (HMX)], and heavy metals (lead, chromium, mercury, and arsenic) from munitions assembly activities; volatile organic compounds (VOCs) from former Building 2B-22 that was utilized for solvent storage; polychlorinated biphenyls (PCBs) from on-site transformers; and PAHs from former Buildings 2B-23 and 2B-24 were used as a heater house.

2.2.3 Building Decontamination and Demolition

Demolition and removal of buildings at Load Line 8, including building slabs and foundations, and the series of wood frame walkways connecting these buildings, was completed in 2006 by the Army Tank-Automotive and Armaments Command and was documented in the *Munitions Response for the Demolition of RVAAP-41 Load Line 8 and RVAAP-43 Load Line 10* (PIKA 2007).

Prior to demolition and disposal, the following activities took place:

- The floors of each building were swept prior to beginning any demolition operations to remove the loose paint chips and other potentially contaminated debris. A total of 2 cubic yards of material were removed, containerized, sampled, and disposed from Load Line 8 and Load Line 10 as PCB-containing material.

- All hazardous and non-hazardous material (e.g., fluorescent light fixtures and mercury switches) from the buildings were removed.
- Asbestos-containing material was removed by a licensed asbestos removal contractor from all buildings. Asbestos-containing material removal operations occurred in June 2006. A total of 94,054 ft^2 of transite roofing were removed from Load Line 8.
- Explosive decontamination was performed on drains and process pipes at Load Line 8. A total of three explosive shots were initiated using .50 grain detonating cord and non-electric shock tube initiation systems on all the drains.
- UXO personnel conducted building walkthroughs to confirm existing conditions, and inspected wall, floor slab, and structural steel surfaces for explosives contamination and other potential explosive hazards. Wall and floor penetrations, openings/cavities, and large cracks were inspected to determine if accumulated explosives were present. A hazard analysis building inspection form was used to document inspection at each building.

Basements in Buildings 2B-9 and 2B-10 (Change Houses) contained water requiring removal and off-site disposal. Prior to removal, the water contained in the basements was sampled to determine proper disposition. Based upon analytical results, all basement water (a portion of 2,491 gal between Load Lines 8 basements and Load Line 10 sumps) was disposed offsite as non-hazardous waste (PIKA 2007). Water samples indicated “negative test results” for explosives.

All concrete floor slabs, subsurface concrete foundations, steam stanchions, overhead steam lines, telephone poles, building sumps, and surface debris were removed. Basements in Building 2B-9 and 2B-10 were demolished in place to 4 ft bgs. Subsurface foundations were removed completely or to a minimum depth of 4 ft bgs. Precautions were taken to avoid disturbing soil beneath the slabs and footers.

Due to high concentrations of PCBs in wall paint, building materials associated with Building 8-51 (Gate House), excluding the concrete floor slabs and foundations which are not painted, were loaded for off-site disposal as PCB Bulk Product Waste at the approved facility.

Soil in the vicinity of the former production buildings was extensively disturbed during building demolition activities. The work areas were re-graded, cavities were filled with approved fill dirt as needed, and the area was revegetated in 2007 (PIKA 2007). The interior of the AOC is currently overgrown with shrub/scrub vegetation in unpaved areas and forested around its perimeter.

USACE completed the Investigation of Under Slab Surface Soil after completing demolition and disposal activities (USACE 2009a). This investigation was conducted to identify any contaminants remaining in the under slab surface soil, as presented in Section 4.2.2.

2.2.4 AOC Boundary

Load Line 8 is bound by the existing perimeter fence, as presented in Figure 2-1, and is located on Fuze and Booster Road, west of Load Line 6, and south of the 40mm Test Area. Separate investigations have occurred at these surrounding AOCs.

As shown in Figure 2-3, the AOC boundary (approximately 44 acres) encompasses the former production area (FPA) and non-production area (NPA). The FPA consists of 12.6 acres and is surrounded by the access road on its northern and western sides, in the central portion of the AOC. The buildings within the FPA were historically used to manufacture booster charges for artillery projectiles, and contained the former production and storage buildings. The NPA is 31.9 acres and includes the areas between the access road and perimeter fence, and the outlying areas in the eastern and southern portion of the AOC and perimeter fence.

The surface and subsurface soil investigation at Load Line 8 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 the unnamed tributary to Hinkley Creek at the southwestern fence line.

2.3 POTENTIAL RECEPTORS AT LOAD LINE 8

The following sections discuss potential human and ecological receptors at Load Line 8.

2.3.1 Human Receptors

Camp Ravenna is a controlled-access facility. Load Line 8 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. 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, 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.

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 access road at Load Line 8, the AOC is vegetated with herbs/grasses and scrub/shrub vegetation in the central portion and has young and mature forest on the perimeter. There are five wetlands within the AOC boundary. Additional information specific to ecological resources at Load Line 8 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 8 but are addressed separately.

2.4.1 Facility-wide Sewers

The defunct sanitary sewers within the perimeter of Load Line 8 are being investigated and assessed as part of the Facility-wide Sewers AOC (RVAAP-67). Storm sewers are not present at Load Line 8. Sanitary sewer sediment, sewer water, and pipe bedding material 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 8 functional area (FA) are part of the network that flowed to the George Road Sewer Treatment Plant 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 sediment and water samples were collected at sanitary sewer manholes during the 2004 Characterization of 14 AOCs. Inspections and explosives field screening tests were conducted at the Load Line 8 FA during a 2007 Summary of CERL Findings, RVAAP Sewer System (USACE-CERL 2007) and the Explosive Evaluation of Sewers (LES 2007). During this investigation, wipe samples were collected from 10 sanitary sewer manholes and tested using Expray® and DropEx field screening methods. None of the sanitary sewer wipe samples tested positive for explosives residue.
Samples of sewer sediment, water, and pipe bedding material (e.g., soil or backfill beneath the pipe) were also collected in 2009 and 2010 as part of the Facility-wide Sewers RI (USACE 2012a). The compiled data effectively characterized the nature and extent of the contamination at the Load Line 8 FA, and no further sampling was recommended. All SRCs found in the subsurface sewer media

samples within the Load Line 8 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 8 FA for the National Guard Trainee or Resident Receptor. Since the Load Line 8 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 8 sanitary sewers. The Facility-wide Sewers RI predated the Technical Memorandum that specified evaluation of Commercial/Industrial Land Use; however, the Load Line 8 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.

Six groundwater monitoring wells were installed at Load Line 8 during the Characterization of 14 AOCs. In 2009, the FWGWMP collected quarterly groundwater samples from each of the six wells at Load Line 8. In October 2010, the FWGWMP collected groundwater data from well LL8mw-003. 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 are discussed below.

- Iron and manganese in LL8mw-001, LL8mw-002, LL8mw-003, and LL8mw-005 exceeded their respective MCLs.
- Bis(2-ethylhexyl)phthalate in LL8mw-003 exceeded the MCL and RSL in January 2009. All subsequent samples had concentrations below the MCL and RSL and/or had non-detectable concentrations.
- Cyanide had an estimated concentration (0.0057J mg/L) above the RSL (TR of 1E-05, HQ of 1) in LL8mw-001. All other samples collected had non-detectable concentrations of cyanide.
- Some arsenic concentrations in wells LL8mw-002 to LL8mw-004 were above the RSL (TR of 1E-05, HQ of 1) of 0.000052 mg/L. However, all arsenic concentrations in each well were below the MCL (0.001 mg/L).

The facility-wide groundwater AOC is currently at the RI phase of the CERCLA process. Any future decisions or actions respective to groundwater at Load Line 8 will be addressed as part of that AOC.

2.4.3 Munitions Response Sites

There is no munitions response site within or adjacent to the AOC boundary identified as part of the Military Munitions Response Program.

2.4.4 Compliance Restoration Sites

There are no compliance restoration sites, such as former or existing underground storage tanks, within or adjacent to the AOC boundary.

2.5 POTENTIAL SITE-RELATED RELEASES

As presented in Table 2-1, there have been no documented site-related releases at Load Line 8. Table 2-1 presents potential contaminants that may be present in Load Line 8 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
Former Production Area (FPA) Buildings			
Building 2B-1	1941-1945 - Utilized for tetryl storage. 1970 Era - Not in use.	None	Tetryl
Building 2B-2	1941-1945 - Utilized for tetryl screening and blending. 1970 Era - Utilized for Octol storage.	None	Tetryl, Octol [TNT and HMX]
Building 2B-3	1941-1945 - Utilized as a tetryl rest house. 1970 Era- Not in use.	None	Tetryl
Building 2B-4	1941-1945 - Utilized as tetryl pelleting (manufacturing) building. 1970 Era - Utilized for melt pour and assembly.	None	Tetryl, Octol [TNT and HMX], RDX
Building 2B-5	1941-1945 - Utilized for detonator storage. Detonators were manufactured at Load Line 9 and arrived containerized at Load Line 8. 1970 Era- Not in use.	None	Mercury fulminate, lead azide
Building 2B-6	1941-1945 - Utilized for booster assembly and shipping. Detonators from Load Line 9 were used in the assembly process. 1970 Era - Utilized for shipping and receiving.	None	Tetryl, mercury fulminate, lead azide
Building 2B-7	1941-1945 - Utilized for testing boosters. 1970 Era - Utilized for curing.	None	Tetryl, mercury fulminate, lead azide, Octol [TNT and HMX], RDX
Building 2B-12	1941-1945 - Utilized for tetryl pellet storage. Building 2B-12 was heated by adjacent heater house (2B-23). 1970 Era - Utilized for S & A device with detonator storage.	None	Tetryl, Octol [TNT and HMX], mercury fulminate, lead azide
Building 2B-13	1941-1945 - Utilized as tetryl cupping building. 1970 Era - Not in use.	None	Tetryl
Building 2B-17	1941-1945 - Utilized as cupped pellet rest house. 1970 Era - Not in use.	None	Tetryl
Building 2B-21	1941-1945 - Utilized for booster assembly and shipping. Finished detonators from Load Line 9 were used in the assembly process. 1970 Era - Not in use	None	Tetryl, mercury fulminate, lead azide
Building 2B-22	1941-1945 - Utilized for solvent storage. 1970 Era- Not in use.	None	Solvents

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
Non-Production Area (NPA) Buildings			
Building 2B-9	1941-1945 - Utilized as change house where workers changed out of work clothing at end of shift. 1970 Era - Change house and office. Basement inside Building 2B-9.	None	Metals, explosives
Building 2B-10	1941-1945 - Utilized as change house where workers changed out of work clothing at end of shift. 1970 Era - Not in use. Basement inside Building 2B-9.	None	Metals, explosives
Buildings 2B-23 and 2B-24	1941-1945 - Heater houses.	None	Metals, PAHs
Transformers	Historical Records indicated 3 transformers serviced all buildings, but locations are not documented. All transformers were tested for PCBs (43 to 57 ppm). All transformers were removed on October 1, 1992, and stored at Building 854 (RVAAP-27, PCB Storage) awaiting final disposition by the Defense Reutilization Material Office.	None	PCBs

Target metals = Lead, chromium, mercury, and arsenic.
Target explosives = Black powder, mercury fulminate, lead azide.
FPA = Former production area.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane.
PAHs = Polycyclic aromatic hydrocarbons.
PCB = Polychlorinated biphenyl.
ppm = Parts per million.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
S&A = Safe and arm.
TNT = 2,4,6-Trinitrotoluene.

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)

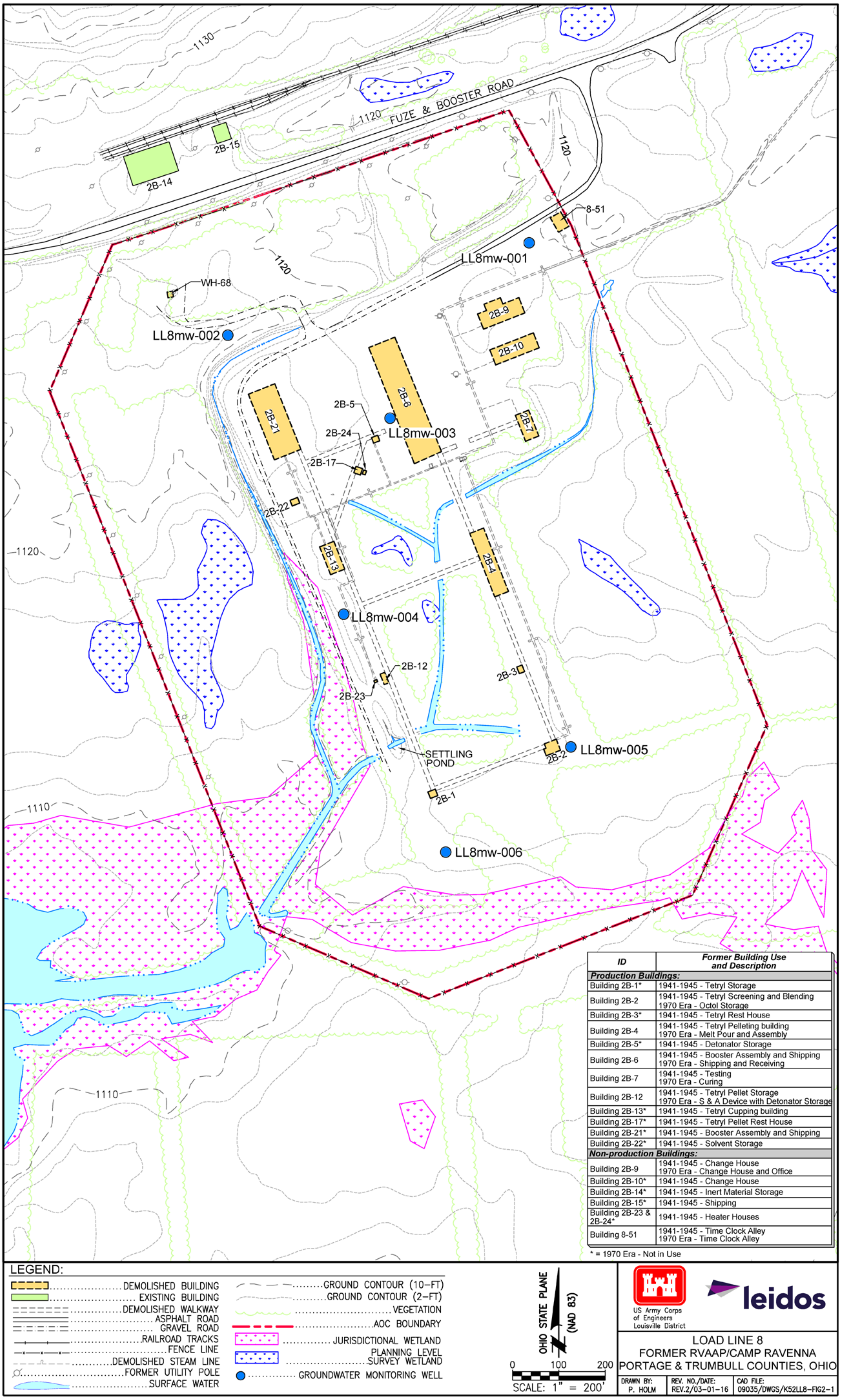
CAMP RAVENNA JOINT MILITARY TRAINING CENTER RARE SPECIES LIST

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*

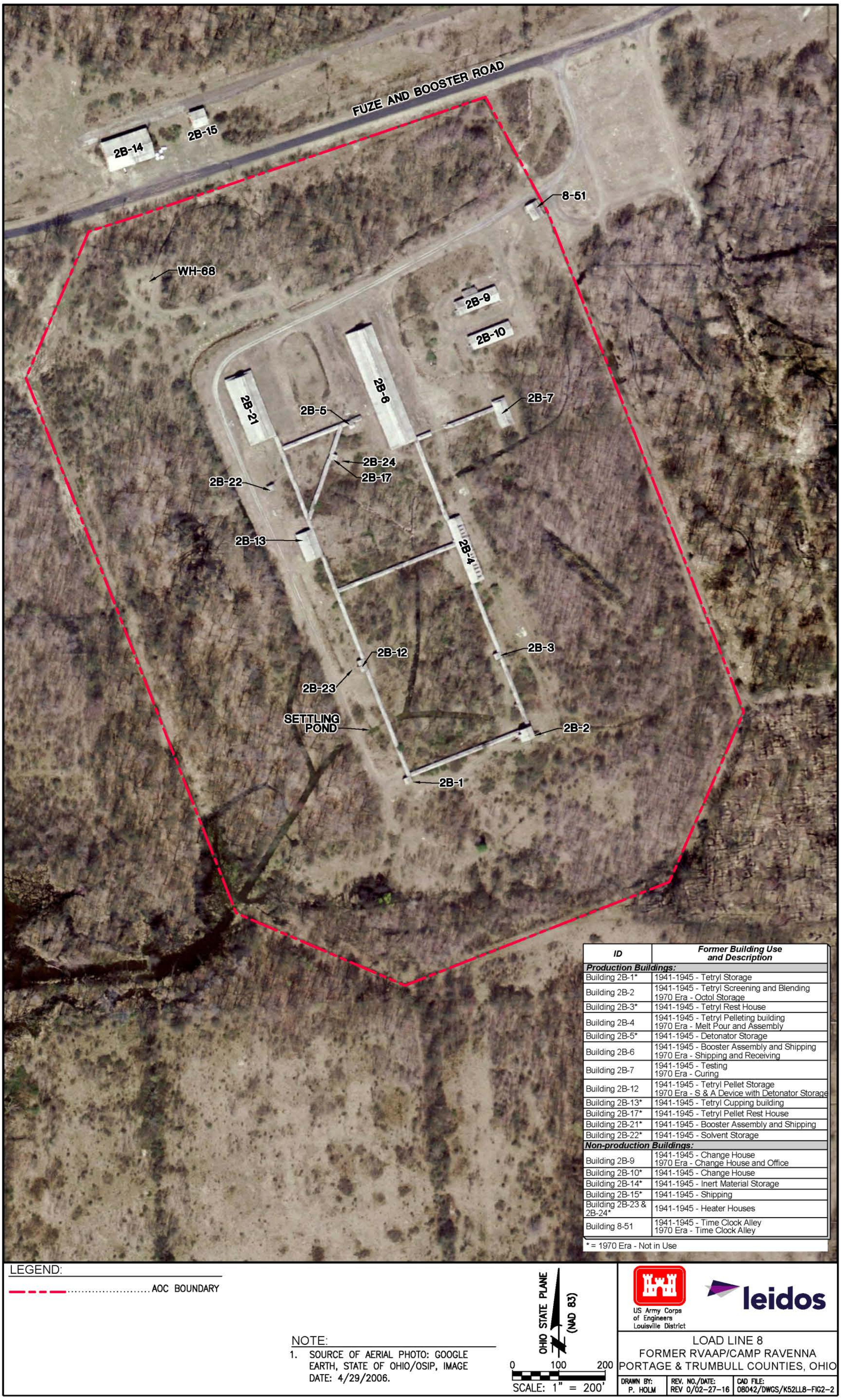
Note: The Integrated Natural Resource Management Plan (OHARNG 2014) indicated that no federally listed species are known to reside at Camp Ravenna, and no critical habitat occurs. However, the Northern Long-eared Bat exists at Camp Ravenna and was expected to be listed as an endangered species in mid-2015.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



ID	Former Building Use and Description
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

Figure 2-1. Load Line 8 Site Features



ID	Former Building Use and Description
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

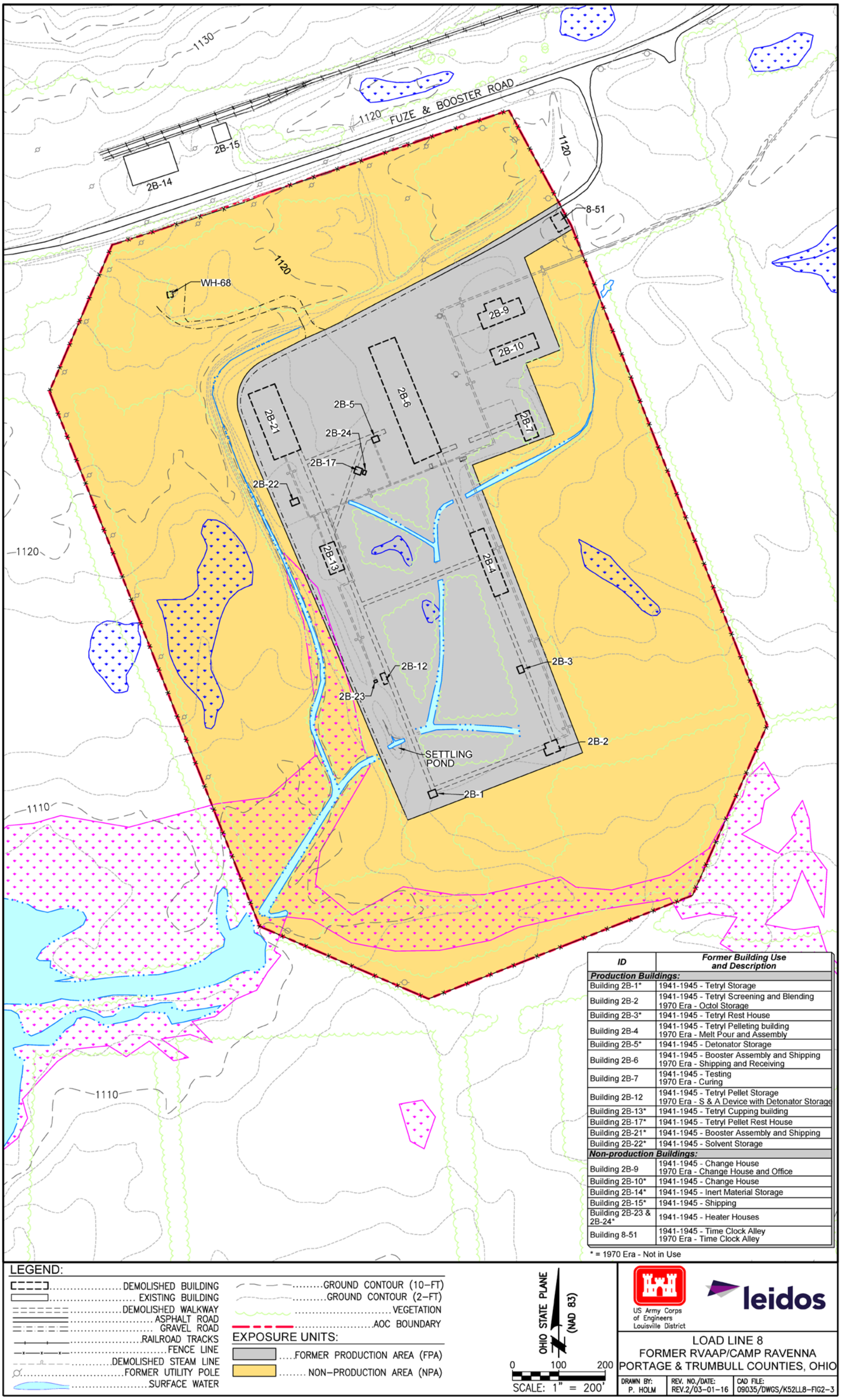
* = 1970 Era - Not in Use

NOTE:

1. SOURCE OF AERIAL PHOTO: GOOGLE EARTH, STATE OF OHIO/OSIP, IMAGE DATE: 4/29/2006.

LOAD LINE 8
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

Figure 2-2. Load Line 8 Site Features Prior to Building Demolition (Aerial Photo dated 4/29/2006)



ID	*Former Building Use and Description*
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

Figure 2-3. Load Line 8 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 8 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 (e.g., 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 included in this report.

Load Line 8 is an approximately 44-acre AOC located on Fuze and Booster Road, west of Load Line 6, and south of the 40mm Test Area in the south-central portion of Camp Ravenna (Figures 1-2 and 2-1). There are five wetlands within the AOC boundary. All buildings and structures have been demolished and building slabs and footers have been removed. Soil in the vicinity of former production buildings was extensively disturbed during building demolition activities. The work areas were re-graded, cavities were filled with approved fill dirt as needed, and the area was vegetated in 2007 (PIKA 2007). A fence exists as the perimeter boundary of the AOC.

Topographic relief at the AOC is moderate, with a topographic high on the northwestern portion of the AOC that slopes downward to the topographic low in the southwestern portion of the AOC. Ground elevations within Load Line 8 range from approximately 1,109–1,125 ft amsl (Figure 3-1). Surface water follows topographic relief and drains into ditches that form the tributary to Hinkley Creek that exits the southwestern corner of the AOC.

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 8 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 in the south-central portion.

Thin coverings of glacial material have 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 locations such as Load Line 1 and the Erie Burning Grounds (USACE 2001a). Where this glacial material is still present, the distribution and character indicate their 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 also has 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 west portion of Camp Ravenna is between 5–11.5 ft per mile to the south.

3.3.3 Geologic Setting of Load Line 8

Bedrock formations at Load Line 8 include the Mercer Member Shale (Winslow et al. 1966) (Figure 3-3). The bedrock formation underlying the unconsolidated formation at Load Line 8 was ascertained from existing geologic data from the 2004 characterization and characterized as the Pennsylvanian-age Pottsville Formation, Homewood Sandstone member. Bedrock was encountered at Load Line 8 from 23.5-24 ft bgs during monitoring well installation activities as part of the Characterization of 14 AOCs. 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 Sandstone Member as indicated by a darker gray shade of color. Bedrock was not encountered during PBA08 RI activities where subsurface borings were drilled to a maximum depth of 13 ft bgs.

Load Line 8 is located within Hiram Till glacial deposits. The soil type found at this AOC is the Mahoning silt loam (MgA) (0-2% and 2-6% slopes). 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).

As observed in PBA08 RI soil borings, the composition of unconsolidated deposits at Load Line 8 generally consist of yellowish-brown to bluish-gray, medium dense, silty clay tills with trace gravel, with silt content increasing with depth. Groundwater, when encountered, ranged from 3.2-8.5 ft bgs in soil borings across the AOC. PBA08 RI boring logs containing geologic descriptions of unconsolidated deposits at Load Line 8 are included in Appendix A. Geologic descriptions of subsurface soil samples collected during the PBA08 RI are generally consistent with the conclusions from the *Characterization of 14 AOCs at the Ravenna Army Ammunition Plant* (herein referred to as the Characterization of 14 AOCs report). Cross-sections of the Load Line 8 subsurface were created from monitoring well lithology records to illustrate lateral distribution and variation of the discontinuous glacial sediment (MKM 2007).

Geotechnical analyses were collected from three subsurface intervals during the Characterization of 14 AOCs. Soil classifications for these samples included: (1) LL8mw-001 at 10-12 ft bgs as brown, silty, clayey sand with gravel; (2) LL8mw-004 at 6-8 ft bgs as a lean clay with sand and trace gravel; and (3) LL8mw-006 at 8-10 ft bgs is a silty, clayey sand with gravel (MKM 2007). No geotechnical samples were collected from Load Line 8 during the PBA08 RI.

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 have 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 (46 m) in the 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, 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 ranged from 30–400 gallons 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 ranging from 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 that hydraulic communication between the two aquifers is occurring.

3.4.2 Load Line 8 Hydrologic/Hydrogeologic Setting

Six groundwater monitoring wells were installed at Load Line 8 during the Characterization of 14 AOCs. Initial depths to groundwater varied from 11–19 ft bgs. Monitoring wells at the AOC ranged in completion from 22.7-32.55 ft bgs. All monitoring well groundwater elevations were collected under the FWGWMP. Monitoring wells LL8mw-001 through LL8mw-004 were screened in the unconsolidated soil to monitor groundwater in overburden, while LL8mw-005 and LL8mw-006 were screened in the Homewood Sandstone bedrock zone (MKM 2007).

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 January 2010 facility-wide potentiometric data presented in the *Facility-wide Groundwater Monitoring Program Report on the January 2010 Sampling Event* (EQM 2010). The potentiometric surface shows the groundwater flow pattern to the southwest. The average hydraulic gradient at the AOC is 0.0058 ft/ft.

Water level elevations from wells installed in the unconsolidated zone at the AOC ranged from 1104.49-1109.47 (11.29-18.62 ft below top of casing) with the highest elevation at the unconsolidated well LL8mw-004. Potentiometric data indicate the groundwater table occurs within unconsolidated soil throughout the AOC.

Results of slug tests performed at the six monitoring wells during the Characterization of 14 AOCs indicate an average hydraulic conductivity of 1.885E-04 cm/s (MKM 2007). However, the hydraulic conductivity of 2.04E-04 cm/sec is used in Section 6.0 because it is the average hydraulic conductivity of the four unconsolidated wells (LL8mw-001 through LL8mw-004). Table 3-1 presents the hydraulic conductivity for each well at Load Line 8.

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 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, 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 to its confluence with Eagle Creek. The drainage area of the south fork of Eagle Creek is 26.2 square miles, including the area drained by Sand Creek. Hinkley Creek originates just southeast of the intersection between State Route 88 and State Route 303 to the north of the facility. Hinkley Creek, with a drainage area of 11 square miles, 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 RVAAP 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 could 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 8 Surface Water

Surface water flow is the primary migration pathway for contamination to leave the AOC, as surface water flows through ditches or surface water drainage features that exit the AOC. Surface water exits the AOC to the southwest. A storm sewer system is not present at Load Line 8.

Surface water drainage generally follows the topography of Load Line 8, flowing into ditch conveyances along the north, west, and central portions of the FPA (Figure 3-1). These ditches contain water for short periods of time only during precipitation or periods of snow melt. During the PBA08 RI, surface water was observed throughout the AOC, flowing through ditches in some areas.

The closest perennial feature to receive the majority of the surface drainage from Load Line 8 is an unnamed perennial stream located at the southwest corner of the AOC. The perennial stream flows west to its confluence with the Hinkley Creek. Hinkley Creek ultimately converges with the west branch of the Mahoning River south of the facility.

3.5 CLIMATE

The general climate of Camp Ravenna is continental and is 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 (http://www1.ncdc.noaa.gov/pub/data/ccd-data/wndspd14.txt) for the available 30-year period of record from 1984–2014.

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 at Load Line 8 during the Characterization of 14 AOCs

Monitoring Well ID	Screened Interval (ft bgs)	Geologic Material Adjacent to Screen	Hydraulic Conductivity (cm/s)
LL8mw-001	14–24	Sandy Silt/Silty Sand	2.03E-04
LL8mw-002	20–30	Sandy Silt/Silty Sand	2.08E-04
LL8mw-003	10.5–20.5	Sandy Silt/Silty Sand	1.14E-05
LL8mw-004	10–20	Sandy Silt/Silty Sand	3.92E-04
LL8mw-005	14–24	Sandy Silt/Silty Sand/Sandstone	7.40E-05
LL8mw-006	14–24	Sandy Silt/Sandstone	2.43E-04

Source: Characterization of 14 AOCs at the Ravenna Army Ammunition Plant (MKM 2007).
AOC = Area of concern.
bgs = Below ground surface.
cm/s = Centimeters per second.
ft = Feet.
ID = Identification.

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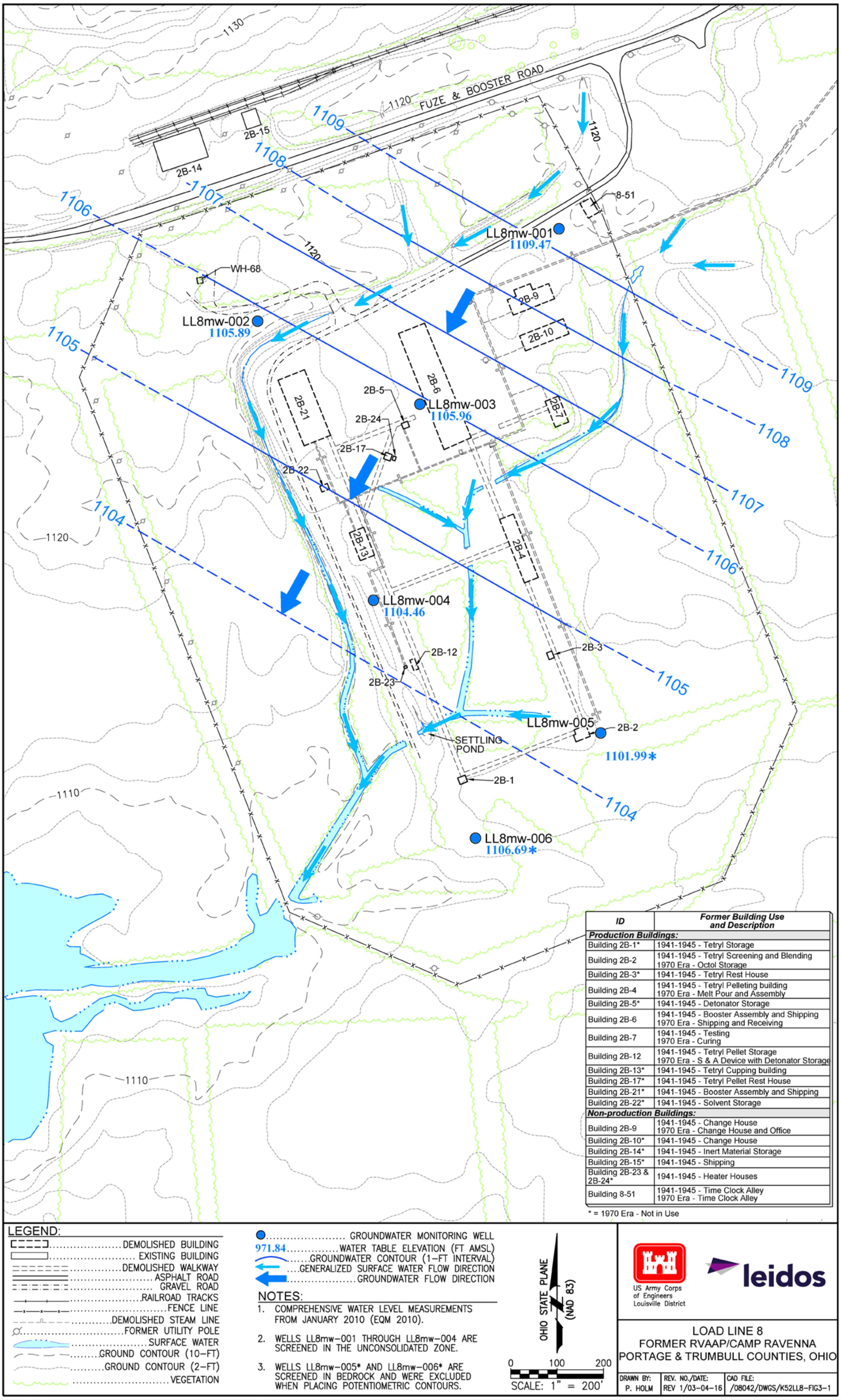


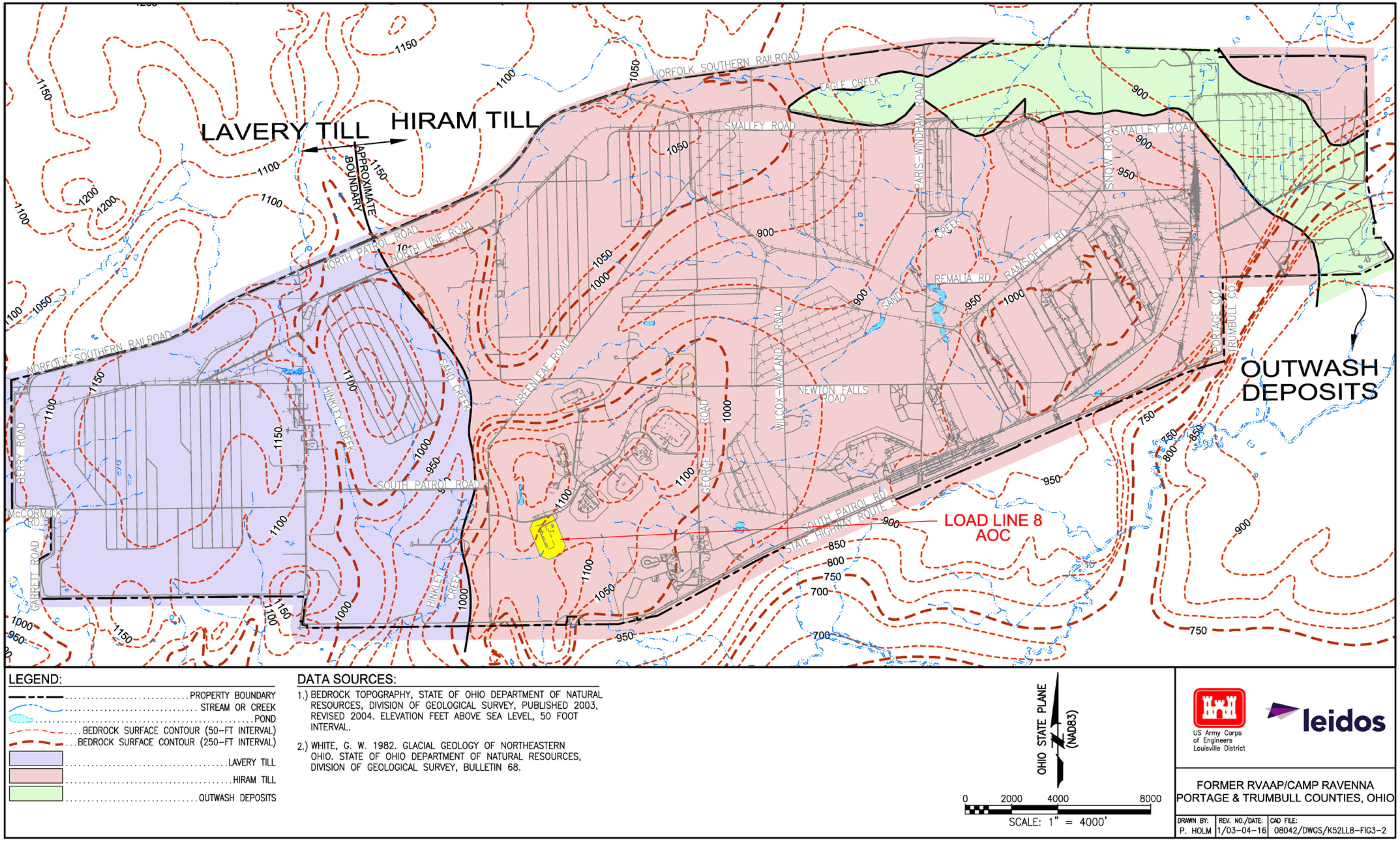
ID	Former Building Use and Description
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

NOTES:

1. COMPREHENSIVE WATER LEVEL MEASUREMENTS FROM JANUARY 2010 (EQM 2010).
2. WELLS LL8mw–001 THROUGH LL8mw–004 ARE SCREENED IN THE UNCONSOLIDATED ZONE.
3. WELLS LL8mw–005* AND LL8mw–006* ARE SCREENED IN BEDROCK AND WERE EXCLUDED WHEN PLACING POTENTIOMETRIC CONTOURS.

Figure 3-1. Topography, Groundwater Flow, and Surface Water Flow at Load Line 8



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.

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

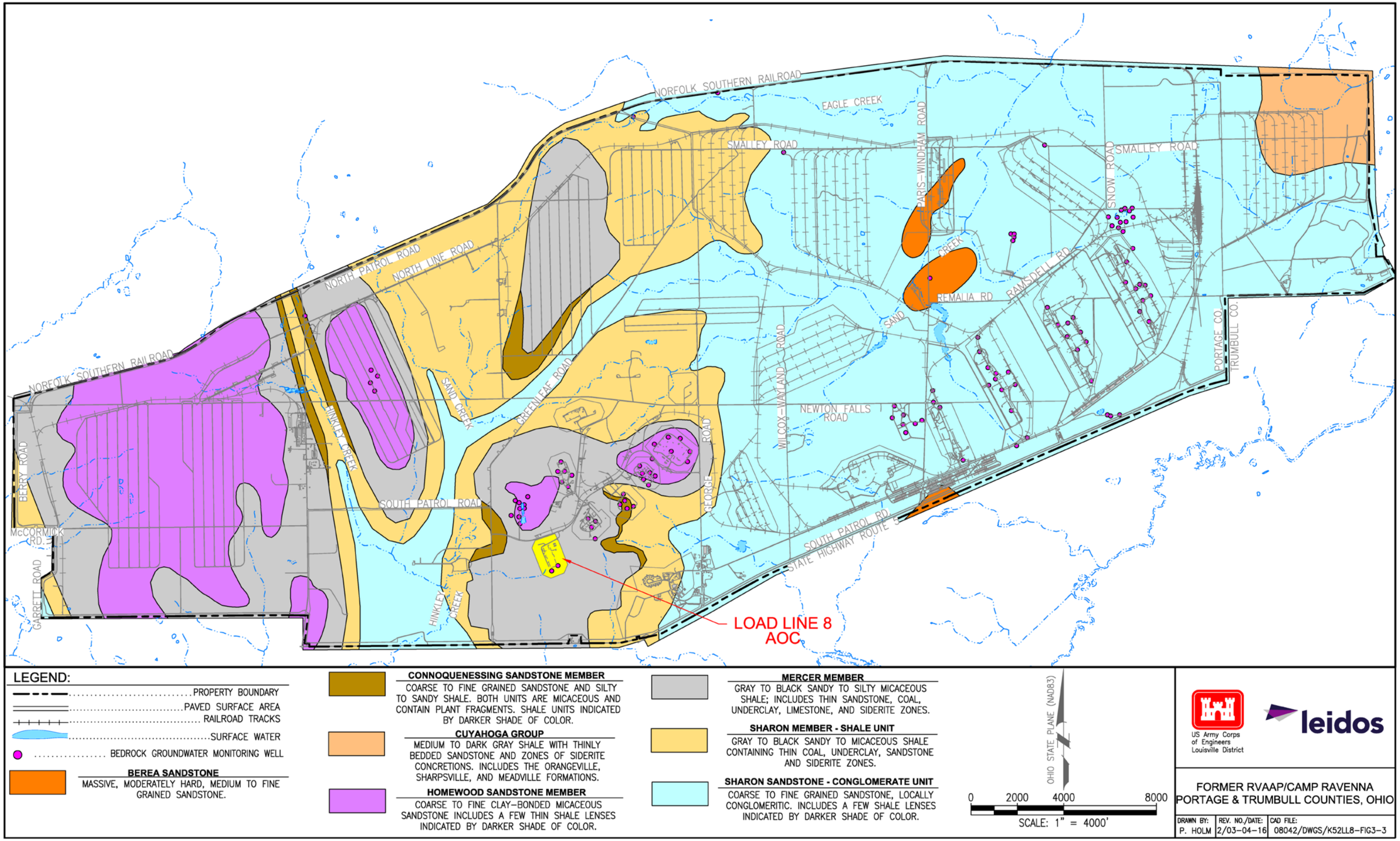
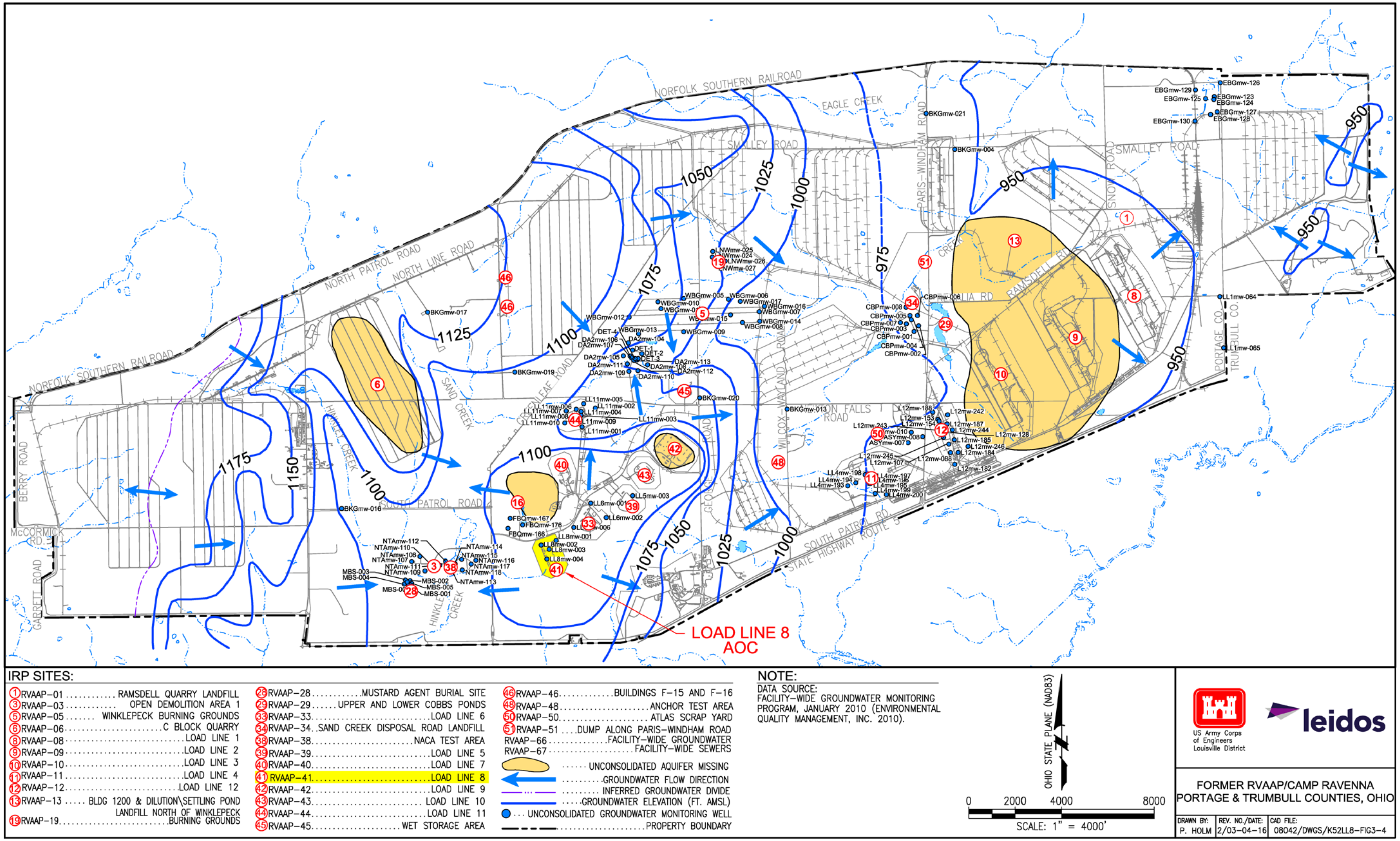


Figure 3-3. Geologic Bedrock Map and Stratigraphic Description of Units on Camp Ravenna



IRP SITES:

①RVAAP–01	RAMSDELL QUARRY LANDFILL
③RVAAP–03	OPEN DEMOLITION AREA 1
⑤RVAAP–05	WINKLEPECK BURNING GROUNDS
⑥RVAAP–06	C BLOCK QUARRY
⑧RVAAP–08	LOAD LINE 1
⑨RVAAP–09	LOAD LINE 2
⑩RVAAP–10	LOAD LINE 3
⑪RVAAP–11	LOAD LINE 4
⑫RVAAP–12	LOAD LINE 12
⑬RVAAP–13	BLDG 1200 & DILUTION\SETTLING POND
⑲RVAAP–19	LANDFILL NORTH OF WINKLEPECK BURNING GROUNDS
㉘RVAAP–28	MUSTARD AGENT BURIAL SITE
㉙RVAAP–29	UPPER AND LOWER COBBS PONDS
㉝RVAAP–33	LOAD LINE 6
㉞RVAAP–34	SAND CREEK DISPOSAL ROAD LANDFILL
㊳RVAAP–38	NACA TEST AREA
㊴RVAAP–39	LOAD LINE 5
㊵RVAAP–40	LOAD LINE 7
㊶RVAAP–41	LOAD LINE 8
㊷RVAAP–42	LOAD LINE 9
㊸RVAAP–43	LOAD LINE 10
㊹RVAAP–44	LOAD LINE 11
㊺RVAAP–45	WET STORAGE AREA
㊻RVAAP–46	BUILDINGS F–15 AND F–16
㊽RVAAP–48	ANCHOR TEST AREA
㊿RVAAP–50	ATLAS SCRAP YARD
(51)RVAAP–51	DUMP ALONG PARIS–WINDHAM ROAD
RVAAP–66	FACILITY–WIDE GROUNDWATER
RVAAP–67	FACILITY–WIDE SEWERS

⬭	UNCONSOLIDATED AQUIFER MISSING
←	GROUNDWATER FLOW DIRECTION
—··—	INFERRED GROUNDWATER DIVIDE
—	GROUNDWATER ELEVATION (FT. AMSL)
●	UNCONSOLIDATED GROUNDWATER MONITORING WELL
— — —	PROPERTY BOUNDARY

NOTE:
DATA SOURCE:
FACILITY–WIDE GROUNDWATER MONITORING PROGRAM, JANUARY 2010 (ENVIRONMENTAL QUALITY MANAGEMENT, INC. 2010).

FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

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

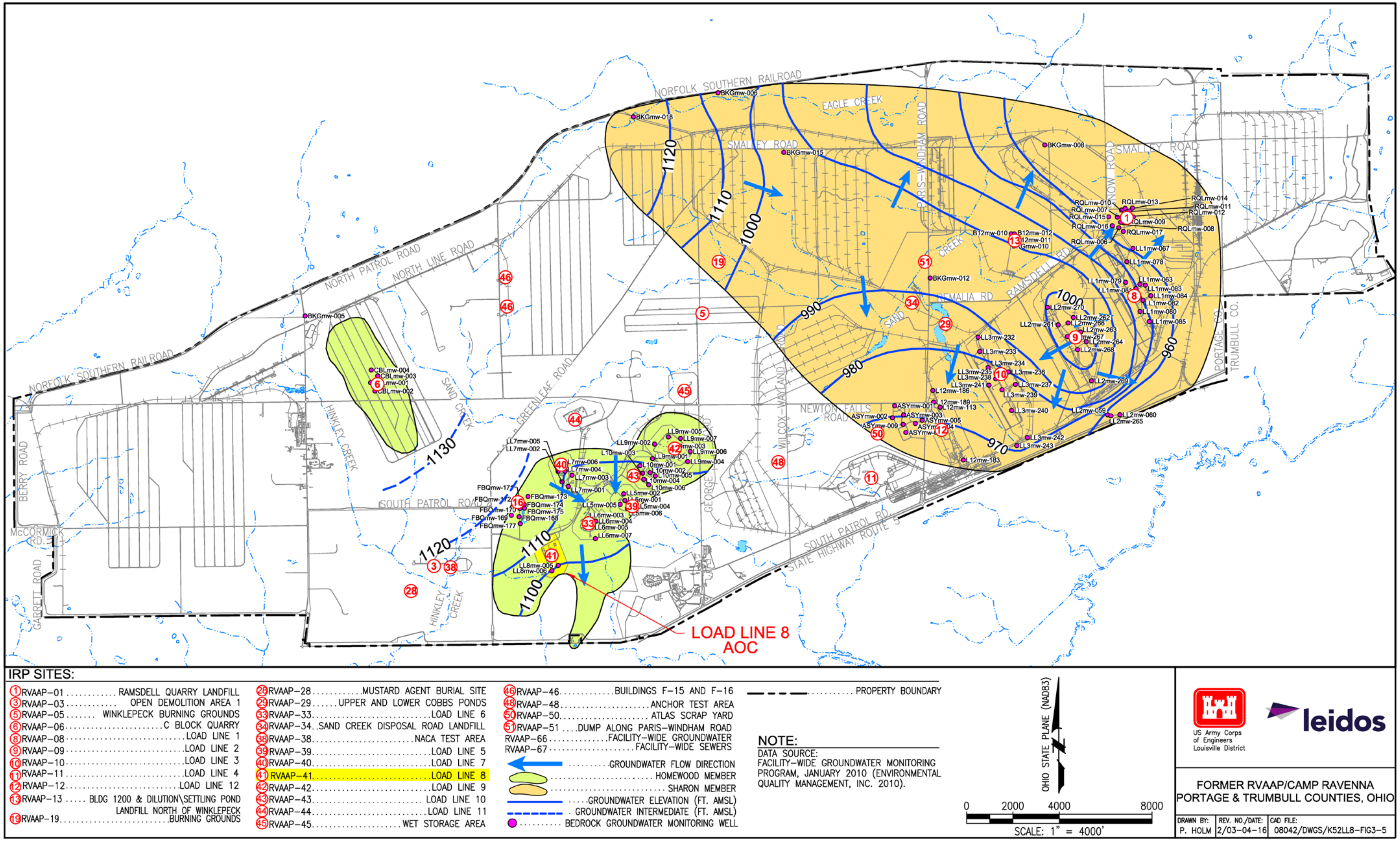

Figure 3-5. Potentiometric Surface of Bedrock Aquifers at Camp Ravenna

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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 8. These previous activities include assessments to prioritize the AOC and investigations that collected data used in support of this RI Report.

4.1 LOAD LINE 8 PREVIOUS ASSESSMENTS AND EVALUATIONS

This section summarizes previous assessments and evaluations conducted at Load Line 8. These activities were generally performed to do 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* 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 8 as part of the assessment. The assessment identified the following conditions at RVAAP as applicable to Load Line 8 (USATHAMA 1978):

- Areas of RVAAP, including the production areas (i.e., Load Lines 5, 7, 8, 10, and 12), burning grounds, test areas, and demolition areas were identified as AOCs contaminated with explosive waste, including TNT, composition B, lead azide, lead styphnate, and black powder;
- Load lines were rehabilitated in 1951; and
- No environmental stress was identified at RVAAP.

4.1.2 Preliminary Assessment Screening of Boundary Load Line Areas

Load Line 8 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 8 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 could be potential contaminant pathways. The assessment recommended further environmental investigation for Load Line 8 (USAEHA 1994).

4.1.3 Relative Risk Site Evaluation for Newly Added Sites

In 1998, the U.S. Army Center for Health Promotion and Preventative Medicine (USACHPPM) completed the *Relative Risk Site Evaluation for Newly Added Sites* (RRSE; USACHPPM 1998) to "provide sufficient data to score RVAAP's newly discovered previously uninvestigated sites…" This document identified and provided a risk evaluation for 13 newly discovered and previously uninvestigated sites for the purpose of prioritizing future remedial or corrective activities. Of the 13 identified AOCs, 5 were assigned a RRSE score of "high," and the remaining 8 were assigned a score of "medium."

The RRSE also included collecting surface soil, subsurface soil, and sediment samples at Load Line 8. 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. The analytical results are not presented and are not used in subsequent evaluations in this RI Report. However, as stated in Appendix I, Section 1.2 of the *Final Sampling and Analysis Plan Addendum for the Characterization of 14 RVAAP AOCs* (MKM 2004), "The results of these investigations (including the RRSE), assessments and evaluations as well as knowledge about Load Line 8's operational history and potential source areas were used to select sampling locations, sampling media, analyses and numbers of samples for this characterization activity."

The RRSE evaluated the soil pathway (human receptor endpoint) using data from the six surface soil samples collected near the former production buildings at Load Line 8 (RV-411 to RV-416). These samples were analyzed for explosives and inorganic chemicals.

The groundwater pathway (human receptor endpoint) was evaluated using the data from one subsurface soil sample (RV-419) collected from 12–16 ft bgs, north-northwest of Building 2B-1. This sample was analyzed for explosives and inorganic chemicals.

Two sediment samples (RV-418 and RV-419) were collected during this evaluation at the conveyance of two ditches in the south-central portion of the AOC, considered a small (approximately 10 ft in diameter) settling pond at that time. Surface water ponds in this area prior to entering a culvert that discharges to a ditch that exits the AOC to the west. Surface water was not evaluated as part of the RRSE as it was considered an intermittent source.

Several inorganic chemicals were detected in surface soil, sediment, and groundwater. Concentrations of analytes detected in surface soil and groundwater are presented in Appendix D of the RRSE (USACHPPM 1998).

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

1. Groundwater
    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. It is unknown if any wells are directly downgradient from this AOC; however, groundwater near the AOC may be used for irrigation or drinking water.
2. Sediment
    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.
3. Surface soil
    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.
4. Surface water
    a. Not evaluated. While surface water is intermittently present at Load Line 8, it was not considered for RRSE scoring.

Human receptor endpoints were evaluated based on the available surface soil, sediment, and groundwater data. The RRSE scored Load Line 8 as a “medium-priority” AOC due to potentially contaminated surface soil, sediment, and groundwater potentially migrating and affecting human and ecological receptors (USACHPPM 1998).

4.2 LOAD LINE 8 REMEDIAL INVESTIGATIONS

This section summarizes previous investigations conducted at Load Line 8 that collected data of sufficient provenance and quality to be used to support the evaluations in this RI Report, including the nature and extent, fate and transport, HHRA, and/or ERA.

Previous reports, such as the Characterization of 14 AOCs report and the *Final Investigation of the Under Slab Surface Soils Post Slab and Foundation Removal at RVAAP-39 Load Line 5, RVAAP-40 Load Line 7, RVAAP-41 Load Line -LL 8, and RVAAP-43 Load Line 10* (USACE 2009a), presented SRCs and/or COPCs based on data evaluation protocols in use at the time the investigations were completed. The data and information is used in this RI Report; 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 “RVAAP full-suite analytes” generally include analyses of target analyte list (TAL) metals, explosives, propellants (nitrocellulose and nitroguanidine), semi-volatile organic compounds (SVOCs), VOCs, PCBs, and pesticides. If an incremental sampling methodology (ISM) sample was analyzed for “RVAAP full-suite analytes,” all parameters except VOCs were collected and analyzed as part of the ISM sample process, and VOCs were analyzed from a discrete soil sample collected within the ISM sample area.

4.2.1 Characterization of 14 AOCs

The Characterization of 14 AOCs data quality objectives (DQOs) were developed to collect and provide sufficient, high-quality data for all applicable media such that future actions (i.e., HHRAs and ERAs) can be efficiently planned and accomplished at each AOC. Data generated by the characterization activities were used to determine if residual contaminants remain at the AOCs; if contaminants impact soil, sediment, surface water, or groundwater; if there is a need for more extensive risk assessments; and if remedial actions are appropriate.

From 2004–2005, sampling was conducted at Load Line 8 in accordance with the *Final Sampling and Analysis Plan Addendum for the Characterization of 14 RVAAP AOCs* (MKM 2004) (herein referred to as the Characterization of 14 AOCs SAP).

The Characterization of 14 AOCs investigation was performed to accomplish the following:

- Provide data for future assessments that may be conducted,
- Develop a conceptual site model (CSM),
- Identify key elements to be considered in future actions,
- Assess potential sources of contamination,
- Identify whether releases of contamination extend beyond the AOC boundary,
- Provide an initial assessment of the nature and lateral extent of contamination, and
- Provide a preliminary human health risk screening (HHRS) evaluation and ecological risk screening (ERS) evaluation.

Results of this characterization are presented in the Characterization of 14 AOCs report (MKM 2007) and are summarized below.

4.2.1.1 <u>Field Activities</u>

The following investigation field activities were conducted from October 2004 to February 2005 to assess potential impacts from former operations at Load Line 8 (MKM 2007):

- Collected 18 multi-increment (MI) surface soil (0–1 ft bgs) samples from dry drainage ditches (2 samples) and around former buildings (16 samples),
- Collected 2 co-located discrete samples for VOC analysis to meet RVAAP full-suite analytical requirements,
- Collected 6 MI sediment (0-0.5 ft bgs) samples from wet ditches,
- Collected 6 surface water samples from wet ditches,
- Collected 1 discrete surface soil (0-1 ft bgs) sample for VOC analysis near the solvent storage building (2B-22),
- Collected 4 surface soil quality assurance/quality control (QA/QC) samples,

- Excavated six test trenches until bedrock or saturated soil was encountered (10.2-12.5 ft bgs), and
- Collected 3 geotechnical samples from monitoring well borings.

The following activities also took place; however, these activities are pertinent to other co-located AOCs associated with Load Line 8 (e.g., Facility-wide Groundwater and Facility-wide Sewers) and are not discussed in this section:

- Collected nine surface water samples from sanitary sewers, sumps, and basements;
- Collected six sediment samples from sewers, sumps, and basins;
- Installed, developed, and sampled six groundwater monitoring wells;
- Completed in-situ permeability testing (slug tests); and
- Completed sampling location and monitoring well survey.

The Characterization of 14 AOCs utilized MI samples. This sampling technique is currently referred to as ISM. Load Line 8 was divided into 18 ISM samples located in portions of the AOC where specific operations occurred and buildings were located. Samples were also collected from dry ditches located within the AOC. Figure 4-1 presents the locations sampled under the Characterization of 14 AOCs.

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 (herein referred to as the FWSAP) current at the time of the investigation, the Characterization of 14 AOCs SAP (MKM 2004), and USACE Louisville Chemistry Guideline (USACE 2002). DQOs were established for the Characterization of 14 AOCs and complied with USEPA Region 5 guidance. The requisite number of QA/QC samples was obtained during the investigation. The data validation determined that the data met the completeness requirements for the project (90% complete), was usable, and that it satisfied the DQOs for the project.

Table 4-1 presents the ISM sample locations, associated operations, and suite of chemicals analyzed as part of the Characterization of 14 AOCs. Table 4-2 presents the results of the analytes detected from samples collected during the Characterization of 14 AOCs.

4.2.1.2 Nature and Extent of Contamination

Contaminants were detected in surface soil (0-1 ft bgs) above RVAAP background concentrations and/or Region 9 residential preliminary remediation goal (PRG) screening values at that time, which included 19 metals, 5 SVOCs, and 1 explosive. Contaminants were detected in sediment above RVAAP background concentrations, Region 9 residential PRGs at that time, and/or laboratory detection limits, which included 20 metals, 1 SVOC, and 2 explosives. Contaminants were detected in surface water above RVAAP background concentrations, Region 9 tap water PRGs at that time, and/or laboratory detection limits, which included 15 metals, 1 VOC, 6 SVOCs, and nitrate. Figure 4-5 presents locations that exceed current screening criteria.

During test trench excavation, trenching was halted upon encountering saturated soil. Saturated conditions were encountered at 10.2 ft bgs in trench LL8tr-001, at 12.5 ft bgs in trench LL8tr-002, at 12 ft bgs in trench LL8tr-003, at 12 ft bgs in trench LL8tr-004, at 12.2 ft bgs in trench LL8tr-005, and at 11.8 ft bgs in trench LL8tr-006. Bedrock was not encountered in the test trenches (MKM 2007). No visual evidence of contamination or munitions or explosives of concern (MEC) were encountered during trenching activities.

4.2.1.3 Human Health Risk Screening

The HHRS compared chemical concentrations detected in the AOC surface soil, sediment, and surface water samples to RVAAP screening criteria in effect at that time, which included facility-wide background concentrations for inorganic constituents and USEPA Region 9 residential PRGs. Constituents were retained if they did not have screening values. The results of the HHRS identified contaminants above screening criteria in surface soil, sediment, and surface water, as summarized in Table 4-3.

4.2.1.4 Ecological Risk Screening

The ERS compared chemical concentrations detected in Load Line 8 surface soil, sediment, and surface water to RVAAP facility-wide background concentrations for inorganic chemicals and ecological screening values (ESVs). The ERS 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 4-4 presents the chemicals identified in the ERS as exceeding screening values for Load Line 8 surface soil, sediment, and surface water.

4.2.1.5 Results and Conclusions

Three metals, five SVOCs, and one propellant were identified as COPCs in surface soil. Five metals were identified as COPCs in sediment, and one metal, one SVOC, and one anion were identified as COPCs in surface water. All VOCs, explosives, pesticides, and PCBs were below Region 9 residential PRGs and/or laboratory detection limits. The Characterization of 14 AOCs report recommended that full HHRAs and ERAs should be considered to assist in the overall risk management decisions for Load Line 8.

4.2.2 Investigation of Under Slab Surface Soil

In 2007, the Investigation of Under Slab Surface Soil was conducted at Load Line 8 in accordance with the *Final Sampling and Analysis Plan RVAAP-39, 40, 41 and 43 for the Exposed Soil Sampling and Characterization After Slab and Foundation Removals at LL5, 7, 8 and 10, Ravenna Army Depot, Ravenna, Ohio* (USACE 2007).

The Investigation of Under Slab Surface Soil was performed to accomplish the following:

- Identify any contaminants remaining in the under slab surface soil,
- Quantify any contaminants identified,
- Determine if any residual contaminants were present at concentrations posing unacceptable risk to future receptors (i.e., end users) by comparing their concentrations to selected criteria applicable at the time of the investigation,
- Assess results and identify areas where additional characterization may be needed, and
- Provide recommendations for further activities.

Results of this characterization are presented in the *Final Investigation of the Under Slab Surface Soils Post Slab and Foundation Removal at RVAAP-39 Load Line 5, RVAAP-40 Load Line 7, RVAAP-41 Load Line -LL 8, and RVAAP-43 Load Line 10* (USACE 2009a) and are summarized in the following subsections.

4.2.2.1 Field Activities

This investigation was performed after the buildings and structures at Load Line 8 were demolished and removed. A total of 13 ISM samples (plus 4 QA/QC samples) were collected from the footprints of 12 former production buildings [excluding the change houses (Buildings 2B-9 and 2B-10) and Time Clock Alley (Building 8-51)] to assess potential impacts on surface soil. Each building consisted of one ISM grid, with the exception of process Building 2B-6 (which was divided into two grids based on its size). All ISM samples collected were analyzed for TAL metals and explosives, and 15% were also analyzed for RVAAP full-suite analytes. Three discrete samples (plus two QA/QC samples) were collected for VOC analysis and were not subject to ISM processing. One of these discrete samples was collected at the location of former Building 2B-22 that was previously used for solvent storage.

4.2.2.2 Results and Conclusions

The investigation compared the analytical results to USEPA Region 9 residential PRG and RVAAP background concentrations. The list below presents a summary of results.

- Six metals were detected above background and/or Region 9 PRGs.
- Two SVOCs, benz(a)anthracene and benzo(b)fluoranthene, were detected above the Region 9 PRG at Building 2B-21 (booster assembly and shipping).
- One propellant compound (nitrocellulose) was detected in the sample collected from Building 2B-2 (tetryl screening storage) at a concentration of 1.7J mg/kg. This result was an estimated concentration.
- One PCB (Aroclor-1254) was detected in the sample collected from Building 2B-4 (tetryl pelleting, melt pour operation) at a concentration of 100 μg/kg but less than the PRG of 0.22 mg/kg.

No VOCs, explosives, herbicides, or pesticides were detected in under slab surface soil. The report concluded that 4 of the 12 process buildings at Load Line 8 had SRCs or COPCs in the surface soil remaining after building demolition and removal. The locations of the SRCs or COPCs are listed below:

- Building 2B-21 [benz(a)anthracene and benzo(b)fluoranthene],
- Building 2B-4 (PCB-1254),
- Building 2B-5 (nickel), and
- Building 2B-12 (chromium).

Figure 4-2 presents the locations sampled during the Investigation of Under Slab Surface Soil. Table 4-5 presents the ISM sample locations, associated operations, and suite of chemicals analyzed as part of the Investigation of Under Slab Surface Soil. Table 4-6 presents the results of the analytes detected from the associated samples.

4.2.3 PBA08 Remedial Investigation – March-April 2010

In November 2008, Science Applications International Corporation (SAIC) scientists performed a site walk of Load Line 8. The site walk was conducted to develop the *Performance-based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1* (herein referred to as the PBA08 SAP) (USACE 2009b), which supplemented the Characterization of 14 AOCs investigation and completed the RI phase of the CERCLA process. Numerous physical changes occurred at Load Line 8 between the 2004 Characterization of 14 AOCs sampling and the development of the PBA08 SAP. As discussed in Section 2.2.3, building demolition activities took place in 2006. The PBA08 SAP considered the prior investigations and changes in AOC conditions when developing the DQOs and sampling scheme for completing the Load Line 8 RI. Section 4.4.4 discusses the suitability and use of samples collected to support this RI Report, 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 4-3 and 4-4, respectively. The screening approach presented in the PBA08 SAP compared sample results from previous investigations at Load Line 8 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 in the *RVAAP Facility-Wide Human Health Risk Assessor's Manual* (USACE 2005a) (herein referred to as the FWHHRAM). 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 a 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 4-7 lists the chemicals with detected concentrations that exceeded screening criteria at the time of the PBA08 SAP in historical soil samples.

In March-April 2010, the PBA08 RI was implemented by collecting surface soil using ISM and discrete sampling techniques and subsurface soil using discrete sampling techniques. Surface water and sediment samples were also collected as part of the PBA08 RI. The results of the PBA08 RI sampling, combined with the results of the Characterization of 14 AOCs and Investigation of Under Slab Surface Soil, 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, as 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 lithologic soil description for each soil boring collected during the PBA08 RI is 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 at the AOC 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 or within sediment accumulation areas such as ditches). Table 4-8 presents the specific rationale for each surface soil sample collected during the PBA08 RI in March 2010. Tables 4-9 and 4-10 present the results of the analytes detected from surface soil samples collected during the PBA08 RI in March 2010. All PBA08 RI and historical sample locations used in this evaluation are presented on Figure 4-7.

Three source area investigation ISM samples were collected around former ISM sample areas to delineate locations where chemicals were detected above FWCUGs (HQ of 1, TR of 1E-05) and to further define the lateral extent of contamination (Figure 4-5). Nine ISM samples were collected in the NPA (including one along dry ditch), and six ISM samples were collected in the FPA, including one surrounding former change house buildings (2B-9 and 2B-10) to complete characterization of the AOC. The sample locations in the PBA08 SAP were derived from the sample polygons provided during the development of the PBA08 SAP. Three ISM samples (15% of the total number of ISM samples collected) were analyzed for RVAAP full suite analytes.

4.2.3.2 Surface Soil Sampling Rationale – Large ISM Samples

A total of 13 large grid ISM samples (samples LL8ss-074M, LL8ss-075M, LL8ss-077M through LL8ss-087M) were collected to complete characterization of the AOC with the objective of providing sample coverage for those portions of the AOC not covered by ISM samples intended to delineate specific sources. The large grid ISM samples included historical operations areas and also provided complete sample coverage in outlying portions of the AOC. Grid ISM sample locations ranged from 1.74–4.26 acres, encompassing the entirety of the AOC. The individual large grid ISM samples included all areas within each grid boundary, including other ISM sample locations intended to delineate specific sources that overlapped with the large grid ISM samples. Table 4-8 presents the specific rationale for each grid ISM surface soil sample collected under the PBA08 SAP. Table 4-9 presents the analytes detected from the large grid ISM samples collected during the PBA08 RI.

4.2.3.3 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 from 0–1 ft bgs were collected in accordance with the bucket hand auger method described in Section 4.5.2.1.1 of the FWSAP (USACE 2001a). All three samples were collected from areas previously identified as having elevated total chromium concentrations (LL8ss-003M, LL8ss-008M, and LL8ss-017M). One additional speciation sample was collected in October 2010 to correspond to the highest detected total chromium results from the March 2010 PBA08 ISM samples at LL8ss-072M. The rationale for all samples collected as part of the PBA08 RI is summarized in Table 4-10. The locations of these samples are presented in Figure 4-5 and results are presented in Table 4-11.

4.2.3.4 Subsurface Soil Sampling Rationale and Methods

The PBA08 RI used discrete samples from soil borings to complete the characterization of 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 (e.g., within PBA08 ISM sample areas) 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. Soil samples from eight soil borings installed in ISM areas with historical screening criteria exceedances were collected to further delineate the vertical extent of contamination in subsurface soil at the AOC (Figure 4-5). Table 4-12 presents the specific rationale for each subsurface soil sample collected for the PBA08 RI. Results of detected analytes are presented in Table 4-13.

To assess the depths of exposure of the Resident Receptor, each soil boring was sampled at the 0–1, 1–4, 4–7, and 7–13 ft bgs interval. These sample intervals were selected 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) would be 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.

One 7-13 ft bgs sample (LL8SB-060-5349-SO) was analyzed due to preliminary screening criteria exceedances for arsenic (26.9 mg/kg) within the 4-7 ft bgs sample interval (LL8SB-060-5348-SO). One sample (LL8SB-067-5376-SO) collected from the 7-13 ft bgs sample interval was submitted for laboratory analysis at Load Line 8 to ensure adequate characterization of the subsurface soil to 13 ft bgs was performed.

All samples were analyzed for TAL metals, explosives, and PAHs; six samples were analyzed for RVAAP full-suite analytes to satisfy the PBA08 SAP sample requirements of a minimum of 15% frequency for full-suite analysis. Three QC field duplicates and three QA split samples were collected to satisfy the QA/QC sample requirements of 10% frequency for subsurface soil samples.

No geotechnical samples were collected at this AOC. Geotechnical samples were collected at Load Lines 7, 10, and 11 during the PBA08 RI and data generated from these samples were used for fate and transport modeling in this RI Report.

4.2.3.5 Surface Water and Sediment Rationale and Methods

Surface water and sediment samples were collected to characterize current conditions and assess potential exit pathways from the AOC (Figure 4-5). Three co-located surface water and sediment samples were collected from the ditches exiting the AOC during the PBA08 RI. The samples were collected at points where contamination may migrate out of the AOC area, such as a ditch or a stream near the AOC boundary, to characterize current conditions and determine whether contaminant migration may occur at surface water runoff exit points.

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 nitrates and RVAAP full-suite analytes. One QC field duplicate and one QA split sample was collected for surface water at this AOC. 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. 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.

The sample collected from location LL8sd-091 was analyzed for RVAAP full-suite analytes, and locations LL8sd-090 and LL8sd-092 were analyzed for TAL metals, explosives, and SVOCs. For

VOC analysis, one discrete sample collected from 0.5 ft bgs was collected within the 5-ft sampling radius of the discrete sample location and placed directly in the appropriate, labeled, sample container. One QC field duplicate and one QA split sample was collected for sediment at this AOC. Table 4-14 presents the specific rationale for the surface water and sediment samples collected for the PBA08 RI. The locations of these samples are presented in Figure 4-5 and results are presented in Table 4-15 and Table 4-16 for sediment and surface water, respectively.

4.2.3.6 Changes from the Work Plan

Significant changes to the PBA08 SAP are documented in the field change requests provided in Appendix B. Changes made in the field based on AOC-specific conditions are not documented on field change requests but on the field sampling logs (Appendix A). Only three changes were made in the field, as presented below:

- Location LL8sw/sd-092 is noted on the plan as location LL8sw/sd-089. However, the map shows the location as LL8sw/sd-092. The sampling labels were changed to LL8sw/sd-092. No new coordinates were required.
- Sample LL8ss-089M-5404-SO was collected in the wet ditch, so it is evaluated as sediment in this report, not as surface soil as presented in the PBA08 SAP.
- One surface water sample (LL8sw-090-5818-SW) was re-collected in April 2011 from the southeast drainage ditch for RVAAP full-suite analysis because the previous surface water sample (LL8sw-090-5384-SW) indicated elevated concentrations of aluminum, barium, and iron. As this sample was collected after the original PBA08 RI and showed significant reductions in these analytes (and other analytes), these results are used solely for qualitative purposes as part of the SRC screen, HHRA, and ERA.

New coordinates for all station locations can be found on the field sampling logs.

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 site visits from 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, 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 to determine 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 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 media. 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 facility-wide background concentrations would only be applicable for inorganics. All organic analytes (e.g., PAHs, 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 or inorganics are presented in Table 4-17.

4.4 DATA EVALUATION METHOD

Data evaluation methods for Load Line 8 are consistent with those established in the FWCUG Report and specified in the PBA08 SAP (USACE 2009b). The process 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 8 data were grouped (aggregated) in three ways to evaluate 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 8 are as follows:

- Surface soil (0-1 ft bgs): This medium was evaluated on an ISM sample by ISM sample basis.
- Subsurface soil (greater than 1 ft bgs): Includes data from discrete sample intervals 1–4, 4–7, and 7–13 ft bgs: this medium was evaluated as an AOC-wide aggregate.
- Sediment: The drainage ditches aggregate encompasses the intermittent drainage conveyances and gullies which were constructed to direct surface water runoff ultimately towards the unnamed tributary to Hinkley Creek at the southwest side of Load Line 8.
- Surface water: This medium was evaluated on the same basis as sediment.

The soil data aggregates were further subdivided to define HHRA and ERA EUs, as discussed in Section 7.1.1.

4.4.2 Data Verification, Reduction, and Screening

4.4.2.1 Data Verification

Data verification was performed on 62 surface soil, subsurface soil, sediment, and surface water samples (including QC duplicates) collected during the PBA08 RI in March-April 2010, and the surface water sample collected in April 2011. Data from the Characterization of 14 AOCs and Investigation of Under Slab Surface Soil were verified and completed as presented in these respective summary reports. Analytical results were reported by the laboratory in electronic format and loaded into the Ravenna Environmental Information Management System (REIMS) 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.
- “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 historic and current AOC data were extracted from the database. Results from QA 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. The ISM and associated discrete (for VOC analysis) samples were used in the SRC screening process for surface soil (0–1 ft bgs). All subsurface soil samples collected under the PBA08 RI were discrete samples and screened for SRCs.

Additional screening of identified SRCs against applicable criteria (e.g., USEPA 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 8 in accordance with the FWCUG Report. The steps involved in the SRC screening process are summarized below. All chemicals that were not eliminated during the screening steps were retained as SRCs.

- **Data quality assessment:** Review 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 naturally occurring 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 daily allowance (RDA) and recommended daily intake (RDI) values are available for all of these chemicals (Table 4-18). 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 screening levels (SLs) were eliminated as SRCs.
- **Frequency-of-detection/WOE screening:** The FWCUG Report and *Final (Revised) USACE RVAAP Position Paper for the Application and Use of Facility-Wide Human Health Cleanup Goals* (USACE 2012b) (herein 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 exception of explosives and propellants) detected in less than 5% of the discrete samples are screened out from further consideration if the sample population consists of 20 or more samples and evidence exists that the analyte is not AOC related. However, for this AOC, no frequency-of-detection screening was performed for subsurface soil, sediment, or surface water because fewer than 20 discrete samples were available for these data sets. Frequency-of-detection screening was not applied to ISM 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 8 are presented for each medium. Analytical results for SRCs are also presented in data summary tables: Tables 4-19 and 4-20 provide data for surface soil, Table 4-21 provides data for subsurface soil, Tables 4-22 and 4-23 provide data for sediment, and Table 4-24 provides data 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 data packages associated with different AOCs. All samples for Load Line 8 have sample identifications beginning with “LL8.”

The tables in Appendix D present the analytical results for samples collected during the PBA08 RI, Characterization of 14 AOCs (MKM 2007), and Investigation of Under Slab Surface Soil (USACE 2009a). Sample locations from these investigations are presented on Figure 4-7. Analytical results are grouped by media (e.g., surface soil, subsurface soil) and class of analyte (e.g., explosives, metals) 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 vs. ISM). Table 4-25 presents the designated use for all available Load Line 8 samples.

4.4.4.1 Surface Soil

Surface and subsurface soil samples at Load Line 8 were collected during the Characterization of 14 AOCs, Investigation of Under Slab Surface Soil, and PBA08 RI. Soil in the vicinity of former production buildings was extensively disturbed during building demolition activities at Load Line 8 in 2006. The work areas were re-graded, cavities were filled with approved fill dirt as needed, and the area was vegetated in 2007 (PIKA 2007). Samples from the 2004 Characterization of 14 AOCs and the 2007 Investigation of Under Slab Surface Soil data sets were evaluated to determine if conditions had changed substantively between earlier characterization efforts and PBA08 RI activities.

Demolition and removal of the remaining buildings at Load Line 8 occurred in 2006. The samples collected in 2004 were collected within dry ditch lines peripheral to the former buildings and in other areas extending substantially beyond the now-demolished buildings. The 2007 Investigation of Under Slab Surface Soil sampling was conducted within the footprints of the demolished buildings following slab removal and exposure of the underlying surface soil. Therefore, both of these data sets were considered representative of current conditions within and surrounding the footprints of the former buildings at Load Line 8 and were included for evaluation in the RI.

The 1998 RRSE samples RV-411 to RV-416 and RV-419 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 (USACHPPM 1998)."

Two types of surface soil samples were collected during the investigation of Load Line 8: discrete and ISM samples. Discrete surface soil samples were collected to evaluate VOCs and as part of the first interval (0-1 ft bgs) of a soil boring. The discrete surface soil samples collected to evaluate VOCs that were considered representative of the ISM sample in which they were taken were used in the SRC screening process and carried forward into the risk assessment along with their corresponding ISM sample. Discrete samples from the 0–1 ft bgs shallow soil interval collected from co-located subsurface soil boring locations during the PBA08 RI were retained for nature and extent evaluation only.

None of the ISM surface soil samples from the PBA08 RI were eliminated from the SRC screening process.

4.4.4.2 Subsurface Soil

The SRC data set for subsurface soil is comprised only of PBA08 RI samples. All subsurface soil samples were applicable for use in this assessment and are included in the SRC screening data set.

4.4.4.3 Sediment

The SRC data set for sediment is comprised of Characterization of 14 AOCs and PBA08 RI samples. Seven sediment samples were collected from the sanitary sewer system and/or sumps during the Characterization of 14 AOCs but were excluded from SRC screening data set. Sediment samples were also collected from the sanitary sewer system during the Facility-wide Sewers RI in 2009-2010 (USACE 2012a), these samples 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, if a PBA08 RI sample was obtained from a 2004 location, the PBA08 RI result was considered representative of current conditions and was 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 evaluating contaminant nature and extent (e.g., temporal trends). Sample LL8ss-089M-5404-SO was collected in the wet drainage ditch, so it is evaluated as sediment in this report, not as surface soil as presented in the PBA08 SAP.

The 1998 RRSE samples RV-417 and RV-418 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 (USACHPPM 1998)."

4.4.4.4 Surface Water

The SRC data set for surface water is comprised of Characterization of 14 AOCs and PBA08 RI samples. Eleven surface water samples were collected from the sanitary sewer system and/or sumps during the Characterization of 14 AOCs, and surface water samples were also collected from the sanitary sewer system during the Facility-wide Sewers RI in 2009-2010 (USACE 2012a). These samples 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). Surface water samples were collected from the previously existing basements in former Buildings 2B-9 and 2B-10. As noted in Section 2.2.3, the basement water was removed and disposed of offsite during building decontamination and demolition activities. (PIKA 2007)

For surface water data from the drainage ditches, if a PBA08 RI sample was obtained from a 2004 location, the PBA08 RI result was considered representative of current conditions and was 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).

One surface water sample (LL8sw-090-5818-SW) was re-collected in April 2011 from the southeast drainage ditch for RVAAP full-suite analysis because the previous surface water sample (LL8sw-090-5384-SW) indicated elevated concentrations of aluminum, barium, and iron. As this sample was collected after the original PBA08 RI and showed significant reductions in these analytes (and other analytes), these results are used solely for qualitative purposes as part of the SRC screen, nature and extent evaluation, HHRA, and ERA.

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Table 4–1. Characterization of 14 AOCs Sampling Locations

Characterization of 14 AOCs Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
LL8ss-001M	0–1	Metals, explosives	Building 2B-7	1941-1945–Utilized for testing boosters. 1970 Era–Utilized for curing.	None	Tetryl, mercury fulminate, lead azide, Octol [TNT and HMX], RDX
LL8ss-002M	0–0.5	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-6	1941-1945–Utilized for booster assembly and shipping. Detonators from Load Line 9 were used in the assembly process. 1970 Era–Utilized for shipping and receiving.	None	Tetryl, mercury fulminate, lead azide
LL8ss-003M	0–0.5	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-6	1941-1945–Utilized for booster assembly and shipping. Detonators from Load Line 9 were used in the assembly process. 1970 Era–Utilized for shipping and receiving.	None	Tetryl, mercury fulminate, lead azide
LL8ss-004M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-21	1941-1945–Utilized for booster assembly and shipping. Detonators from Load Line 9 were used in the assembly process. 1970 Era–Not in use.	None	Tetryl, mercury fulminate, lead azide
LL8ss-005D	0–0.5	VOCs	Building 2B-21	1941-1945–Utilized for booster assembly and shipping. Detonators from Load Line 9 were used in the assembly process. 1970 Era–Not in use.	None	Tetryl, mercury fulminate, lead azide
LL8ss-005M	0–0.5	Full suite				
LL8ss-006M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-5	1941-1945–Utilized for detonator storage. Detonators were manufactured at Load Line 9 and arrived containerized at Load Line 8. 1970 Era–Not in Use	None	Mercury fulminate, lead azide
LL8ss-007M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-17	1941-1945–Utilized as cupped pellet rest house. 1970 Era–Not in use	None	Tetryl
LL8ss-008M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-22	1941-1945–Utilized for solvent storage. 1970 Era–Not in use.	None	Solvents
LL8ss-019	0–1	VOCs				
LL8ss-009M	0–0.5	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-13	1941-1945–Utilized as tetryl cupping building. 1970 Era–Not in use.	None	Tetryl
LL8ss-010M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-13	1941-1945–Utilized as tetryl cupping building. 1970 Era–Not in use Also QC sample collected.	None	Tetryl
LL8ss-011M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-4	1941-1945–Utilized as tetryl pelleting (manufacturing) building. 1970 Era–Utilized for melt pour and assembly.	None	Tetryl, Octol [TNT and HMX], RDX
LL8ss-012M	0–0.5	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-4	1941-1945–Utilized as tetryl pelleting (manufacturing) building. 1970 Era–Utilized for melt pour and assembly.	None	Tetryl, Octol [TNT and HMX], RDX
LL8ss-013M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-3	1941-1945–Utilized as a tetryl rest house. 1970 Era–Not in Use. Also QA sample collected.	None	Tetryl
LL8ss-014M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-12	1941-1945–Utilized for tetryl pellet storage. 1970 Era–Utilized for S & A device with detonator storage.	None	Tetryl, Octol [TNT and HMX], Mercury fulminate, lead azide
LL8ss-015D	0–1	VOCs	Building 2B-1	1941-1945–Utilized for tetryl storage. 1970 Era–Not in use.	None	Tetryl
LL8ss-015M	0–1	Full suite				
LL8ss-016M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-2	1941-1945–Utilized for tetryl screening and blending. 1970 Era–Utilized for Octol storage.	None	Tetryl, Octol [TNT and HMX]
LL8ss-017M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Drainage Ditch	Drainage ditch constructed in northern portion of former production area near Buildings 2B-21, 2B-17, and 2B-5.	None	Metals, explosives
LL8ss-018M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Drainage Ditch	Drainage ditch constructed in central portion of former production area between Buildings 2B-3 and 2B-4.	None	Metals, explosives

AOC = Area of concern.
bgs = Below ground surface.
ft = Feet.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane.
NPA = Non-production area.
PAH = Polycyclic aromatic hydrocarbon.
PBA08 RI = Performance-Based Acquisition 2008 Remedial Investigation.
QA = Quality assurance.
QC= Quality control.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
S&A = Safe and arm.
TNT = 2,4,6-Trinitrotoluene.
VOC = Volatile organic compound.

Table 4–2. Analytes Detected in Characterization of 14 AOCs Surface Soil Samples

Station		**LL8ss-001M**	**LL8ss-002M**	**LL8ss-003M**	**LL8ss-004M**	**LL8ss-005D**	**LL8ss-005D**	**LL8ss-005M**	**LL8ss-005M**	**LL8ss-006M**	**LL8ss-007M**
Sample ID		**LL8ss-001M-SO**	**LL8ss-002M-SO**	**LL8ss-003M-SO**	**LL8ss-004M-SO**	**LL8ss-005D-DUP**	**LL8ss-005D-SO**	**LL8ss-005M-DUP**	**LL8ss-005M-SO**	**LL8ss-006M-SO**	**LL8ss-007M-SO**
Date		**10/27/04**	**10/27/04**	**10/27/04**	**10/29/04**	**11/01/04**	**11/01/04**	**11/01/04**	**11/01/04**	**10/27/04**	**11/01/04**
Depth (ft)		**0.0 - 1.0**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 1.0**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed[a] **Analyte**	**Background Criteria[b]**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**VOCs**	**VOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives**	**TAL Metals, Explosives**
Metals (mg/kg)											
Aluminum	17700	9100	4900	16000	3400	NR	NR	15000	15000	12000	10000
Arsenic	15.4	12	4.3	7.3	6.5	NR	NR	4.3	4	8.1	10
Barium	88.4	**150***	**140***	**180***	**110***	NR	NR	**220***	**260***	**110***	59
Beryllium	0.88	0.68	0.85	**4.3***	0.47	NR	NR	**3.5***	**3.5***	**1.6***	0.61
Cadmium	0	<0.24U	**1.4***	**0.99***	**2.8***	NR	NR	**1.4***	**1.4***	**0.16***	<0.26U
Calcium	15800	8100	**110000***	**83000***	**150000***	NR	NR	**180000***	**180000***	**38000***	3600
Chromium	17.4	**26***	**36***	**39***	14	NR	NR	**36***	**35***	**22***	**22***
Cobalt	10.4	7.9	3.5	2.6	4.2	NR	NR	2.4	2.3	5.1	7.5
Copper	17.7	**23***	**67***	**18***	**30***	NR	NR	**23***	**24***	14	15
Iron	23100	19000	11000	10000	11000	NR	NR	14000	9600	15000	19000
Lead	26.1	**88***	**89***	**120***	**210***	NR	NR	**110***	**110***	**53***	**42***
Magnesium	3030	2500	2800	**12000***	2100	NR	NR	**13000***	**13000***	**5400***	2400
Manganese	1450	500	690	**2400***	500	NR	NR	**1800***	**1800***	1100	380
Mercury	0.036	**0.04***	**0.06***	0.03	**0.05J***	NR	NR	**0.04***	0.03	**0.04***	0.03
Nickel	21.1	20	**24***	21	17	NR	NR	16	17	16	19
Potassium	927	**1100***	770	**1100***	760	NR	NR	**1300***	**1300***	**1300***	**1300***
Selenium	1.4	<1.4U	0.75	1.4	0.93	NR	NR	0.85	1.2	0.51	<1.6U
Sodium	123	**330***	**340***	**1700***	**190***	NR	NR	**930***	**930***	**790***	**250***
Thallium	0	**0.2***	<0.55U	<0.63U	<0.58U	NR	NR	<0.68U	<0.66U	<0.55U	<0.6U
Vanadium	31.1	16	7.3	12	6.7	NR	NR	10	9.4	16	18
Zinc	61.8	**96***	**140***	**150***	**220***	NR	NR	**170***	**160***	**67***	**68***
Explosives/Propellants (mg/kg)											
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	**2.5***	**2.2***	NR	NR
Tetryl	None	<0.4U	<0.39U	<0.4U	<0.39U	NR	NR	<0.39U	<0.4U	<0.39U	<0.4U
SVOCs (mg/kg)											
2-Methylnaphthalene	None	NR	NR	NR	NR	NR	NR	**0.075***	**0.086***	NR	NR
Acenaphthylene	None	NR	NR	NR	NR	NR	NR	<0.036U	**0.01J***	NR	NR
Anthracene	None	NR	NR	NR	NR	NR	NR	**0.013J***	**0.018J***	NR	NR
Benz(a)anthracene	None	NR	NR	NR	NR	NR	NR	**0.064***	**0.082***	NR	NR
Benzenemethanol	None	NR	NR	NR	NR	NR	NR	<0.73U	<0.74U	NR	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	NR	**0.09***	**0.12***	NR	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	NR	**0.14***	**0.17***	NR	NR
Benzo(ghi)perylene	None	NR	NR	NR	NR	NR	NR	**0.045***	**0.06***	NR	NR
Benzo(k)fluoranthene	None	NR	NR	NR	NR	NR	NR	**0.067***	**0.088***	NR	NR
Bis(2-ethylhexyl)phthalate	None	NR	NR	NR	NR	NR	NR	<0.18U	<0.18U	NR	NR
Chrysene	None	NR	NR	NR	NR	NR	NR	**0.097***	**0.11***	NR	NR
Di-n-butyl phthalate	None	NR	NR	NR	NR	NR	NR	<0.18U	**0.033J***	NR	NR
Dibenz(a,h)anthracene	None	NR	NR	NR	NR	NR	NR	**0.014J***	**0.015J***	NR	NR
Dibenzofuran	None	NR	NR	NR	NR	NR	NR	**0.022J***	**0.025J***	NR	NR
Fluoranthene	None	NR	NR	NR	NR	NR	NR	**0.13***	**0.17***	NR	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	NR	NR	NR	**0.043***	**0.054***	NR	NR
Naphthalene	None	NR	NR	NR	NR	NR	NR	**0.054***	**0.059***	NR	NR

Table 4–2. Analytes Detected in Characterization of 14 AOCs Surface Soil Samples (continued)

Station		**LL8ss-001M**	**LL8ss-002M**	**LL8ss-003M**	**LL8ss-004M**	**LL8ss-005D**	**LL8ss-005D**	**LL8ss-005M**	**LL8ss-005M**	**LL8ss-006M**	**LL8ss-007M**
Sample ID		**LL8ss-001M-SO**	**LL8ss-002M-SO**	**LL8ss-003M-SO**	**LL8ss-004M-SO**	**LL8ss-005D-DUP**	**LL8ss-005D-SO**	**LL8ss-005M-DUP**	**LL8ss-005M-SO**	**LL8ss-006M-SO**	**LL8ss-007M-SO**
Date		**10/27/04**	**10/27/04**	**10/27/04**	**10/29/04**	**11/01/04**	**11/01/04**	**11/01/04**	**11/01/04**	**10/27/04**	**11/01/04**
Depth (ft)		**0.0 - 1.0**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 1.0**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed[a]		**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**VOCs**	**VOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives**	**TAL Metals, Explosives**
Analyte	**Background Criteria[b]**										
Phenanthrene	None	NR	NR	NR	NR	NR	NR	**0.09***	**0.12***	NR	NR
Phenol	None	NR	NR	NR	NR	NR	NR	<0.18U	<0.18U	NR	NR
Pyrene	None	NR	NR	NR	NR	NR	NR	**0.099***	**0.13***	NR	NR
PCBs (mg/kg)											
PCB-1254	None	NR	NR	NR	NR	NR	NR	**0.011J***	**0.019J***	NR	NR
beta-BHC	None	NR	NR	NR	NR	NR	NR	**0.0025***	**0.0027***	NR	NR

Table 4–2. Analytes Detected in Characterization of 14 AOCs Surface Soil Samples (continued)

Station		**LL8ss-008M**	**LL8ss-009M**	**LL8ss-010M**	**LL8ss-010M**	**LL8ss-011M**	**LL8ss-012M**	**LL8ss-013M**	**LL8ss-013M**	**LL8ss-014M**	**LL8ss-015D**
Sample ID		**LL8ss-008M-SO**	**LL8ss-009M-SO**	**LL8ss-010M-DUP**	**LL8ss-010M-SO**	**LL8ss-011M-SS**	**LL8ss-012M-SS**	**LL8ss-013M-SS**	**LL8ss-013M-QA**	**LL8ss-014M-SO**	**LL8ss-015D-SO**
Date		**11/01/04**	**11/01/04**	**11/01/04**	**11/01/04**	**11/02/04**	**11/02/04**	**11/02/04**	**11/02/04**	**11/01/04**	**11/02/04**
Depth (ft)		**0.0 - 1.0**	**0.0 - 0.5**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 0.5**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed[a] **Analyte**	**Background Criteria[b]**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**VOCs**
Metals (mg/kg)											
Aluminum	17700	10000	17000	8300	8100	7300	8600	10000	10000	12000	NR
Arsenic	15.4	7.6	5.3	7.5	7.6	11	11	11	11	9.2	NR
Barium	88.4	**100***	**190***	70	76	52	65	60	63	**100***	NR
Beryllium	0.88	**1.7***	**3.4***	0.69	0.71	0.57	0.62	0.67	0.73	**1.2***	NR
Cadmium	0	**0.29***	**1.1***	**0.73***	**0.59J***	**0.73***	**1.9***	<0.25U	<0.23U	**0.4***	NR
Calcium	15800	**59000***	**80000***	3100	3300	3700	3000	3900	6200	**43000***	NR
Chromium	17.4	**19***	**34***	**27***	**27***	**25***	**19***	**20***	**19***	**21***	NR
Cobalt	10.4	4.1	3	8.2	8.1	6.4	6.2	8.5	8	7	NR
Copper	17.7	12	**22***	**22***	**23***	**34***	**39***	16	**19***	**18***	NR
Iron	23100	14000	14000	19000	19000	20000	20000	19000	20000	18000	NR
Lead	26.1	**27***	**99***	**84***	**80***	**75***	**71***	**41***	**47***	**76***	NR
Magnesium	3030	**6100***	**12000***	2100	2100	2100	2000	2500	2800	**5400***	NR
Manganese	1450	1200	**1700***	380	380	410	400	480	460	760	NR
Mercury	0.036	0.02	**0.04***	**0.06***	**0.06***	**0.87***	**0.26***	**0.05***	**0.04***	0.03	NR
Nickel	21.1	13	14	23*	**24***	21	17	19	19	19	NR
Potassium	927	**1200***	**1200***	**1100***	**1000J***	890	**950***	**1200***	**1200***	**1600***	NR
Selenium	1.4	<1.6U	1.1	<1.7U	<1.7U	<1.4U	<1.4U	<1.5U	<1.4U	<1.6U	NR
Sodium	123	**570***	**590***	**250***	**230***	**240***	**230***	**280***	**290***	**340***	NR
Thallium	0	<0.63U	<0.76U	<0.66U	<0.67U	<0.58U	<0.59U	<0.6U	<0.59U	<0.64U	NR
Vanadium	31.1	13	11	15	15	14	16	18	17	16	NR
Zinc	61.8	56	**120***	**140***	**140***	**110***	**130***	**85***	**87***	**110***	NR
Aluminum	17700	10000	17000	8300	8100	7300	8600	10000	10000	12000	NR
Explosives/Propellants (mg/kg)											
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tetryl	None	<0.4U	<0.4U	<0.39U	<0.4U	<0.4U	**0.63***	<0.4U	<0.4U	<0.4U	NR
SVOCs (mg/kg)											
2-Methylnaphthalene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Acenaphthylene	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
Benzenemethanol	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
Di-n-butyl phthalate	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
Dibenzofuran	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

Table 4–2. Analytes Detected in Characterization of 14 AOCs Surface Soil Samples (continued)

Station		**LL8ss-008M**	**LL8ss-009M**	**LL8ss-010M**	**LL8ss-010M**	**LL8ss-011M**	**LL8ss-012M**	**LL8ss-013M**	**LL8ss-013M**	**LL8ss-014M**	**LL8ss-015D**
Sample ID		**LL8ss-008M-SO**	**LL8ss-009M-SO**	**LL8ss-010M-DUP**	**LL8ss-010M-SO**	**LL8ss-011M-SS**	**LL8ss-012M-SS**	**LL8ss-013M-SS**	**LL8ss-013M-QA**	**LL8ss-014M-SO**	**LL8ss-015D-SO**
Date		**11/01/04**	**11/01/04**	**11/01/04**	**11/01/04**	**11/02/04**	**11/02/04**	**11/02/04**	**11/02/04**	**11/01/04**	**11/02/04**
Depth (ft)		**0.0 - 1.0**	**0.0 - 0.5**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 0.5**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed[a] **Analyte**	**Background Criteria[b]**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**VOCs**
Phenanthrene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Phenol	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pyrene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
PCBs (mg/kg)											
PCB-1254	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
beta-BHC	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 4–2. Analytes Detected in Characterization of 14 AOCs Surface Soil Samples (continued)

Station		**LL8ss-015M**	**LL8ss-016M**	**LL8ss-017M**	**LL8ss-018M**	**LL8ss-019**
Sample ID		**LL8ss-015M-SO**	**LL8ss-016M-SO**	**LL8ss-017M-SO**	**LL8ss-018M-SO**	**LL8ss-019-SO**
Date		**11/02/04**	**11/01/04**	**10/29/04**	**11/01/04**	**11/19/04**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed[a]		**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**VOCs**
Analyte	**Background Criteria**[b]					
Metals (mg/kg)						
Aluminum	17700	11000	9400	15000	11000	NR
Arsenic	15.4	8.8	11	12	12	NR
Barium	88.4	83	**120***	**94***	**99***	NR
Beryllium	0.88	**0.94***	0.66	0.83	0.8	NR
Cadmium	0	**0.19***	**0.63***	**0.11***	<0.28U	NR
Calcium	15800	**23000***	5600	3100	3300	NR
Chromium	17.4	**23***	**27***	**22***	**33***	NR
Cobalt	10.4	7	7	9.7	10	NR
Copper	17.7	17	**25***	**19***	**22***	NR
Iron	23100	18000	19000	**27000***	**25000***	NR
Lead	26.1	**31***	**150***	25	25	NR
Magnesium	3030	**3600***	2600	**3200***	2700	NR
Manganese	1450	430	430	470	440	NR
Mercury	0.036	0.03	**0.12***	**0.04***	**0.06***	NR
Nickel	21.1	19	21	**22***	**27***	NR
Potassium	927	**1400***	**1300***	**1700***	**1100J***	NR
Selenium	1.4	<1.5U	<1.5U	<1.5U	<1.7U	NR
Sodium	123	**280***	**250***	**280***	**290***	NR
Thallium	0	<0.59U	<0.63U	<0.61U	<0.62U	NR
Vanadium	31.1	17	17	26	22	NR
Zinc	61.8	**73***	**160***	**130***	**140***	NR
Explosives/Propellants (mg/kg)						
Nitrocellulose	None	**1.4***	NR	NR	NR	NR
Tetryl	None	<0.4U	<0.39U	<0.39U	<0.4U	NR
SVOCs (mg/kg)						
2-Methylnaphthalene	None	**0.012J***	NR	NR	NR	NR
Acenaphthylene	None	<0.033U	NR	NR	NR	NR
Anthracene	None	**0.015J***	NR	NR	NR	NR
Benz(a)anthracene	None	**0.053***	NR	NR	NR	NR
Benzenemethanol	None	**0.45J***	NR	NR	NR	NR
Benzo(a)pyrene	None	**0.043***	NR	NR	NR	NR
Benzo(b)fluoranthene	None	**0.06***	NR	NR	NR	NR
Benzo(ghi)perylene	None	**0.028J***	NR	NR	NR	NR
Benzo(k)fluoranthene	None	**0.03J***	NR	NR	NR	NR
Bis(2-ethylhexyl)phthalate	None	**0.062J***	NR	NR	NR	NR
Chrysene	None	**0.073***	NR	NR	NR	NR
Di-n-butyl phthalate	None	<0.17U	NR	NR	NR	NR
Dibenz(a,h)anthracene	None	<0.033U	NR	NR	NR	NR
Dibenzofuran	None	<0.067U	NR	NR	NR	NR
Fluoranthene	None	**0.11***	NR	NR	NR	NR
Indeno(1,2,3-cd)pyrene	None	**0.025J***	NR	NR	NR	NR
Naphthalene	None	**0.012J***	NR	NR	NR	NR

Table 4–2. Analytes Detected in Characterization of 14 AOCs Surface Soil Samples (continued)

Station		**LL8ss-015M**	**LL8ss-016M**	**LL8ss-017M**	**LL8ss-018M**	**LL8ss-019**
Sample ID		**LL8ss-015M-SO**	**LL8ss-016M-SO**	**LL8ss-017M-SO**	**LL8ss-018M-SO**	**LL8ss-019-SO**
Date		**11/02/04**	**11/01/04**	**10/29/04**	**11/01/04**	**11/19/04**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed[a]		**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**VOCs**
Analyte	**Background Criteria[b]**					
Phenanthrene	None	**0.061***	NR	NR	NR	NR
Phenol	None	**0.037J***	NR	NR	NR	NR
Pyrene	None	**0.1***	NR	NR	NR	NR
PCBs (mg/kg)						
PCB-1254	None	**0.022J***	NR	NR	NR	NR
beta-BHC	None	<0.0017U	NR	NR	NR	NR

[a] Only detected site-related contaminants 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.
BHC = Hexachlorocyclohexane.
ft = Feet.
ID = Identification.
mg/kg = Milligrams per kilogram.
NR = Not reported/not analyzed.
PCB = Polychlorinated biphenyl.
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 4–3. Human Health Chemicals of Potential Concern per the Characterization of 14 AOCs Report

Surface Soil	Sediment	Surface Water	Groundwater
Chromium	Arsenic	Manganese	Manganese
Iron	Barium	Bis(2-ethylhexyl)phthalate	
Manganese	Iron	Nitrate	
2-Methylnapthalene	Manganese		
Acenaphthylene	Vanadium		
Benzo(a)pyrene			
Benzo(ghi)perylene			
Phenanthrene			
Nitrocellulose			

Adapted from Table LL8-18: Characterization of 14 AOCs at the Ravenna Army Ammunition Plant (MKM 2007).

[a] Sediment and surface water samples collected during the investigation were associated only with infrastructure (i.e., sumps, basins, and sewers) and are not included in the summary table.

AOC = Area of concern.

Table 4–4. Chemicals Exceeding ESVs per the Characterization of 14 AOCs Report

Soil	Sediment		Surface Water	Groundwater
Chromium	Arsenic	Selenium	Iron	Not evaluated
Copper	Barium	Mercury	Manganese	
Iron	Beryllium	4,4-DDD	Selenium	
Lead	Cadmium	4,4-DDE	Nitrate	
Manganese	Iron	4,4-DDT		
Zinc	Lead	Nitrocellulose		
Mercury	Manganese			
Beta-BHC				
PCB-1254				
Dibenzofuran				
Tetryl				
Nitrocellulose				

Adapted from Table LL8-19: Characterization of 14 AOCs at the Ravenna Army Ammunition Plant (MKM 2007).

[a] Sediment and surface water samples collected during the investigation were associated only with infrastructure (i.e., sumps, basins, and sewers) and are not included in the summary table.

AOC = Area of concern.
BHC = Beta-hexachlorocyclohexane.
DDD = Dichlorodiphenyldichloroethane.
DDE = Dichlorodiphenyldichloroethylene.
DDT = Dichlorodiphenyltrichloroethane.
ESV = Ecological screening value.
PCB = Polychlorinated biphenyl.

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Table 4–5. Investigation of Under Slab Surface Soil Sample Locations

Underslab Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
LL8ss-042M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-1	1941-1945- Utilized for tetryl storage. 1970 Era - Not in use.	None	Tetryl
LL8ss-043M	0–1	Metals, explosives, propellants (PAHs assessed during PBA08 RI)	Building 2B-2	1941-1945 - Utilized for tetryl screening and blending. 1970 Era - Utilized for Octol storage.	None	Tetryl, Octol [TNT and HMX]
LL8ss-044M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-3	1941-1945 - Utilized as a tetryl rest house. 1970 Era - Not in use.	None	Tetryl
LL8ss-045M LL8ss-045D	0–1	Full suite	Building 2B-4	1941-1945 - Utilized as tetryl pelleting (manufacturing) building. 1970 Era - Utilized for melt pour and assembly. Also QA/QC samples collected.	None	Tetryl, Octol [TNT and HMX], RDX
LL8ss-046M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-5	1941-1945 - Utilized for detonator storage. Detonators were manufactured at Load Line 9 and arrived containerized at Load Line 8. 1970 Era - Not in use.	None	Mercury fulminate, lead azide
LL8ss-047M LL8ss-047D	0–1	Metals, explosives, VOCs (PAHs assessed during PBA08 RI); QA - also SVOCs/Pest/Herb/PCBs	Building 2B-6	1941-1945 - Utilized for booster assembly and shipping. Detonators from Load Line 9 were used in the assembly process. 1970 Era - Utilized for shipping and receiving. Assessed northern half of subslab. Also QA/QC samples collected.	None	Tetryl, mercury fulminate, lead azide
LL8ss-048M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-6	1941-1945 - Utilized for booster assembly and shipping. Detonators from Load Line 9 were used in the assembly process. 1970 Era - Utilized for shipping and receiving. Assessed northern half of subslab.	None	Tetryl, mercury fulminate, lead azide
LL8ss-049M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-7	1941-1945 - Utilized for testing boosters. 1970 Era - Utilized for curing.	None	Tetryl, mercury fulminate, lead azide, Octol [TNT and HMX], RDX
LL8ss-050M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-12	1941-1945 - Utilized for tetryl pellet storage. 1970 Era- Utilized for S & A Device with detonator storage.	None	Tetryl, Octol [TNT and HMX], mercury fulminate, lead azide
LL8ss-051M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-13	1941-1945 - Utilized as tetryl cupping building. 1970 Era - Not in use.	None	Tetryl
LL8ss-052M	0–1	Metals, explosives (PAHs assessed during PBA08 RI)	Building 2B-17	1941-1945 - Utilized as cupped pellet rest house. 1970 Era - Not in use.	None	Tetryl
LL8ss-053M	0–1	Metals, explosives, SVOCs, Pest., Herb, PCBs	Building 2B-21	1941-1945 - Utilized for booster assembly and shipping. Detonators from Load Line 9 were used in the assembly process. 1970 Era - Not in use.	None	Tetryl, mercury fulminate, lead azide
LL8ss-054M LL8ss-055D	0–1	Full Suite	Building 2B-22	1941-1945 - Utilized for solvent storage. 1970 Era - Not in use. Also QA/QC samples collected (VOCs only).	None	Solvents

bgs = Below ground surface.
ft = Feet.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane.
PAH = Polycyclic aromatic hydrocarbon.
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.
PCB = Polychlorinated biphenyl.
QA = Quality assurance.
QC = Quality control.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
S&A = Safe and arm.
SVOC = Semi-volatile organic compound.
TNT = 2,4,6-Trinitrotoluene.
VOC = Volatile organic compound.

Table 4–6. Analytes Detected in Investigation of Under Slab Surface Soil Samples

Station		**LL8ss-042M**	**LL8ss-043M**	**LL8ss-044M**	**LL8ss-045D**	**LL8ss-045M**	**LL8ss-045M**	**LL8ss-045M**	**LL8ss-046M**	**LL8ss-047D**	**LL8ss-047M**
Sample ID		**LL8ss-042M-SO**	**LL8ss-043M-SO**	**LL8ss-044M-SO**	**LL8ss-045D-SO**	**LL8ss-056M-SO**	**LL8ss-058M-SO**	**LL8ss-045M-SO**	**LL8ss-046M-SO**	**LL8ss-047D-SO**	**LL8ss-059M-SO**
Date		**08/08/07**	**08/08/07**	**08/08/07**	**08/14/07**	**08/09/07**	**08/14/07**	**08/14/07**	**08/07/07**	**08/14/07**	**08/14/07**
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[a]	**Background Criteria**[b]	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**VOCs**	**TAL Metals, Explosives, Herbicides, Pesticides/PCBs, SVOCs**	**Explosives**	**TAL Metals, Explosives, Herbicides, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives**	**VOCs**	**Explosives**
Metals (mg/kg)											
Aluminum	17700	7740	6760	9110	NR	7910	NR	8880	9810	NR	NR
Arsenic	15.4	8.9	9.9	11.6	NR	8.9	NR	8.1	8.8	NR	NR
Barium	88.4	78.1	47.8	64.1	NR	58.8	NR	61.5	**93***	NR	NR
Beryllium	0.88	<1U	<1U	<1U	NR	<1U	NR	<1U	<1U	NR	NR
Cadmium	0	<1U	<1U	<1U	NR	<1U	NR	<1U	<1U	NR	NR
Calcium	15800	**28100***	4310	12100	NR	6670	NR	7400	**24200***	NR	NR
Chromium	17.4	**27.5***	**21.8***	**19***	NR	**19.8***	NR	**20***	**27.9***	NR	NR
Cobalt	10.4	6.4	6.4	7.5	NR	6.2	NR	6	6.5	NR	NR
Copper	17.7	17.4	17.7	**18.2***	NR	**17.9***	NR	16	17.2	NR	NR
Iron	23100	15000	16100	18800	NR	16200	NR	15500	17200	NR	NR
Lead	26.1	**52.9***	**40***	**52.3***	NR	**63.9***	NR	**51.5***	**60.1***	NR	NR
Magnesium	3030	**3520***	1980	**3320***	NR	2370	NR	2410	**4190***	NR	NR
Manganese	1450	573	377	552	NR	425	NR	427	906	NR	NR
Mercury	0.036	<0.029U	<0.021U	<0.017U	NR	**0.087J***	NR	**0.066J***	**0.041J***	NR	NR
Nickel	21.1	**28.6***	**28***	**24***	NR	**23.7***	NR	20.7	**162***	NR	NR
Potassium	927	<663U	<627U	788	NR	<713U	NR	886	836	NR	NR
Silver	0	<2U	<2U	<2U	NR	<2U	NR	<2U	<2U	NR	NR
Sodium	123	<100U	<100U	<100U	NR	<100U	NR	<100U	<100U	NR	NR
Thallium	0	<2U	<2U	<2U	NR	<2U	NR	<2U	<2U	NR	NR
Vanadium	31.1	11.6	11.6	13.6	NR	13	NR	13.9	13.3	NR	NR
Zinc	61.8	**109***	**79.3***	**98.6***	NR	**109***	NR	**89.4***	**105***	NR	NR
Explosives/Propellants (mg/kg)											
Nitrocellulose	None	NR	**1.7J***	NR	NR	**4.3J***	**4.5J***	**4J***	NR	NR	NR
SVOCs (mg/kg)											
Benz(a)anthracene	None	NR	NR	NR	NR	**0.46***	NR	<1.3U	NR	NR	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	**0.33***	NR	<1.3U	NR	NR	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	**0.45***	NR	<1.3U	NR	NR	NR
Chrysene	None	NR	NR	NR	NR	**0.45***	NR	<1.3U	NR	NR	NR
Fluoranthene	None	NR	NR	NR	NR	**1.1***	NR	**3***	NR	NR	NR
Phenanthrene	None	NR	NR	NR	NR	**0.58***	NR	**2***	NR	NR	NR
Pyrene	None	NR	NR	NR	NR	**0.8***	NR	**2.2***	NR	NR	NR
PCBs (mg/kg)											
PCB-1254	None	NR	NR	NR	NR	<0.05U	NR	**0.1***	NR	NR	NR

Table 4–6. Analytes Detected in Investigation of Under Slab Surface Soil Samples (continued)

Station		**LL8ss-047M**	**LL8ss-047M**	**LL8ss-047M**	**LL8ss-048M**	**LL8ss-049M**	**LL8ss-050M**	**LL8ss-051M**	**LL8ss-052M**	**LL8ss-053M**	**LL8ss-054M**	**LL8ss-055D**	**LL8ss-055D**
Sample ID		**LL8ss-047M-SO**	**LL8ss-057M-SO**	**LL8ss-047M-QB**	**LL8ss-048M-SO**	**LL8ss-049M-SO**	**LL8ss-050M-SO**	**LL8ss-051M-SO**	**LL8ss-052M-SO**	**LL8ss-053M-SO**	**LL8ss-054M-SO**	**LL8ss-060D-SO**	**LL8ss-055D-SO**
Date		**08/14/07**	**08/14/07**	**08/14/07**	**08/07/07**	**08/07/07**	**08/08/07**	**08/07/07**	**08/07/07**	**08/07/07**	**08/14/07**	**08/14/07**	**08/14/07**
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**	**0.0 - 1.0**
Parameters Analyzed[a]	**Background Criteria**[b]	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives, Herbicides, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Herbicides, Pesticides/PCBs, SVOCs**	**VOCs**	**VOCs**
Metals (mg/kg)													
Aluminum	17700	9020	9990	10500	7790	7020	8030	7530	8490	11300	8930	NR	NR
Arsenic	15.4	7.1	7.6	8.24	8.7	10.5	9.5	9	10.5	13.3	8.8	NR	NR
Barium	88.4	65.6J	79.2	68.3	60.7	56.7	68.4	63.8	65.4	79.1	78.2	NR	NR
Beryllium	0.88	<1U	<1U	0.689	<1U	<1U	<1U	<1U	<1U	<1U	<1U	NR	NR
Cadmium	0	<1U	<1U	**0.439***	**1***	<1U	<1U	<1U	<1U	<1U	<1U	NR	NR
Calcium	15800	12600	**16800***	14300	**21600***	8520	13900	12100	7450	**16800***	**26300***	NR	NR
Chromium	17.4	**18.4J***	**21.1***	**25***	**23.1***	**20***	**30.5***	**24.7***	**19.5***	**28.2***	16	NR	NR
Cobalt	10.4	5.2	6	6.09	5.3	7	7.2	7.4	8.2	8	6	NR	NR
Copper	17.7	16.3	17.7	17.5	16.1	**19.5***	**18.2***	17.5	**19***	**20.7***	**18***	NR	NR
Iron	23100	14000	15700	18900	14700	16100	19300	16700	18000	**23700***	15100	NR	NR
Lead	26.1	23J	**31.2***	**34.2***	**37***	**39.7***	**42.3***	**53.9***	**66.5***	23.5	22	NR	NR
Magnesium	3030	2540	3000	**3430***	2600	2080	2320	3010	2780	**3360***	**3980***	NR	NR
Manganese	1450	414	543	411	517	476	473	588	496	455	790	NR	NR
Mercury	0.036	<0.1UJ	0.017J	0.0268J	0.032J	0.023J	<0.045U	0.022J	0.034J	0.039J*	0.026J	NR	NR
Nickel	21.1	**22.2J***	**25.9***	**27.8***	**35.9***	**30.6***	**28.3***	**26.5***	**36.9***	**31***	**23.6***	NR	NR
Potassium	927	923J	847	**952***	629	<651U	824	692	807	**1050***	**968***	NR	NR
Silver	0	<2U	<2U	**0.592J***	<2U	<2U	<2U	<2U	<2U	<2U	<2U	NR	NR
Sodium	123	<100U	<100U	81.3	<100U	<100U	<100U	<100U	<100U	<100U	<100U	NR	NR
Thallium	0	<2U	<2U	**0.126***	<2U	<2U	<2U	<2U	<2U	<2U	<2U	NR	NR
Vanadium	31.1	12.7	13.7	16.9	12.1	11.8	14.6	12.5	13.4	18.3	13.2	NR	NR
Zinc	61.8	57	**64.5***	**70.4***	61	**77.3***	**94.5***	**83.7***	**119***	**76.9***	58.9	NR	NR
Explosives/Propellants (mg/kg)													
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)													
Benz(a)anthracene	None	NR	NR	NR	NR	NR	NR	NR	NR	**1.5***	<0.33U	NR	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	NR	NR	NR	<1.3U	<0.33U	NR	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	NR	**1.6J***	<0.33U	NR	NR
Chrysene	None	NR	NR	NR	NR	NR	NR	NR	NR	**1.4***	<0.33U	NR	NR
Fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	NR	**3.6J***	<0.33U	NR	NR
Phenanthrene	None	NR	NR	NR	NR	NR	NR	NR	NR	**2.1J***	<0.33U	NR	NR
Pyrene	None	NR	NR	NR	NR	NR	NR	NR	NR	**2.7***	<0.33U	NR	NR
PCBs (mg/kg)													
PCB-1254	None	NR	NR	NR	NR	NR	NR	NR	NR	<0.05U	<0.05U	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.
mg/kg = Milligrams per kilogram.
NR = Not reported/not analyzed.
PCB = Polychlorinated biphenyl.
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 4–7. Chemicals Detected at Concentrations above Screening Criteria in Previous Investigations

Surface Soil	Subsurface Soil	Sediment	Surface Water
Chromium Manganese Benzo(a)pyrene	Medium not previously sampled	Benzo(a)pyrene	Nitrate Manganese Bis(2-ethylhexyl)phthalate

Note: This table was generated using data from the Characterization of 14 AOCs at the Ravenna Army Ammunition Plant (MKM 2007).
-- = Not applicable.
mg/kg = Milligrams per kilogram.
mg/L = Milligrams per liter.

Table 4–8. PBA08 RI Surface Soil Samples and Rationales

PBA08 RI Location	Targeted Area	Purpose	Analyses Performed				
			Metals	Explosives	VOCs	Pesticides/ PCBs	SVOC
LL8ss-071M	LL8ss-009M (Building 2B-13)	Delineate lateral extent of previously identified contamination.	Y	Y	N	N	PAH
LL8ss-072M	LL8ss-005M (Building 2B-21)	Delineate lateral extent of previously identified contamination.	Y	Y	N	N	PAH
LL8ss-073M	LL8ss-003M (Building 2B-6)	Delineate lateral extent of previously identified contamination.	Y	Y	N	N	PAH
LL8ss-074M	Northeast portion of AOC	Characterize area not previously sampled. Analyzed for RVAAP full-suite analytes.	Y	Y	Y	Y	Y
		QA/QC. Analyzed for RVAAP full-suite analytes.	Y	Y	Y	Y	Y
			Y	Y	Y	Y	Y
LL8ss-075M	Northeastern portion of AOC around Buildings 2B-7, 2B-9, and 2B-10	Characterize area not previously sampled.	Y	Y	N	N	PAH
LL8ss-076M	Buildings 2B-9 and 2B-10	Characterize area around former Buildings 2B-9 and 2B-10 not previously sampled.	Y	Y	N	N	PAH
LL8ss-077M	Eastern portion of AOC	Characterize area not previously sampled.	Y	Y	N	N	PAH
LL8ss-078M	Southeastern portion of AOC	Characterize area not previously sampled.	Y	Y	N	N	PAH
LL8ss-079M	Southern portion of AOC	Characterize area not previously sampled.	Y	Y	N	N	PAH
LL8ss-080M	Southwestern portion of AOC	Characterize area not previously sampled. Analyzed for RVAAP full-suite analytes.	Y	Y	Y	Y	Y
LL8ss-081M	Western (south) portion of AOC	Characterize area not previously sampled.	Y	Y	N	N	PAH
LL8ss-082M	Western (north) portion of AOC	Characterize area not previously sampled.	Y	Y	N	N	PAH
LL8ss-083M	Northwestern portion of AOC	Characterize area not previously sampled.	Y	Y	N	N	PAH
LL8ss-084M	Northeastern portion of Operational Area around Buildings 2B-5 (LL8ss-006M), 2B-6 (LL8ss-003M), and 2B-17 (LL8ss-007M)	Further characterize previously identified contamination.	Y	Y	N	N	PAH

Table 4–8. PBA08 RI Surface Soil Samples and Rationales (continued)

PBA08 RI Location	Targeted Area	Purpose	Analyses Performed				
			Metals	Explosives	VOCs	Pesticides/ PCBs	SVOC
LL8ss-085M	Northwestern portion of Operational Area around Buildings 2B-13 (LL8ss-008M, LL8ss-009M), 2B-21 (LL8ss-005M), and 2B-22 (LL8ss-008M)	Further characterize previously identified contamination in former operational area.	Y	Y	N	N	PAH
LL8ss-086M	Southwestern portion of Operational Area around Buildings 2B-12/2B-23 (LL8ss-014M)	Further characterize previously identified contamination.	Y	Y	N	N	PAH
		QA/QC	Y	Y	N	N	PAH
			Y	Y	N	N	PAH
LL8ss-087M	Southeastern portion of Operational Area around Buildings 2B-3 (LL8ss-013M) and 2B-4 (LL8ss-011M, LL8ss-012M)	Further characterize previously identified contamination	Y	Y	N	N	PAH
LL8ss-088M	Northern Portion of drainage ditch along road	Characterize dry portion of the ditch not previously sampled. Analyzed for RVAAP full-suite analytes	Y	Y	Y	Y	Y
LL8ss-089M	Western Portion of drainage ditch along road	Further characterize previously identified contamination in wet portion of the ditch.	Y	Y	N	N	PAH

AOC = Area of concern.
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.

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Table 4–9. Analytes Detected in PBA08 RI ISM Surface Soil Samples

Station		**LL8ss-071M**	**LL8ss-072M**	**LL8ss-073M**	**LL8ss-074M**	**LL8ss-074M**	**LL8ss-075M**	**LL8ss-076M**	**LL8ss-077M**	**LL8ss-078M**	**LL8ss-079M**
Sample ID		**LL8ss-071M-5386-SO**	**LL8ss-072M-5387-SO**	**LL8ss-073M-5388-SO**	**LL8ss-074M-6117-FD**	**LL8ss-074M-5389-SO**	**LL8ss-075M-5390-SO**	**LL8ss-076M-5392-SO**	**LL8ss-077M-5393-SO**	**LL8ss-078M-5394-SO**	**LL8ss-079M-5395-SO**
Date		**03/18/10**	**03/18/10**	**03/18/10**	**03/17/10**	**03/17/10**	**03/18/10**	**03/18/10**	**03/17/10**	**03/17/10**	**03/17/10**
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**	**0.0 - 1.0**
Parameters Analyzed[a] **Analyte**	**Background Criteria[b]**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**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**
Metals (mg/kg)											
Aluminum	17700	10500	10900	10100	9850	9670	9350	7960	12600	10500	10100
Antimony	0.96	0.13J	0.13J	0.073J	0.068J	0.069J	0.074J	0.076J	0.073J	0.073J	0.069J
Arsenic	15.4	9.7J	10.2J	8.1J	9J	9.2J	8.4J	8.6J	7.7J	10.5J	9.8J
Barium	88.4	82.5J	**105J***	78.2	71.2	67.3	63.6	62.2	60.8	58.8	60.6
Beryllium	0.88	0.84	0.87	0.7	0.53	0.54	0.51	0.55	0.53	0.51	0.51
Cadmium	0	**0.34***	**0.36***	**0.23***	**0.16J***	**0.17J***	**0.17J***	**0.31***	**0.21***	**0.1J***	**0.1J***
Calcium	15800	**21600***	**45000***	**24100J***	2280J	2380J	4060J	19900J*	871J	562J	5830J
Chromium	17.4	**28.7***	**30.7***	**22.3***	**17.9***	16.8	**20.7***	**22.5***	**18.4***	**20.7***	16.8
Cobalt	10.4	6.9J	8J	6.7	8.8	8.7	**10.6***	6.4	8.1	7.9	7.9
Copper	17.7	15.3	**18.3***	13.6	11.2	11.4	16.3	15.3	11.4	9	11
Iron	23100	18600	19700	18100	20200	20400	19700	16500	19900	22000	20300
Lead	26.1	**42.1J***	**35J***	25.3	22.4	18	17.8	24.6	17.3	17.2	15.8
Magnesium	3030	**4030***	**4310***	**3530***	2090	1950	2280	**3130***	2380	1690	**4960***
Manganese	1450	709	713	643	786	863	820	508	643	664	543
Mercury	0.036	0.042J*	0.033J	0.025J	**0.049J***	**0.054J***	0.026J	0.018J	**0.045J***	**0.044J***	**0.041J***
Nickel	21.1	**22.4***	**28.9***	18.4	15.2	14.4	19	19.7	15.8	14.1	14.7
Potassium	927	821J	**1010J***	828	684	673	756	687	855	622	696
Selenium	1.4	0.96J	1.1J	1.3J	0.95J	0.92J	1.1J	1.1J	1J	1J	0.95J
Silver	0	<0.034UJ	<0.029UJ	<0.022UJ	<0.048UJ	<0.048UJ	<0.031UJ	<0.02UJ	<0.034UJ	<0.044UJ	<0.037UJ
Sodium	123	114	120	98.4J	27.5J	26.2J	29.9J	63.9J	25.3J	19.7J	23.9J
Thallium	0	**0.15J***	**0.14J***	**0.12J***	**0.13J***	**0.13J***	**0.13J***	**0.1J***	**0.16J***	**0.14J***	**0.13J***
Vanadium	31.1	14.7	15.5	15.1J	19.7J	20.1J	16.9J	12.7J	22.3J	21.3J	19.6J
Zinc	61.8	**70.8***	**77.6***	54	**65.5***	**71***	55.1	56.8	**62.6***	46.8	48.3
Explosives/Propellants (mg/kg)											
HMX	None	<0.25U	<0.25U	**0.015J***	<0.25U	<0.24U	<0.24U	**0.013J***	<0.24U	<0.25U	<0.24U
Nitrocellulose	None	NR	NR	NR	**1.2J***	**1.3J***	NR	NR	NR	NR	NR
Tetryl	None	**0.027J***	**0.052J***	<0.25U	<0.25U	<0.24U	<0.24U	**0.018J***	<0.24U	<0.25U	<0.24U
SVOCs (mg/kg)											
2-Methylnaphthalene	None	NR	NR	NR	**0.019J***	**0.021J***	NR	NR	NR	NR	NR
Acenaphthene	None	**0.041***	**0.43***	**0.18***	<0.051U	<0.051U	**0.0076***	<0.068U	<0.0068U	<0.0068U	<0.0068U
Acenaphthylene	None	<0.034U	<0.027U	<0.068U	<0.051U	<0.051U	<0.0068U	<0.068U	<0.0068U	<0.0068U	<0.0068U
Anthracene	None	**0.097***	**0.77***	**0.79***	<0.051U	<0.051U	0.015*	**0.16***	<0.0068U	<0.0068U	<0.0068U
Benz(a)anthracene	None	**0.29***	**1.7***	**1.4***	**0.016J***	**0.025J***	**0.053***	**0.45***	<0.0068U	<0.0068U	<0.0068U
Benzenemethanol	None	NR	NR	NR	<0.34UJ	<0.34UJ	NR	NR	NR	NR	NR
Benzo(a)pyrene	None	**0.24***	**1.3***	**1.2***	**0.018J***	**0.028J***	**0.042***	**0.4***	**0.015***	<0.0068U	**0.0099***
Benzo(b)fluoranthene	None	**0.33***	**1.8***	**1.7***	**0.037J***	**0.051***	**0.082***	**0.64***	**0.042***	**0.027***	<0.0068U
Benzo(ghi)perylene	None	**0.14***	**0.72***	**0.67***	**0.017J***	**0.027J***	**0.028***	**0.28***	<0.0068U	<0.0068U	<0.0068U
Benzo(k)fluoranthene	None	**0.16***	**0.74***	**0.75***	**0.012J***	**0.027J***	**0.04***	**0.3***	**0.014***	<0.0068U	<0.0068U
Bis(2-ethylhexyl)phthalate	None	NR	NR	NR	**0.053J***	0.058J*	NR	NR	NR	NR	NR

Table 4–9. Analytes Detected in PBA08 RI ISM Surface Soil Samples (continued)

Station	**Background Criteria[b]**	**LL8ss-071M**	**LL8ss-072M**	**LL8ss-073M**	**LL8ss-074M**	**LL8ss-074M**	**LL8ss-075M**	**LL8ss-076M**	**LL8ss-077M**	**LL8ss-078M**	**LL8ss-079M**
Sample ID		**LL8ss-071M-5386-SO**	**LL8ss-072M-5387-SO**	**LL8ss-073M-5388-SO**	**LL8ss-074M-6117-FD**	**LL8ss-074M-5389-SO**	**LL8ss-075M-5390-SO**	**LL8ss-076M-5392-SO**	**LL8ss-077M-5393-SO**	**LL8ss-078M-5394-SO**	**LL8ss-079M-5395-SO**
Date		**03/18/10**	**03/18/10**	**03/18/10**	**03/17/10**	**03/17/10**	**03/18/10**	**03/18/10**	**03/17/10**	**03/17/10**	**03/17/10**
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**	**0.0 - 1.0**
Parameters Analyzed[a]		**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**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**
Analyte											
Chrysene	None	**0.31***	**1.5***	**1.4***	**0.024J***	**0.039J***	**0.059***	**0.51***	**0.023***	**0.0079***	**0.013***
Dibenz(a,h)anthracene	None	**0.13***	**0.29***	<0.068U	<0.051U	<0.051U	<0.0068U	<0.068U	<0.0068U	<0.0068U	<0.0068U
Diethyl phthalate	None	NR	NR	NR	<0.34UJ	<0.34UJ	NR	NR	NR	NR	NR
Fluoranthene	None	**0.68***	**4***	**3.7***	**0.042J***	**0.061***	**0.11***	**0.94***	**0.033***	**0.011***	**0.018***
Fluorene	None	**0.038***	**0.35***	**0.18***	<0.051U	<0.051U	<0.0068U	<0.068U	<0.0068U	<0.0068U	<0.0068U
Indeno(1,2,3-cd)pyrene	None	**0.2***	**0.75***	0.61*	**0.016J***	**0.023J***	**0.025***	**0.24***	<0.0068U	<0.0068U	<0.0068U
Naphthalene	None	<0.034U	**0.26***	<0.068U	**0.015J***	**0.016J***	**0.011***	<0.068U	**0.0082***	**0.0075***	**0.0076***
Phenanthrene	None	**0.34***	**2.5***	**2***	**0.023J***	**0.03J***	**0.054***	**0.48***	**0.016***	**0.0082***	**0.012***
Pyrene	None	**0.52***	**3***	**3.3***	**0.032J***	**0.05J***	**0.09***	**0.87***	**0.028***	**0.0098***	**0.017***
Pesticides (mg/kg)											
4,4'-DDD	None	NR	NR	NR	<0.01UJ	<0.01UJ	NR	NR	NR	NR	NR
4,4'-DDE	None	NR	NR	NR	**0.0038J***	<0.0087U	NR	NR	NR	NR	NR
4,4'-DDT	None	NR	NR	NR	<0.01U	<0.01U	NR	NR	NR	NR	NR
VOCs (mg/kg)											
2-Butanone	None	NR	NR	NR	**0.0057J***	**0.002J***	NR	NR	NR	NR	NR
Acetone	None	NR	NR	NR	**0.018J***	<0.027UJ	NR	NR	NR	NR	NR

Table 4–9. Analytes Detected in PBA08 RI ISM Surface Soil Samples (continued)

Station		**LL8ss-080M**	**LL8ss-081M**	**LL8ss-082M**	**LL8ss-083M**	**LL8ss-084M**	**LL8ss-085M**	**LL8ss-086M**	**LL8ss-086M**	**LL8ss-087M**	**LL8ss-088M**
Sample ID		**LL8ss-080M-5396-SO**	**LL8ss-081M-5397-SO**	**LL8ss-082M-5398-SO**	**LL8ss-083M-5399-SO**	**LL8ss-084M-5400-SO**	**LL8ss-085M-5782-SO**	**LL8ss-086M-6119-FD**	**LL8ss-086M-5401-SO**	**LL8ss-087M-5402-SO**	**LL8ss-088M-5403-SO**
Date		**03/17/10**	**03/17/10**	**03/17/10**	**03/17/10**	**03/18/10**	**03/18/10**	**03/18/10**	**03/18/10**	**03/18/10**	**03/18/10**
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**	**0.0 - 1.0**
Parameters Analyzed[a] **Analyte**	**Background Criteria**[b]	**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**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**
Metals (mg/kg)											
Aluminum	17700	9760	9670	10500	11300	11200	9550	10400	10700	10400	11100
Antimony	0.96	0.067J	<0.51UJ	<0.51UJ	0.076J	0.095J	0.11J	0.067J	0.078J	0.079J	0.073J
Arsenic	15.4	8.3J	6.5J	8.5J	9.5J	10.2J	8.9J	8.9J	9.7J	9.7J	13.9J
Barium	88.4	61.3	60.3	61.9	69.1	76.2	71.1J	69	67.9	62.8	85.6
Beryllium	0.88	0.49	0.48	0.5	0.54	0.61	0.53	0.55	0.56	0.63	0.62
Cadmium	0	**0.15J***	**0.11J***	**0.13J***	**0.2***	**0.24***	**0.26***	0.18J*	**0.21***	**0.21***	**0.2J***
Calcium	15800	2200J	1080J	2720J	5530J	10000J	11700	3530J	4260J	5260J	14100J
Chromium	17.4	**18.7***	**19.2***	**18.1***	**26***	**22.7***	**22.4***	**22.3***	**20.1***	**24.9***	**20.2***
Cobalt	10.4	7.9	7.7	8.5	9	7.7	7.7J	9	8.9	8.2	**11.2***
Copper	17.7	13.4	9.6	11	13.6	15.5	13.4	14.9	17.2	14.7	**26.3***
Iron	23100	19300	17400	22800	22800	22600	20000	21300	21800	21000	**29800***
Lead	26.1	16.1	16.1	15.5	17.6	**27.7***	25.9J	21.9	**31.3***	24.2	15.7
Magnesium	3030	1860	1780	2360	**3040***	**3140***	2510	2840	2920	2970	**3950***
Manganese	1450	728	947	614	598	426	504	410	450	415	669
Mercury	0.036	**0.045J***	0.035J	**0.064J***	**0.049J***	0.03J	0.017J	0.014J	0.031J	**0.065J***	**0.076J***
Nickel	21.1	16.1	14.3	15.3	21	20.1	20.8	**22.1***	**21.6***	**22***	**25***
Potassium	927	660	601	749	**930***	**969***	862J	**938***	**929***	889	**1110***
Selenium	1.4	0.98J	0.82J	1J	1.1J	1.2J	0.81J	1.1J	1.1J	1.2J	1.3J
Silver	0	<0.041UJ	<0.043UJ	**0.036J***	<0.038UJ	<0.032UJ	<0.031UJ	<0.033UJ	<0.032UJ	<0.026UJ	<0.032UJ
Sodium	123	<22UJ	<21.8UJ	24.6J	<33UJ	<52.8UJ	49.5J	<30UJ	<36.1UJ	<42.9UJ	<69.2UJ
Thallium	0	**0.14J***	**0.13J***	**0.14J***	**0.15J***	**0.13J***	**0.13J***	**0.13J***	**0.13J***	**0.12J***	**0.14J***
Vanadium	31.1	18J	19.8J	20.2J	21.2J	19.8J	16.4	18.6J	18.5J	17.9J	20.1J
Zinc	61.8	59.5	46.6	54	**70.2***	**64.1***	**63.3***	**73.7***	**77.6***	61.1	**88.7***
Explosives/Propellants (mg/kg)											
HMX	None	<0.25U	<0.25U	<0.25U	<0.25U	<0.25U	<0.25U	<0.24U	<0.25U	<0.25U	<0.25U
Nitrocellulose	None	**1.1J***	NR	NR	NR	NR	NR	NR	NR	NR	**1.7J***
Tetryl	None	<0.25U	<0.25U	<0.25U	<0.25U	<0.25U	**0.047J***	<0.24U	**0.015J***	<0.25U	**0.019J***
SVOCs (mg/kg)											
2-Methylnaphthalene	None	**0.021J***	NR	NR	NR	NR	NR	NR	NR	NR	**0.019J***
Acenaphthene	None	<0.051U	<0.0068U	<0.0068U	<0.0068U	<0.068U	**0.16***	**0.016***	**0.019***	**0.02***	<0.052U
Acenaphthylene	None	<0.051U	<0.0068U	<0.0068U	<0.0068U	<0.068U	<0.0068U	**0.007***	<0.0068U	<0.0068U	<0.052U
Anthracene	None	<0.051U	<0.0068U	<0.0068U	<0.0068U	<0.068U	**0.26***	**0.033***	**0.041***	**0.031***	<0.052U
Benz(a)anthracene	None	**0.0083J***	<0.0068U	<0.0068U	<0.0068U	<0.068U	**0.6***	**0.075***	**0.086***	**0.098***	**0.03J***
Benzenemethanol	None	**0.027J***	NR	NR	NR	NR	NR	NR	NR	NR	<0.34UJ
Benzo(a)pyrene	None	**0.012J***	<0.0068U	<0.0068U	**0.017***	**0.079***	**0.46***	**0.062***	**0.074***	**0.08***	**0.031J***
Benzo(b)fluoranthene	None	**0.02J***	<0.0068U	**0.013***	**0.045***	**0.2***	**0.64***	**0.09***	**0.13***	**0.12***	**0.051J***
Benzo(ghi)perylene	None	**0.011J***	<0.0068U	<0.0068U	<0.0068U	<0.068U	**0.27***	**0.039***	**0.051***	**0.05***	**0.026J***
Benzo(k)fluoranthene	None	**0.01J***	<0.0068U	<0.0068U	**0.017***	<0.068U	**0.29***	**0.057***	**0.061***	**0.085***	**0.019J***
Bis(2-ethylhexyl)phthalate	None	**0.18J***	NR	NR	NR	NR	NR	NR	NR	NR	**0.12J***

Table 4–9. Analytes Detected in PBA08 RI ISM Surface Soil Samples (continued)

Station		**LL5ss-071M**	**LL5ss-072M**	**LL5ss-072M**	**LL5ss-073M**	**LL5ss-074M**	**LL5ss-075M**	**LL5ss-076M**	**LL5ss-077M**	**LL8ss-087M**	**LL8ss-088M**
Sample ID		**LL5ss-071M-5053-SO**	**LL5ss-072M-6053-FD**	**LL5ss-072M-5054-SO**	**LL5ss-073M-5055-SO**	**LL5ss-074M-5056-SO**	**LL5ss-075M-5057-SO**	**LL5ss-076M-5058-SO**	**LL5ss-077M-5059-SO**	**LL8ss-087M-5402-SO**	**LL8ss-088M-5403-SO**
Date		**03/08/10**	**03/08/10**	**03/08/10**	**03/08/10**	**03/03/10**	**03/03/10**	**03/03/10**	**03/08/10**	**03/18/10**	**03/18/10**
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**	**0.0 - 1.0**
Parameters Analyzed[a] **Analyte**	**Background Criteria[b]**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**
Chrysene	None	**0.014J***	<0.0068U	**0.0093***	**0.022***	**0.076***	**0.52***	**0.073***	**0.082***	**0.1***	**0.037J***
Dibenz(a,h)anthracene	None	<0.051U	<0.0068U	<0.0068U	<0.0068U	<0.068U	**0.096***	<0.0068U	<0.0068U	<0.0068U	<0.052U
Diethyl phthalate	None	**0.027J***	NR	NR	NR	NR	NR	NR	NR	NR	<0.34UJ
Fluoranthene	None	**0.023J***	**0.011***	**0.015***	**0.036***	**0.18***	**1.4***	**0.17***	**0.22***	**0.23***	**0.059***
Fluorene	None	**0.0085J***	<0.0068U	<0.0068U	<0.0068U	<0.068U	**0.13***	**0.013***	**0.018***	**0.013***	<0.052U
Indeno(1,2,3-cd)pyrene	None	**0.0094J***	<0.0068U	<0.0068U	<0.0068U	<0.068U	**0.26***	**0.035***	**0.044***	**0.042***	**0.021J***
Naphthalene	None	**0.017J***	**0.012***	**0.012***	**0.014***	<0.068U	**0.12***	**0.014***	**0.011***	**0.013***	**0.012J***
Phenanthrene	None	**0.021J***	**0.014***	**0.014***	**0.032***	**0.11***	**0.95***	**0.11***	**0.15***	**0.13***	**0.029J***
Pyrene	None	**0.017J***	**0.0098***	**0.011***	**0.032***	**0.16***	**1.1***	**0.14***	**0.18***	**0.2***	**0.047J***
Pesticides (mg/kg)											
4,4'-DDD	None	<0.01UJ	NR	NR	NR	NR	NR	NR	NR	NR	**0.014J***
4,4'-DDE	None	<0.0087U	NR	NR	NR	NR	NR	NR	NR	NR	**0.024***
4,4'-DDT	None	<0.01U	NR	NR	NR	NR	NR	NR	NR	NR	**0.0083J***
VOCs (mg/kg)											
2-Butanone	None	<0.028UJ	NR	NR	NR	NR	NR	NR	NR	NR	**0.0024J***
Acetone	None	<0.028UJ	NR	NR	NR	NR	NR	NR	NR	NR	<0.029U

[a] Only detected site-related contaminants are presented in the table.

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

DDD = Dichlorodiphenyldichloroethane.
DDE = Dichlorodiphenyldichloroethylene.
DDT = Dichlorodiphenyltrichloroethane.
ft = Feet.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
ID = Identification.
ISM = Incremental sampling methodology.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
PBA08 RI = Performance-Based Acquisition 2008 Remedial Investigation.
NR = Not reported/not analyzed.
RVAAP = Ravenna Army Ammunition Plant.
SVOCs = Semi-volatile organic compound.
TAL = Target analyte list.
U = Non-detectable concentration.
VOC = Volatile organic compound.
* = Result exceeds background criteria or no background criteria was available.
< = Less than.

Table 4–10. Chromium Speciation Samples under PBA08 RI

PBA08 RI Location	Rationale for Sample Selection
LL8ss-068	Discrete sample collected at Building 2B-6 to assess chromium speciation. Previous chromium result represents elevated chromium concentration (LL8ss-003M at 39 mg/kg).
LL8ss-069	Discrete sample collected in drainage ditch to assess chromium speciation. Previous chromium result represents elevated chromium concentration (LL8ss-017M at 22 mg/kg).
LL8ss-070	Discrete sample collected at Building 2B-22 to assess chromium speciation. Previous chromium result represents elevated chromium concentration (LL8ss-008M at 19 mg/kg).
LL8ss-072	Discrete sample collected at Building 2B-21 to assess chromium speciation. PBA08 RI ISM sample's chromium result represents elevated chromium concentration (LL8ss-072M at 30.7 mg/kg).

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

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Table 4–11. Analytes Detected in PBA08 RI Discrete Surface Soil Samples

Station		**LL8sb-060**	**LL8sb-061**	**LL8sb-062**	**LL8sb-063**	**LL8sb-063**	**LL8sb-064**	**LL8sb-065**	**LL8sb-066**	**LL8sb-067**	**LL8ss-068**	**LL8ss-069**	**LL8ss-070**	**LL8ss-072**
Sample ID		**LL8sb-060-5346-SO**	**LL8sb-061-5350-SO**	**LL8sb-062-5354-SO**	**LL8sb-063-6139-FD**	**LL8sb-063-5358-SO**	**LL8sb-064-5362-SO**	**LL8sb-065-5366-SO**	**LL8sb-066-5369-SO**	**LL8sb-067-5373-SO**	**LL8ss-068-5380-SO**	**LL8ss-069-5381-SO**	**LL8ss-070-5382-SO**	**LL8ss-072-5808-SO**
Date		**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**	**03/11/10**	**03/11/10**	**03/18/10**	**03/18/10**	**03/18/10**	**10/18/10**
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**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed[a] **Analyte**	**Background Criteria[b]**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**Chromium Speciation**	**Chromium Speciation**	**Chromium Speciation**	**Chromium Speciation**
Metals (mg/kg)														
Aluminum	17700	5680J	9010J	2490J	9440J	10200J	1420J	2860J	8930J	9710J	NR	NR	NR	NR
Antimony	0.96	<0.6UJ	0.093J	<0.57UJ	0.11J	0.094J	0.088J	0.11J	0.15J	0.14J	NR	NR	NR	NR
Arsenic	15.4	6.4	15.2	4.2	13.3	11.5	2.5	12.5	12.9J	13.3J	NR	NR	NR	NR
Barium	88.4	49J	48.4J	57.5J	63.2J	70J	41.8J	64.2J	61.5	49	NR	NR	NR	NR
Beryllium	0.88	0.67	0.52	0.35	0.53	0.62	0.25	0.44	0.52J	0.64J	NR	NR	NR	NR
Cadmium	0	**0.13J***	**0.06J***	**0.17J***	**0.14J***	**0.16J***	**0.099J***	**0.1J***	**0.39***	**0.27***	NR	NR	NR	NR
Calcium	15800	**16700***	1910	**154000***	2660	**17500***	**41300***	**109000***	13900J	2640J	NR	NR	NR	NR
Chromium	17.4	8.2	14.2	4.6	14.8	**18***	3.8	8	11.5	12.9	11.2	**18.3***	8.4	**23.3***
Chromium, hexavalent	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	**0.86J***	**2***	**2***	**0.41J***
Cobalt	10.4	4.8	10.1	3.1	8.7	**11.8***	2.9	4.4	7.6	**12.8***	NR	NR	NR	NR
Copper	17.7	8.7	17.4	11.3	**18.1***	**18.3***	4.3	6.3	**23.2J***	**28.4J***	NR	NR	NR	NR
Iron	23100	17400	**25800***	10000	**24900***	**26900***	10700	11300	21000	**29200***	NR	NR	NR	NR
Lead	26.1	12.8	13.4	8.3	24.1	24.8	7.6	13.1	**58.1***	18.3	NR	NR	NR	NR
Magnesium	3030	2790J	2660J	1990J	3010J	**6040J***	909J	2570J	2810J	2710J	NR	NR	NR	NR
Manganese	1450	725	334	476	273	581	365	621	499	238	NR	NR	NR	NR
Nickel	21.1	10.1	**21.4***	10.4	**23***	**25.4***	6.4	13.1	17.6J	**23.5J***	NR	NR	NR	NR
Potassium	927	407	876	401	835	**1480***	289	478	805J	784J	NR	NR	NR	NR
Selenium	1.4	0.61J	0.75J	0.42J	0.68J	0.75J	0.4J	0.37J	0.75J	0.83J	NR	NR	NR	NR
Silver	0	**0.0086J***	**0.015J***	**0.0073J***	**0.021J***	**0.029J***	<0.0045UJ	**0.0099J***	**0.03J***	<0.017UJ	NR	NR	NR	NR
Sodium	123	74.1J	35.1J	94.3J	40.7J	71.6J	36J	83.4J	46.9J	44.2J	NR	NR	NR	NR
Thallium	0	**0.071J***	**0.13J***	<0.23U	**0.13J***	**0.17J***	**0.069J***	**0.074J***	**0.14J***	**0.15J***	NR	NR	NR	NR
Vanadium	31.1	8.6	18	5.2	18.5	21.7	4	6.1	15.9J	18.5J	NR	NR	NR	NR
Zinc	61.8	44J	50.3J	26.8J	**63.2J***	**62.7J***	28.5J	28.4J	**122***	**102***	NR	NR	NR	NR
SVOCs (mg/kg)														
2-Methylnaphthalene	None	NR	NR	**0.039J***	NR	NR	NR	**0.015J***	NR	NR	NR	NR	NR	NR
Acenaphthene	None	<0.008U	<0.008U	<0.057U	<0.0081U	<0.0082U	**0.013***	<0.059U	**0.011***	<0.0085U	NR	NR	NR	NR
Anthracene	None	<0.008U	<0.008U	**0.016J***	<0.0081U	<0.0082U	**0.029***	**0.01J***	**0.03***	<0.0085U	NR	NR	NR	NR
Benz(a)anthracene	None	**0.024***	<0.008U	**0.065***	**0.0082***	**0.0089***	**0.1***	**0.041J***	**0.14J***	**0.011***	NR	NR	NR	NR
Benzo(a)pyrene	None	**0.037***	<0.008U	**0.07***	**0.026***	**0.01***	<0.083UJ	**0.058J***	**0.11J***	**0.0088***	NR	NR	NR	NR
Benzo(b)fluoranthene	None	**0.044***	**0.02***	**0.095***	**0.028***	**0.015***	**0.12***	**0.085***	**0.16J***	**0.013***	NR	NR	NR	NR
Benzo(ghi)perylene	None	<0.008U	<0.008U	**0.042J***	<0.0081U	<0.0082U	**0.042***	**0.052J***	**0.073***	<0.0085U	NR	NR	NR	NR
Benzo(k)fluoranthene	None	<0.008U	<0.008U	**0.017J***	<0.0081U	<0.0082U	<0.038UJ	**0.014J***	**0.07***	<0.0085U	NR	NR	NR	NR
Chrysene	None	**0.016***	<0.008U	**0.051J***	<0.0081U	**0.011***	<0.087UJ	**0.051J***	**0.14J***	**0.012***	NR	NR	NR	NR
Dibenz(a,h)anthracene	None	<0.008U	<0.008U	<0.057U	<0.0081U	<0.0082U	<0.0074U	**0.035J***	**0.02***	<0.0085U	NR	NR	NR	NR
Fluoranthene	None	**0.034***	**0.0048J***	**0.13***	**0.013***	**0.017***	<0.23UJ	**0.082***	**0.24J***	**0.022***	NR	NR	NR	NR
Fluorene	None	<0.008U	<0.008U	<0.057U	<0.0081U	<0.0082U	**0.0094***	<0.059U	**0.0086***	<0.0085U	NR	NR	NR	NR

Table 4–11. Analytes Detected in PBA08 RI Discrete Surface Soil Samples (continued)

Station		**LL8sb-060**	**LL8sb-061**	**LL8sb-062**	**LL8sb-063**	**LL8sb-063**	**LL8sb-064**	**LL8sb-065**	**LL8sb-066**	**LL8sb-067**	**LL8ss-068**	**LL8ss-069**	**LL8ss-070**	**LL8ss-072**
Sample ID		**LL8sb-060-5346-SO**	**LL8sb-061-5350-SO**	**LL8sb-062-5354-SO**	**LL8sb-063-6139-FD**	**LL8sb-063-5358-SO**	**LL8sb-064-5362-SO**	**LL8sb-065-5366-SO**	**LL8sb-066-5369-SO**	**LL8sb-067-5373-SO**	**LL8ss-068-5380-SO**	**LL8ss-069-5381-SO**	**LL8ss-070-5382-SO**	**LL8ss-072-5808-SO**
Date		**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**	**03/11/10**	**03/11/10**	**03/18/10**	**03/18/10**	**03/18/10**	**10/18/10**
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**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed[a]	**Background Criteria[b]**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**Chromium Speciation**	**Chromium Speciation**	**Chromium Speciation**	**Chromium Speciation**
Analyte														
							Metals (mg/kg)							
Indeno(1,2,3-cd)pyrene	None	**0.033***	<0.008U	**0.052J***	**0.028***	<0.0082U	**0.054***	**0.052J***	**0.065***	<0.0085U	NR	NR	NR	NR
Naphthalene	None	<0.008U	<0.008U	**0.027J***	<0.0081U	<0.0082U	**0.01***	**0.011J***	<0.0085U	<0.0085U	NR	NR	NR	NR
Phenanthrene	None	**0.011***	<0.008U	**0.067***	<0.0081U	<0.0082U	<0.12UJ	**0.035J***	**0.11J***	<0.0085U	NR	NR	NR	NR
Pyrene	None	**0.028***	<0.008U	**0.11***	**0.011***	**0.014***	**0.17***	**0.067***	**0.22J***	**0.017***	NR	NR	NR	NR

[a] Only detected site-related contaminants 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.
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 4–12. Subsurface Soil Rationale and Analyses

PBA08 RI Location	Comments/Rationale	Sample Type	Depth (ft bgs)	Analyses Performed				
				Metals	**Explosives**	**VOCs**	**Pesticides/ PCBs**	**SVOC**
LL8sb-060	Characterize an area not previously sampled.	Discrete	0-1	Y	Y	N	N	PAH
		Discrete	1-4	Y	Y	N	N	PAH
		Discrete	4-7	Y	Y	N	N	PAH
		Discrete[a]	7-13	N	N	N	N	N
LL8sb-061	Delineate vertical extent of contamination in previously sampled area.	Discrete	0-1	Y	Y	N	N	PAH
		Discrete	1-4	Y	Y	N	N	PAH
		Discrete	4-7	Y	Y	N	N	PAH
		NA	7-13	Y	Y	N	N	PAH
LL8sb-062	Delineate vertical extent of contamination in previously sampled area. 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
		NA	7-13	N	N	N	N	N
	QA/QC. Analyzed for RVAAP full-suite analytes.	Discrete	4-7	Y	Y	Y	Y	Y
		Discrete	4-7	Y	Y	Y	Y	Y
LL8sb-063	Delineate vertical extent of contamination in previously sampled area.	Discrete	0-1	Y	Y	N	N	PAH
		Discrete	1-4	Y	Y	N	N	PAH
		Discrete	4-7	Y	Y	N	N	PAH
		NA	7-13	N	N	N	N	N
	QA/QC	Discrete	0-1	Y	Y	N	N	PAH
		Discrete	0-1	Y	Y	N	N	PAH
LL8sb-064	Delineate vertical extent of contamination in previously sampled area.	Discrete	0-1	Y	Y	N	N	PAH
		Discrete	1-4	Y	Y	N	N	PAH
		Discrete	4-7	N	N	N	N	PAH
		NA	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
LL8sb-065	Delineate vertical extent of contamination in previously sampled area. 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
		NA	7-13	N	N	N	N	N
		Discrete	1-4	Y	Y	N	N	PAH
		Discrete	4-7	Y	Y	N	N	PAH
		Discrete[b]	7-13	Y	Y	N	N	PAH

Table 4–12. Subsurface Soil Rationale and Analyses (continued)

PBA08 RI Location	Comments/Rationale	Sample Type	Depth (ft bgs)	Analyses Performed				
				Metals	Explosives	VOCs	Pesticides/ PCBs	SVOC
LL8sb-066	Delineate vertical extent of contamination in previously sampled area.	Discrete	0-1	Y	Y	N	N	PAH
		Discrete	1-4	Y	Y	N	N	PAH
		Discrete	4-7	Y	Y	N	N	PAH
		NA	7-13	N	N	N	N	N
LL8sb-067	Delineate vertical extent of contamination in previously sampled area.	Discrete	0-1	Y	Y	N	N	PAH
		Discrete	1-4	Y	Y	N	N	PAH
		Discrete	4-7	Y	Y	N	N	PAH
		Discrete[b]	7-13	Y	Y	N	N	PAH
		Discrete	1-4	Y	Y	N	N	PAH

[a] Sample analyzed by the laboratory based on exceedance of preliminary screening criteria of the 4-7 ft sample interval.

[b] One sample (10%) from 7-13 ft was submitted for laboratory analysis to characterize subsurface soil to 13 ft bgs.

bgs = Below ground surface.
ft = Feet.
NA = Sample not analyzed by the laboratory based on preliminary screening criteria of the 4-7 ft sample interval.
PAH = Polycyclic aromatic hydrocarbon.
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.
PCB = Polychlorinated biphenyl.
QA = Quality assurance.
QC = Quality control.
RVAAP = Ravenna Army and Ammunition Plant.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.

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

Station		**LL8sb-060**	**LL8sb-060**	**LL8sb-060**	**LL8sb-061**	**LL8sb-061**	**LL8sb-062**	**LL8sb-062**	**LL8sb-062**	**LL8sb-063**	**LL8sb-063**
Sample ID		**LL8sb-060-5347-SO**	**LL8sb-060-5348-SO**	**LL8sb-060-5349-SO**	**LL8sb-061-5351-SO**	**LL8sb-061-5352-SO**	**LL8sb-062-5355-SO**	**LL8sb-062-6138-FD**	**LL8sb-062-5356-SO**	**LL8sb-063-5359-SO**	**LL8sb-063-5360-SO**
Date		**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**
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**	**4.0 - 7.0**	**4.0 - 7.0**	**1.0 - 4.0**	**4.0 - 7.0**
Parameters Analyzed[a]		**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**
Analyte	**Background Criteria[b]**										
Metals (mg/kg)											
Aluminum	19500	6190J	11600J	12800J	9080J	9310J	9110J	9940J	10200J	9730J	10100J
Antimony	0.96	<0.62UJ	0.13J	0.075J	<0.63UJ	0.072J	0.073J	<0.59UJ	<0.59UJ	0.1J	<0.62UJ
Arsenic	19.8	5.5	**26.9***	9.1	10.5	4.5	8.9	10.7	9.3	11.4	9.1
Barium	124	52.6J	75.1J	85.1J	66.5J	64.9J	45.5J	60.5J	89.4J	73.1J	61J
Beryllium	0.88	0.37	0.76	0.69	0.52	0.45	0.69	0.67	0.53	0.54	0.55
Cadmium	0	**0.061J***	**0.055J***	**0.066J***	**0.093J***	**0.03J***	**0.051J***	**0.069J***	**0.043J***	**0.083J***	**0.077J***
Calcium	35500	1060	20600	32600	1450	1110	4900	31700	49500*	4260	2530
Chromium	27.2	7.6	18.7	20.6	12.2	13.7	16	20.2	18	16.3	14.1
Cobalt	23.2	7.7	12.6	10	7.6	8	12.1	14.2	10.9	9	12
Copper	32.3	4.8	24.9	18.8J	12.8	14.5	16.9	20.8	18.5	16.1	14
Iron	35200	16500	33100	27300	19200	18800	25300	29300	26400	23700	20100
Lead	19.1	10.4	**20.3***	10.6	12.3	11	11.4	13.7	11.6	17	14.5
Magnesium	8790	962J	6440J	8470J	2090J	1920J	3750J	8380J	**20100J***	3350J	2570J
Manganese	3030	462	317	345	267	210	337	423	365	327	257
Mercury	0.044	<0.12U	<0.12U	<0.12U	<0.13U	<0.017UJ	<0.12U	<0.12U	<0.12U	<0.12U	<0.02UJ
Nickel	60.7	8.5	29.9	27.9J	16.4	16.3	26.3	31.9	27.2	22.8	17.9
Potassium	3350	402	1770	2830J	664	744	1140	2170	1830	1060	737
Selenium	1.5	0.48J	1.2J	0.76J	0.77J	0.97J	0.78J	0.67J	0.76J	0.74J	0.92J
Silver	0	**0.046J***	<0.019UJ	**0.029J***	**0.031J***	<0.029UJ	**0.016J***	**0.017J***	<0.02UJ	**0.029J***	<0.027UJ
Sodium	145	45.7J	85.9J	139	35.4J	38.1J	97.7J	**163***	137	58.9J	66.6J
Thallium	0.91	0.11J	0.18J	0.21J	0.12J	0.13J	0.15J	0.18J	0.16J	0.15J	0.15J
Vanadium	37.6	14.5	23.1	22.9	17.7	17	20	22	19.2	19.6	20.9
Zinc	93.3	35.5J	60.4J	56.7	45.8J	40.1J	47.2J	57.9J	51.4J	61.4J	47.3J
SVOCs (mg/kg)											
Benz(a)anthracene	None	<0.0083U	<0.0081U	<0.0078U	<0.0084U	<0.0077U	**0.011J***	<0.059U	<0.059U	<0.0082U	<0.0083U
Benzo(a)pyrene	None	**0.023***	<0.0081U	<0.0078U	<0.0084U	<0.0077U	**0.026J***	<0.059U	<0.059U	<0.0082U	<0.0083U
Benzo(b)fluoranthene	None	**0.027***	<0.0081U	<0.0078U	**0.026***	<0.0077U	**0.027J***	<0.059U	<0.059U	<0.0082U	<0.0083U
Benzo(ghi)perylene	None	<0.0083U	<0.0081U	<0.0078U	<0.0084U	<0.0077U	<0.059U	<0.059U	<0.059U	<0.0082U	<0.0083U
Benzo(k)fluoranthene	None	<0.0083U	<0.0081U	<0.0078U	<0.0084U	<0.0077U	<0.059U	<0.059U	<0.059U	<0.0082U	<0.0083U
Dibenz(a,h)anthracene	None	<0.0083U	<0.0081U	<0.0078U	<0.0084U	<0.0077U	<0.059U	<0.059U	<0.059U	<0.0082U	<0.0083U
Fluoranthene	None	**0.012***	<0.0081U	<0.0078U	**0.015***	<0.0077U	**0.017J***	<0.059U	<0.059U	<0.0082U	<0.0083U
Indeno(1,2,3-cd)pyrene	None	<0.0083U	<0.0081U	<0.0078U	<0.0084U	<0.0077U	**0.028J***	<0.059U	<0.059U	<0.0082U	<0.0083U
Pyrene	None	<0.0083U	<0.0081U	<0.0078U	**0.0086***	<0.0077U	**0.013J***	<0.059U	<0.059U	<0.0082U	<0.0083U
VOCs (mg/kg)											
Acetone	None	NR	NR	NR	NR	NR	<0.024UJ	<0.024UJ	<0.024UJ	NR	NR

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

Station		**LL8sb-064**	**LL8sb-064**	**LL8sb-064**	**LL8sb-065**	**LL8sb-065**	**LL8sb-066**	**LL8sb-066**	**LL8sb-067**	**LL8sb-067**	**LL8sb-067**
Sample ID		**LL8sb-064-6140-FD**	**LL8sb-064-5363-SO**	**LL8sb-064-5364-SO**	**LL8sb-065-5367-SO**	**LL8sb-065-5368-SO**	**LL8sb-066-5370-SO**	**LL8sb-066-5371-SO**	**LL8sb-067-5374-SO**	**LL8sb-067-5375-SO**	**LL8sb-067-5376-SO**
Date		**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**	**03/15/10**	**03/11/10**	**03/11/10**	**03/11/10**	**03/11/10**	**03/11/10**
Depth (ft)		**1.0 - 4.0**	**1.0 - 4.0**	**4.0 - 7.0**	**1.0 - 4.0**	**4.0 - 7.0**	**1.0 - 4.0**	**4.0 - 7.0**	**1.0 - 4.0**	**4.0 - 7.0**	**7.0 - 13.0**
Parameters Analyzed[a]		**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**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**
Analyte	**Background Criteria**[b]										
					Metals (mg/kg)						
Aluminum	19500	11700	9690J	9850J	8780J	13100J	10500J	10700	10600J	9870	6520J
Antimony	0.96	0.076J	0.084J	<0.58UJ	<0.61UJ	0.082J	0.096J	0.11J	0.09J	0.073J	0.077J
Arsenic	19.8	12.3J	10.1	10.1	6.4	14.7	10.8J	16.4	9.1J	14.1	15.2J
Barium	124	93.9	80.5J	57.6J	59.3J	95.8J	75	86.5	80.8	57	26.1
Beryllium	0.88	0.7	0.67	0.47	0.4	0.71	0.58J	0.61	0.53J	0.53	0.38J
Cadmium	0	**0.035J***	**0.08J***	**0.065J***	**0.041J***	**0.056J***	**0.07J***	<0.1UJ	**0.074J***	<0.047UJ	**0.059J***
Calcium	35500	7080	18900	33500	1690	16100	7040J	2030	2140J	15400	8390J
Chromium	27.2	19.2	17.4	16.6	11.6	20.8	15.2	15.9	14.6	15.9	11.9
Cobalt	23.2	13.9	11.8	11.1	4.8	11.9	10.1	11	8.2	11	8.8
Copper	32.3	19.3	17.6	19	11.9	21.4	19.7J	22.7	15.5J	19.3	16.4J
Iron	35200	27500	27100	25100	15500	32900	23400	27300	21600	26500	20200
Lead	19.1	12.4	11.1	10.8	12	12.5	15.1	13.9	13.8	11	11.3
Magnesium	8790	6560J	5780J	8400J	1520J	6500J	3770J	3500	3090J	6400	3950J
Manganese	3030	333	430	396	202	322	618	511	357	408	452
Mercury	0.044	<0.12U	<0.12U	<0.12U	<0.12U	<0.022UJ	<0.12U	0.023J	<0.12U	<0.12U	<0.12U
Nickel	60.7	29.8	27.4	26.6	12.8	34.6	20.7J	25.6	20.1J	26.4	21.4J
Potassium	3350	1640	1600	1730	637	1710	982J	1070	992J	1520	1090J
Selenium	1.5	0.91J	0.58J	0.84J	0.61J	**1.6J***	0.77J	1.2	0.76J	1	0.62J
Silver	0	**0.025J***	**0.014J***	<0.019UJ	**0.034J***	<0.028UJ	<0.025UJ	<0.027UJ	<0.024UJ	<0.022UJ	<0.02UJ
Sodium	145	76.9J	78.4J	84.7J	68.5J	116J	42.9J	72.8J	60.4J	76.5J	53.9J
Thallium	0.91	0.18J	0.16J	0.18J	0.12J	0.18J	0.16J	0.17J	0.16J	0.16J	0.11J
Vanadium	37.6	21.9	19.5	18.3	14.7	23.8	20.6J	18.6	19.3J	17.1	11.3J
Zinc	93.3	57.1	61.4J	51.4J	30.8J	63.7J	54	64.7	49.8	55.6	51
					SVOCs (mg/kg)						
Benz(a)anthracene	None	<0.008U	<0.0081U	<0.0078U	<0.061U	<0.06U	<0.0083U	<0.0077U	<0.0081U	<0.0077U	<0.0077U
Benzo(a)pyrene	None	<0.008U	<0.0081U	<0.0078U	<0.061U	<0.06U	<0.0083U	<0.0077U	<0.0081U	<0.0077U	<0.0077U
Benzo(b)fluoranthene	None	<0.008U	<0.0081U	<0.0078U	<0.061U	<0.06U	<0.0083U	**0.011***	<0.0081U	<0.0077U	<0.0077U
Benzo(ghi)perylene	None	<0.008U	<0.0081U	<0.0078U	<0.061U	<0.06U	<0.0083U	**0.015***	<0.0081U	<0.0077U	<0.0077U
Benzo(k)fluoranthene	None	<0.008U	<0.0081U	<0.0078U	<0.061U	<0.06U	<0.0083U	**0.01***	<0.0081U	<0.0077U	<0.0077U
Dibenz(a,h)anthracene	None	<0.008U	<0.0081U	<0.0078U	<0.061U	<0.06U	<0.0083U	**0.014***	<0.0081U	<0.0077U	<0.0077U
Fluoranthene	None	<0.008U	<0.0081U	<0.0078U	<0.061U	<0.06U	<0.0083U	<0.0077U	<0.0081U	<0.0077U	<0.0077U
Indeno(1,2,3-cd)pyrene	None	<0.008U	<0.0081U	<0.0078U	<0.061U	<0.06U	<0.0083U	**0.014***	<0.0081U	<0.0077U	<0.0077U
Pyrene	None	<0.008U	<0.0081U	<0.0078U	<0.061U	<0.06U	<0.0083U	<0.0077U	<0.0081U	<0.0077U	<0.0077U
					VOCs (mg/kg)						
Acetone	None	NR	NR	NR	**0.015J***	<0.024UJ	NR	NR	NR	NR	NR

[a] Only detected site-related contaminants 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.
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.
NR = Not reported/not analyzed.
R = Rejected as per results of validation process.
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 4–14. 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**
LL8ss-089M	Western Portion of drainage ditch along road	Further characterize previously identified contamination in wet portion of the ditch.	Composite	0 - 0.5	Y	Y	N	N	PAH
LL8sd-090	Southern drainage ditch west of settling pond	Characterize drainage ditch downstream of the former operational area.	Composite	0 - 0.5	Y	Y	N	N	Y
LL8sw-090			Grab	N/A	Y	Y	Y	Y	Y
		QA/QC samples collected.	Grab	N/A	Y	Y	Y	Y	Y
			Grab	N/A	Y	Y	Y	Y	Y
		Recollected sample in April 2011 to further evaluate March 2010 sample with elevated aluminum, barium, and iron concentrations.	Grab	N/A	Y	Y	Y	Y	Y
LL8sw-091	Western Ditch south of LL8sd-005M	Characterize drainage ditch west of the former operational area. Sediment analyzed for RVAAP full-suite analytes.	Grab	N/A	Y	Y	Y	Y	Y
LL8sd-091			Composite	0 - 0.5	Y	Y	Y	Y	Y
		QA/QC samples collected. Analyzed for RVAAP full-suite analytes.	Composite	0 - 0.5	Y	Y	Y	Y	Y
			Composite	0 - 0.5	Y	Y	Y	Y	Y
LL8sw-092	Discharge point	Current characterization of drainage ditch exiting the AOC to the southwest.	Grab	N/A	Y	Y	Y	Y	Y
LL8sd-092			Grab	0 - 0.5	Y	Y	Y	Y	Y

AOC = Area of concern.
bgs = Below ground surface.
ft = Feet.
NA = Not applicable.
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 4–15. Analytes Detected in PBA08 RI Sediment Samples

Station	**Background Criteria[b]**	**LL8sd-090**	**LL8sd-091**	**LL8sd-091**	**LL8sd-092**	**LL8ss-089M**
Sample ID		**LL8sd-090-5378-SD**	**LL8sd-091-6113-FD**	**LL8sd-091-5379-SD**	**LL8sd-092-5377-SD**	**LL8ss-089M-5404-SO**
Date		**03/01/10**	**03/01/10**	**03/01/10**	**03/01/10**	**03/18/10**
Depth (ft)		**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 1.0**
Parameters Analyzed[a]		**LL8sd-090**	**LL8sd-091**	**LL8sd-091**	**LL8sd-092**	**LL8ss-089M**
Analyte						
Metals (mg/kg)						
Aluminum	13900	**15700***	6850	9430	10100	10900
Arsenic	19.5	1.8J	3.7J	1.4J	3.6J	11.6J
Barium	123	48.8	36.2	39.9	73.4	78.6
Beryllium	0.38	**0.43***	**0.41***	0.29	**0.41***	**0.58***
Cadmium	0	**0.089J***	**0.15J***	**0.024J***	**0.14J***	**0.095J***
Calcium	5510	1560J	956J	1150J	2620J	**27000J***
Chromium	18.1	17.1J	7.7J	9.4J	11.3J	**20.3***
Cobalt	9.1	4.7	4.8	2.8	8.2	**11.8***
Copper	27.6	17.1	15.1	11.1	11.3	20.4
Iron	28200	13600	13400	9650	15300	26500
Lead	27.4	12.7	9.8	8.8	14.9	12.5
Magnesium	2760	2650J	1360J	1450J	1170J	**7110***
Manganese	1950	89.9	184	69.2	1070	555
Mercury	0.059	<0.028UJ	<0.045UJ	<0.02UJ	<0.046UJ	0.029J
Nickel	17.7	12.8	10.5	8.2	9.2	**29.4***
Potassium	1950	1140	508	511J	694	1660
Selenium	1.7	0.96	0.72	0.65J	0.8	1.2J
Silver	0	**0.018J***	<0.025UJ	<0.025UJ	<0.054UJ	<0.026UJ
Thallium	0.89	0.16J	<0.29U	0.097J	0.13J	0.16J
Vanadium	26.1	22.1J	11.5J	11.7J	14.2J	18.9J
Zinc	532	67.7	60.3	31.8	65.1	64.9
Explosives (mg/kg)						
Tetryl	None	<0.25U	<0.25U	<0.25U	<0.25U	**0.014J***
SVOCs (mg/kg)						
Benz(a)anthracene	None	<0.07U	<0.071U	<0.069U	**0.05J***	**0.017***
Benzo(a)pyrene	None	<0.07U	<0.071U	<0.069U	<0.078U	**0.014***
Benzo(b)fluoranthene	None	<0.07U	<0.071U	<0.069U	<0.078U	**0.035***
Chrysene	None	<0.07U	<0.071U	<0.069U	<0.078U	**0.02***
Fluoranthene	None	<0.07U	**0.013J***	<0.069U	**0.06J***	**0.039***
Naphthalene	None	<0.07U	<0.071U	<0.069U	<0.078U	**0.014***

Table 4–15 Analytes Detected in PBA08 RI Sediment Samples (continued)

Station		**LL8sd-090**	**LL8sd-091**	**LL8sd-091**	**LL8sd-092**	**LL8ss-089M**
Sample ID		**LL8sd-090-5378-SD**	**LL8sd-091-6113-FD**	**LL8sd-091-5379-SD**	**LL8sd-092-5377-SD**	**LL8ss-089M-5404-SO**
Date		**03/01/10**	**03/01/10**	**03/01/10**	**03/01/10**	**03/18/10**
Depth (ft)		**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 1.0**
Parameters Analyzed[a] **Analyte**	**Background Criteria[b]**	**LL8sd-090**	**LL8sd-091**	**LL8sd-091**	**LL8sd-092**	**LL8ss-089M**
Phenanthrene	None	<0.07U	<0.071U	<0.069U	**0.043J***	**0.031***
Pyrene	None	<0.07U	**0.01J***	<0.069U	**0.049J***	**0.034***
Pesticides (mg/kg)						
4,4'-DDE	None	NR	**0.0014J***	<0.0047UJ	NR	NR
VOCs (mg/kg)						
Toluene	None	NR	**0.00041J***	**0.00059J***	NR	NR

[a] Only detected site-related contaminants are presented in the table.
[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).
DDE = Dichlorodiphenyldichloroethylene.
ID = Identification.
ft = Feet.
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 as per results of validation process.
SVOC = Semi-volatile organic compound.
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 4–16. Analytes Detected in PBA08 RI Surface Water Samples

Station	**Background Criteria**[b]	**LL8sw-090**	**LL8sw-090**	**LL8sw-090**	**LL8sw-091**	**LL8sw-092**
Sample ID		**LL8sw-090-6115-FD**	**LL8sw-090-5384-SW**	**LL8sw-090-5818-SW**	**LL8sw-091-5385-SW**	**LL8sw-092-5383-SW**
Date		**03/01/10**	**03/01/10**	**04/18/11**	**03/01/10**	**03/01/10**
Parameters Analyzed[a]		**RVAAP Full-suite analytes + Nitrate**	**RVAAP Full-suite analytes + Nitrate**	**RVAAP Full-suite analytes + Nitrate**	**RVAAP Full-suite analytes + Nitrate**	**RVAAP Full-suite analytes + Nitrate**
Analyte (mg/L)						
Metals (mg/L)						
Aluminum	3.37	**6.58***	**23.9***	0.682	2.21	0.977
Arsenic	0.0032	0.0017J	**0.0048J***	<0.005U	0.0014J	0.00086J
Barium	0.0475	**0.0571***	**0.169***	0.0208	0.0293	0.0221
Beryllium	0	**0.0002J***	**0.00083J***	<0.001U	**0.00009J***	**0.00005J***
Cadmium	0	**0.00029J***	**0.0011J***	<0.002U	**0.00006J***	**0.00016J***
Calcium	41.4	22.1	21.9	23.4J	27	6.49
Chromium	0	**0.0075***	**0.0264***	**0.0013J***	**0.0027J***	**0.0015J***
Cobalt	0	**0.0029J***	**0.0085***	**0.00022J***	**0.00099J***	**0.00067J***
Copper	0.0079	**0.0085***	**0.0266***	0.0027J	0.004J	0.0043J
Iron	2.56	**8.59***	**23.6***	0.858	**3.92***	1.58
Lead	0	**0.0061***	**0.024***	**0.0005J***	**0.0018J***	**0.0014J***
Magnesium	10.8	4.49	6.7	3.88	5.24	1.66
Manganese	0.391	**0.983***	**1.23***	0.0525	0.17	0.196
Nickel	0	**0.0059J***	**0.0191***	**0.0013J***	**0.0028J***	**0.0024J***
Potassium	3.17	**3.48***	**5.05***	1.47	2.22	1.46
Selenium	0	**0.00063J***	**0.0017J***	<0.005U	**0.00044J***	**0.0003J***
Sodium	21.3	1.68	1.95	1.45	2.24	1.07
Vanadium	0	**0.0113***	**0.0416***	**0.00078J***	**0.0041J***	**0.0016J***
Zinc	0.042	**0.0948***	**0.278***	0.0178J	0.0397J	**0.0806***
Anions (mg/L)						
Nitrate	None	**0.2***	**0.2***	<0.1U	<0.1U	<0.1U
SVOCs (mg/L)						
3+4-Methylphenol	None	**0.0024J***	<0.01U	<0.01U	<0.01U	<0.01U

Table 4–16. Analytes Detected in PBA08 RI Surface Water Samples (continued)

Station		**LL8sw-090**	**LL8sw-090**	**LL8sw-090**	**LL8sw-091**	**LL8sw-092**
Sample ID		**LL8sw-090-6115-FD**	**LL8sw-090-5384-SW**	**LL8sw-090-5818-SW**	**LL8sw-091-5385-SW**	**LL8sw-092-5383-SW**
Date		**03/01/10**	**03/01/10**	**04/18/11**	**03/01/10**	**03/01/10**
Parameters Analyzed[a]	**Background Criteria**[b]	**RVAAP Full-suite analytes + Nitrate**	**RVAAP Full-suite analytes + Nitrate**	**RVAAP Full-suite analytes + Nitrate**	**RVAAP Full-suite analytes + Nitrate**	**RVAAP Full-suite analytes + Nitrate**
Analyte (mg/L)						
Metals (mg/L)						
VOCs (mg/L)						
Toluene	None	**0.00041J***	<0.001U	<0.001U	<0.001U	<0.001U

[a] Only detected site-related contaminants 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.
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.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.
* = Result exceeds background concentration.

Table 4–17. 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

Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (USACE 2001b).
mg/kg = Milligrams per kilogram.
mg/L = Milligrams per liter.
NA = Not available. Aluminum results were rejected in validation.
RVAAP = Ravenna Army Ammunition Plant.

Table 4–18. RDA/RDI 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 = Milligram per day.
RDA = Recommended daily allowance.
RDI = Recommended 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 4–19. SRC Screening Summary for ISM 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	49/49	3400	17000	9920	17700	No	Below background
Antimony	7440-36-0	16/47	0.067	0.13	1.67	0.96	No	Below background
Arsenic	7440-38-2	49/49	4	13.9	9.2	15.4	No	Below background
Barium	**7440-39-3**	**49/49**	**47.8**	**260**	**85.4**	**88.4**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**36/49**	**0.47**	**4.3**	**0.839**	**0.88**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**33/49**	**0.1**	**2.8**	**0.488**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	49/49	562	180000	24100	15800	No	Essential Nutrient
Chromium	**7440-47-3**	**49/49**	**14**	**39**	**23.5**	**17.4**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**49/49**	**2.3**	**11.2**	**7.04**	**10.4**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**49/49**	**9**	**67**	**18.9**	**17.7**	**Yes**	**Exceeds background**
Iron	7439-89-6	49/49	9600	29800	18400	23100	No	Essential Nutrient
Lead	**7439-92-1**	**49/49**	**15.5**	**210**	**48.6**	**26.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	49/49	1690	13000	3580	3030	No	Essential Nutrient
Manganese	**7439-96-5**	**49/49**	**377**	**2400**	**673**	**1450**	**Yes**	**Exceeds background**
Mercury	**7439-97-6**	**44/49**	**0.017**	**0.87**	**0.061**	**0.036**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**49/49**	**13**	**162**	**24.3**	**21.1**	**Yes**	**Exceeds background**
Potassium	7440-09-7	46/49	601	1700	922	927	No	Essential Nutrient
Selenium	7782-49-2	24/49	0.51	1.4	0.827	1.4	No	Below background
Silver	7440-22-4	1/49	0.036	0.036	0.469	0	No	<5% Detected
Sodium	7440-23-5	29/49	19.7	1700	194	123	No	Essential Nutrient
Thallium	**7440-28-0**	**19/49**	**0.1**	**0.2**	**0.426**	**0**	**Yes**	**Exceeds background**
Vanadium	7440-62-2	49/49	6.7	26	15.8	31.1	No	Below background
Zinc	**7440-66-6**	**49/49**	**46.6**	**220**	**89.6**	**61.8**	**Yes**	**Exceeds background**
Explosives/Propellants								
HMX	**2691-41-0**	**2/49**	**0.013**	**0.015**	**0.11**	**None**	**Yes**	**Detected organic**
Nitrocellulose	**9004-70-0**	**7/7**	**1.1**	**4**	**1.91**	**None**	**Yes**	**Detected organic**
Tetryl	**479-45-8**	**7/49**	**0.015**	**0.63**	**0.148**	**None**	**Yes**	**Detected organic**
SVOCs								
2-Methylnaphthalene	**91-57-6**	**5/8**	**0.012**	**0.086**	**0.203**	**None**	**Yes**	**Detected organic**
Acenaphthene	**83-32-9**	**7/23**	**0.0076**	**0.43**	**0.11**	**None**	**Yes**	**Detected organic**
Acenaphthylene	208-96-8	1/23	0.01	0.01	0.0754	**None**	No	<5% Detected
Anthracene	**120-12-7**	**10/23**	**0.015**	**0.79**	**0.165**	**None**	**Yes**	**Detected organic**
Benz(a)anthracene	**56-55-3**	**14/23**	**0.0083**	**1.7**	**0.315**	**None**	**Yes**	**Detected organic**

Table 4–19. SRC Screening Summary for ISM 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
Benzenemethanol	**100-51-6**	**2/5**	**0.027**	**0.45**	**0.237**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**17/23**	**0.0099**	**1.3**	**0.245**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**19/23**	**0.013**	**1.8**	**0.371**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**13/23**	**0.011**	**0.72**	**0.169**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**15/23**	**0.01**	**0.75**	**0.18**	**None**	**Yes**	**Detected organic**
Bis(2-ethylhexyl)phthalate	**117-81-7**	**4/8**	**0.058**	**0.18**	**0.247**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**20/23**	**0.0079**	**1.5**	**0.31**	**None**	**Yes**	**Detected organic**
Di-n-butyl phthalate	**84-74-2**	**1/8**	**0.033**	**0.033**	**0.262**	**None**	**Yes**	**Detected organic**
Dibenz(a,h)anthracene	**53-70-3**	**4/23**	**0.015**	**0.29**	**0.0966**	**None**	**Yes**	**Detected organic**
Dibenzofuran	**132-64-9**	**1/8**	**0.025**	**0.025**	**0.254**	**None**	**Yes**	**Detected organic**
Diethyl phthalate	**84-66-2**	**1/8**	**0.027**	**0.027**	**0.238**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**22/23**	**0.011**	**4**	**0.816**	**None**	**Yes**	**Detected organic**
Fluorene	**86-73-7**	**7/23**	**0.0085**	**0.35**	**0.103**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**13/23**	**0.0094**	**0.75**	**0.166**	**None**	**Yes**	**Detected organic**
Naphthalene	**91-20-3**	**16/23**	**0.0075**	**0.26**	**0.0946**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**22/23**	**0.0082**	**2.5**	**0.493**	**None**	**Yes**	**Detected organic**
Phenol	**108-95-2**	**1/8**	**0.037**	**0.037**	**0.263**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**22/23**	**0.0098**	**3.3**	**0.649**	**None**	**Yes**	**Detected organic**
Pesticides/PCBs								
4,4'-DDD	**72-54-8**	**1/8**	**0.014**	**0.014**	**0.00588**	**None**	**Yes**	**Detected organic**
4,4'-DDE	**72-55-9**	**1/8**	**0.024**	**0.024**	**0.00701**	**None**	**Yes**	**Detected organic**
4,4'-DDT	**50-29-3**	**1/8**	**0.0083**	**0.0083**	**0.00517**	**None**	**Yes**	**Detected organic**
PCB-1254	**11097-69-1**	**3/8**	**0.019**	**0.1**	**0.0303**	**None**	**Yes**	**Detected organic**
beta-BHC	**319-85-7**	**1/8**	**0.0027**	**0.0027**	**0.00766**	**None**	**Yes**	**Detected organic**
VOCs								
2-Butanone	**78-93-3**	**2/7**	**0.002**	**0.0024**	**0.00899**	**None**	**Yes**	**Detected organic**

[a] Background criteria for 0-1 ft below ground surface from final facility-wide background values for Ravenna Army Ammunition Plant, Ravenna (RVAAP), published in the Final Phase II Remedial Investigation Report for Winklepeck Burning Grounds at RVAAP, Ravenna, Ohio (USACE 2001b).

[b] Facility-wide clean-up goals (FWCUG) for Resident Farmer Adult, Resident Farmer Child, and National Guard Trainee from Facility-wide Human Health Cleanup Goals for RVAAP (USACE 2010).

[c] Screening level source:

[d] FWCUG is the most conservative (smallest) of the FWCUGs for hexavalent and trivalent chromium.

BHC = Hexachlorocyclohexane.
CAS = Chemical Abstract Service.
DDD = Dichlorodiphenyldichloroethane
DDE = Dichlorodiphenyldichloroethylene.
DDT = Dichlorodiphenyltrichloroethane.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane.
ISM = Incremental sampling methodology.
mg/kg = Milligrams per kilogram.
PCB = Polychlorinated biphenyl.
SRC = Site-related chemical.
SVOC = Semi-volatile organic compound.
Bold = Chemical is a chemical of potential concern.

Table 4–20. SRC Screening Summary for Discrete 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	8/8	1420	10200	6290	17700	No	Below background
Antimony	7440-36-0	6/8	0.088	0.15	0.158	0.96	No	Below background
Arsenic	7440-38-2	8/8	2.5	15.2	9.81	15.4	No	Below background
Barium	7440-39-3	8/8	41.8	70	55.2	88.4	No	Below background
Beryllium	7440-41-7	8/8	0.25	0.67	0.501	0.88	No	Below background
Cadmium	**7440-43-9**	**8/8**	**0.06**	**0.39**	**0.172**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	8/8	1910	154000	44600	15800	No	Essential Nutrient
Chromium	**7440-47-3**	**12/12**	**3.8**	**23.3**	**11.9**	**17.4**	**Yes**	**Exceeds background**
Chromium, hexavalent	**18540-29-9**	**4/4**	**0.41**	**2**	**1.32**		**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**8/8**	**2.9**	**12.8**	**7.19**	**10.4**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**8/8**	**4.3**	**28.4**	**14.7**	**17.7**	**Yes**	**Exceeds background**
Iron	7439-89-6	8/8	10000	29200	19000	23100	No	Essential Nutrient
Lead	**7439-92-1**	**8/8**	**7.6**	**58.1**	**19.6**	**26.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	8/8	909	6040	2810	3030	No	Essential Nutrient
Manganese	7439-96-5	8/8	238	725	480	1450	No	Below background
Nickel	**7440-02-0**	**8/8**	**6.4**	**25.4**	**16**	**21.1**	**Yes**	**Exceeds background**
Potassium	7440-09-7	8/8	289	1480	690	927	No	Essential Nutrient
Selenium	7782-49-2	8/8	0.37	0.83	0.61	1.4	No	Below background
Silver	**7440-22-4**	**6/8**	**0.0073**	**0.03**	**0.0138**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	8/8	35.1	94.3	60.7	123	No	Essential Nutrient
Thallium	**7440-28-0**	**7/8**	**0.069**	**0.17**	**0.115**	**0**	**Yes**	**Exceeds background**
Vanadium	7440-62-2	8/8	4	21.7	12.3	31.1	No	Below background
Zinc	**7440-66-6**	**8/8**	**26.8**	**122**	**58.1**	**61.8**	**Yes**	**Exceeds background**
SVOCs								
2-Methylnaphthalene	**91-57-6**	**2/2**	**0.015**	**0.039**	**0.027**	**None**	**Yes**	**Detected organic**
Acenaphthene	**83-32-9**	**2/8**	**0.011**	**0.013**	**0.0123**	**None**	**Yes**	**Detected organic**
Anthracene	**120-12-7**	**4/8**	**0.01**	**0.03**	**0.0127**	**None**	**Yes**	**Detected organic**
Benz(a)anthracene	**56-55-3**	**7/8**	**0.0089**	**0.14**	**0.0492**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**6/8**	**0.0088**	**0.11**	**0.0424**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**8/8**	**0.013**	**0.16**	**0.069**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**4/8**	**0.042**	**0.073**	**0.0282**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**3/8**	**0.014**	**0.07**	**0.017**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**6/8**	**0.011**	**0.14**	**0.0411**	**None**	**Yes**	**Detected organic**

Table 4–20. SRC Screening Summary for Discrete 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
Dibenz(a,h)anthracene	**53-70-3**	**2/8**	**0.02**	**0.035**	**0.0129**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**7/8**	**0.0048**	**0.24**	**0.0806**	**None**	**Yes**	**Detected organic**
Fluorene	**86-73-7**	**2/8**	**0.0086**	**0.0094**	**0.0115**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**5/8**	**0.033**	**0.065**	**0.0335**	**None**	**Yes**	**Detected organic**
Naphthalene	**91-20-3**	**3/8**	**0.01**	**0.027**	**0.00858**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**4/8**	**0.011**	**0.11**	**0.0369**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**7/8**	**0.014**	**0.22**	**0.0788**	**None**	**Yes**	**Detected organic**

[a] Background criteria for 0-1 ft below ground surface from final facility-wide background values for Ravenna Army Ammunition Plant (RVAAP), published in the Final Phase II Remedial Investigation Report for Winklepeck Burning Grounds at RVAAP, Ravenna, Ohio (USACE 2001b).

[b] Facility-wide Clean-up Goals (FWCUGs) for Resident Farmer Adult, Resident Farmer Child, and National Guard Trainee from Facility-wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant (USACE 2010).

[c] Screening level source:

[d] FWCUG is the most conservative (smallest) of the FWCUGs for hexavalent and trivalent chromium.

CAS = Chemical Abstract Service.

SRC = Site-related chemical.

SVOC = Semi-volatile organic compound.

Bold = Chemical is a chemical of potential concern.

Table 4–21. SRC Screening Summary for Subsurface 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	18/18	6190	13100	9870	19500	No	Below background
Antimony	7440-36-0	12/18	0.072	0.13	0.16	0.96	No	Below background
Arsenic	**7440-38-2**	**18/18**	**4.5**	**26.9**	**11.2**	**19.8**	**Yes**	**Exceeds background**
Barium	7440-39-3	18/18	26.1	95.8	68.4	124	No	Below background
Beryllium	7440-41-7	18/18	0.37	0.76	0.554	0.88	No	Below background
Cadmium	**7440-43-9**	**16/18**	**0.03**	**0.093**	**0.0599**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	18/18	1060	49500	12400	35500	No	Essential Nutrient
Chromium	7440-47-3	18/18	7.6	20.8	15.4	27.2	No	Below background
Cobalt	7440-48-4	18/18	4.8	12.6	9.92	23.2	No	Below background
Copper	7440-50-8	18/18	4.8	24.9	16.9	32.3	No	Below background
Iron	7439-89-6	18/18	15500	33100	23900	35200	No	Essential Nutrient
Lead	**7439-92-1**	**18/18**	**10.4**	**20.3**	**12.8**	**19.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	18/18	962	20100	5140	8790	No	Essential Nutrient
Manganese	7439-96-5	18/18	202	618	366	3030	No	Below background
Mercury	7439-97-6	1/18	0.023	0.023	0.0499	0.044	No	Below background
Nickel	7440-02-0	18/18	8.5	34.6	22.7	60.7	No	Below background
Potassium	7440-09-7	18/18	402	2830	1250	3350	No	Essential Nutrient
Selenium	**7782-49-2**	**18/18**	**0.48**	**1.6**	**0.853**	**1.5**	**Yes**	**Exceeds background**
Silver	**7440-22-4**	**7/18**	**0.014**	**0.046**	**0.0183**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	18/18	35.4	139	75.5	145	No	Essential Nutrient
Thallium	7440-28-0	18/18	0.11	0.21	0.153	0.91	No	Below background
Vanadium	7440-62-2	18/18	11.3	23.8	18.8	37.6	No	Below background
Zinc	7440-66-6	18/18	30.8	64.7	51.6	93.3	No	Below background
SVOCs								
Benz(a)anthracene	**56-55-3**	**1/18**	**0.011**	**0.011**	**0.00873**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**2/18**	**0.023**	**0.026**	**0.0106**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**4/18**	**0.011**	**0.027**	**0.0125**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**1/18**	**0.015**	**0.015**	**0.0104**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**1/18**	**0.01**	**0.01**	**0.0101**	**None**	**Yes**	**Detected organic**
Dibenz(a,h)anthracene	**53-70-3**	**1/18**	**0.014**	**0.014**	**0.0103**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**3/18**	**0.012**	**0.017**	**0.0101**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**2/18**	**0.014**	**0.028**	**0.0102**	**None**	**Yes**	**Detected organic**

Table 4–21. SRC Screening Summary for Subsurface 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
Pyrene	**129-00-0**	**2/18**	**0.0086**	**0.013**	**0.00908**	**None**	**Yes**	**Detected organic**
				SVOCs				
Acetone	**67-64-1**	**1/4**	**0.015**	**0.015**	**0.0128**	**None**	**Yes**	**Detected organic**

[a] Background criteria for greater than 1 ft below ground surface from final facility-wide background values for Ravenna Army Ammunition Plant (RVAAP), published in the Final Phase II Remedial Investigation Report for Winklepeck Burning Grounds at RVAAP, Ravenna, Ohio (USACE 2001b).

[b] Facility-wide Clean-up Goals (FWCUGs) for Resident Farmer Adult, Resident Farmer Child, and National Guard Trainee from Facility-wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant (USACE 2010).

[c] Screening level source:

[d] FWCUG is the most conservative (smallest) of the FWCUGs for hexavalent and trivalent chromium.

[e] Pyrene regional screening level used as a surrogate for benzo(ghi)perylene.

CAS = Chemical Abstract Service.

mg/kg = Milligrams per kilogram.

SRC = Site-related chemical.

Bold = Chemical is a chemical of potential concern.

Table 4–22. SRC Screening Summary for ISM Sediment

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	7/7	9900	13000	11000	13900	No	Below background
Arsenic	7440-38-2	7/7	2.3	11.6	7.69	19.5	No	Below background
Barium	**7440-39-3**	**7/7**	**65**	**140**	**97.4**	**123**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**7/7**	**0.58**	**1.3**	**0.923**	**0.38**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**5/7**	**0.095**	**2.6**	**1.07**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	7/7	1700	27000	9030	5510	No	Essential Nutrient
Chromium	**7440-47-3**	**7/7**	**13**	**20.3**	**16.3**	**18.1**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**7/7**	**5.2**	**16**	**10.8**	**9.1**	**Yes**	**Exceeds background**
Copper	7440-50-8	7/7	17	27	21.9	27.6	No	Below background
Iron	7439-89-6	7/7	14000	30000	22200	28200	No	Essential Nutrient
Lead	**7439-92-1**	**7/7**	**12.5**	**38**	**26.2**	**27.4**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	7/7	1500	7110	3170	2760	No	Essential Nutrient
Manganese	7439-96-5	7/7	150	910	569	1950	No	Below background
Mercury	**7439-97-6**	**7/7**	**0.029**	**0.26**	**0.0927**	**0.059**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**7/7**	**11**	**29.4**	**21.1**	**17.7**	**Yes**	**Exceeds background**
Potassium	7440-09-7	7/7	810	1700	1320	1950	No	Essential Nutrient
Selenium	**7782-49-2**	**4/7**	**1.2**	**2.3**	**1.59**	**1.7**	**Yes**	**Exceeds background**
Sodium	7440-23-5	4/7	210	390	310	112	No	Essential Nutrient
Thallium	7440-28-0	1/7	0.16	0.16	0.623	0.89	No	Below background
Vanadium	7440-62-2	7/7	18	26	21	26.1	No	Below background
Zinc	7440-66-6	7/7	64.9	430	246	532	No	Below background
Explosives/Propellants								
Nitrocellulose	**9004-70-0**	**1/2**	**1.1**	**1.1**	**0.875**	**None**	**Yes**	**Detected organic**
Tetryl	**479-45-8**	**1/7**	**0.014**	**0.014**	**0.545**	**None**	**Yes**	**Detected organic**
SVOCs								
Benz(a)anthracene	**56-55-3**	**2/3**	**0.017**	**0.1**	**0.0535**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**2/3**	**0.014**	**0.092**	**0.0498**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**3/3**	**0.027**	**0.18**	**0.0807**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**1/3**	**0.12**	**0.12**	**0.0556**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**1/3**	**0.079**	**0.079**	**0.042**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**2/3**	**0.02**	**0.11**	**0.0578**	**None**	**Yes**	**Detected organic**

Table 4–22. SRC Screening Summary for ISM Sediment (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
Fluoranthene	**206-44-0**	**3/3**	**0.039**	**0.16**	**0.081**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**1/3**	**0.064**	**0.064**	**0.037**	**None**	**Yes**	**Detected organic**
Naphthalene	**91-20-3**	**1/3**	**0.014**	**0.014**	**0.0408**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**2/3**	**0.031**	**0.059**	**0.0517**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**2/3**	**0.034**	**0.16**	**0.0863**	**None**	**Yes**	**Detected organic**
Pesticides								
4,4'-DDD	**72-54-8**	**1/2**	**0.0015**	**0.0015**	**0.0018**	**None**	**Yes**	**Detected organic**
4,4'-DDE	**72-55-9**	**1/2**	**0.023**	**0.023**	**0.0128**	**None**	**Yes**	**Detected organic**
4,4'-DDT	**50-29-3**	**1/2**	**0.0065**	**0.0065**	**0.0043**	**None**	**Yes**	**Detected organic**

[a] Background criteria for sediment from final facility-wide background values for Ravenna Army Ammunition Plant (RVAAP), published in the Final Phase II Remedial Investigation Report for Winklepeck Burning Grounds at RVAAP, Ravenna, Ohio (USACE 2001b).

[b] Facility-wide Clean-up Goals (FWCUGs) for Resident Farmer Adult, Resident Farmer Child, and National Guard Trainee from Facility-wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant (USACE 2010).

[c] Screening level source:

[d] FWCUG is the most conservative (smallest) of the FWCUGs for hexavalent and trivalent chromium.

[e] Pyrene regional screening level used as a surrogate for benzo(ghi)perylene and for phenanthrene.

CAS = Chemical Abstract Service.
DDD = Dichlorodiphenyldichloroethane.
DDE = Dichlorodiphenyldichloroethylene.
DDT = Dichlorodiphenyltrichloroethane.
ISM = Incremental sampling methodology.
mg/kg = Milligrams per kilogram.
SRC = Site-related chemical.
SVOC = Semi-volatile organic compound.
Bold = Chemical is a chemical of potential concern.

Table 4–23. SRC Screening Summary for Discrete Sediment

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**	**3/3**	**9430**	**15700**	**11700**	**13900**	**Yes**	**Exceeds background**
Arsenic	7440-38-2	3/3	1.4	3.6	2.27	19.5	No	Below background
Barium	7440-39-3	3/3	39.9	73.4	54	123	No	Below background
Beryllium	**7440-41-7**	**3/3**	**0.29**	**0.43**	**0.377**	**0.38**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**3/3**	**0.024**	**0.14**	**0.0843**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	3/3	1150	2620	1780	5510	No	Essential Nutrient
Chromium	7440-47-3	3/3	9.4	17.1	12.6	18.1	No	Below background
Cobalt	7440-48-4	3/3	2.8	8.2	5.23	9.1	No	Below background
Copper	7440-50-8	3/3	11.1	17.1	13.2	27.6	No	Below background
Iron	7439-89-6	3/3	9650	15300	12900	28200	No	Essential Nutrient
Lead	7439-92-1	3/3	8.8	14.9	12.1	27.4	No	Below background
Magnesium	7439-95-4	3/3	1170	2650	1760	2760	No	Essential Nutrient
Manganese	7439-96-5	3/3	69.2	1070	410	1950	No	Below background
Nickel	7440-02-0	3/3	8.2	12.8	10.1	17.7	No	Below background
Potassium	7440-09-7	3/3	511	1140	782	1950	No	Essential Nutrient
Selenium	7782-49-2	3/3	0.65	0.96	0.803	1.7	No	Below background
Silver	**7440-22-4**	**1/3**	**0.018**	**0.018**	**0.0192**	**0**	**Yes**	**Exceeds background**
Thallium	7440-28-0	3/3	0.097	0.16	0.129	0.89	No	Below background
Vanadium	7440-62-2	3/3	11.7	22.1	16	26.1	No	Below background
Zinc	7440-66-6	3/3	31.8	67.7	54.9	532	No	Below background
SVOCs								
Benz(a)anthracene	**56-55-3**	**1/3**	**0.05**	**0.05**	**0.0398**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**1/3**	**0.06**	**0.06**	**0.0432**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**1/3**	**0.043**	**0.043**	**0.0375**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**1/3**	**0.049**	**0.049**	**0.0395**	**None**	**Yes**	**Detected organic**

Table 4–23. SRC Screening Summary for Discrete Sediment (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
VOCs								
Toluene	**108-88-3**	**1/1**	**0.00059**	**0.00059**	**0.00059**	**None**	**Yes**	**Detected organic**

[a] Background criteria for sediment from final facility-wide background values for Ravenna Army Ammunition Plant (RVAAP), published in the Final Phase II Remedial Investigation Report for Winklepeck Burning Grounds at RVAAP, Ravenna, Ohio (USACE 2001b).

[b] Facility-wide Clean-up Goals (FWCUGs) for Resident Farmer Adult, Resident Farmer Child, and National Guard Trainee from Facility-wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant (USACE 2010).

[c] Screening level source:

[d] FWCUG is the most conservative (smallest) of the FWCUGs for hexavalent and trivalent chromium.

[e] Pyrene regional screening level used as a surrogate for phenanthrene.

CAS = Chemical Abstract Service.
mg/kg = Milligrams per kilogram.
SRC = Site-related chemical.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.
Bold = Chemical is a chemical of potential concern.

Table 4–24. SRC Screening Summary for Surface Water

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**	**3/3**	**0.977**	**23.9**	**9.03**	**3.37**	**Yes**	**Exceeds background**
Arsenic	**7440-38-2**	**3/3**	**0.00086**	**0.0048**	**0.00235**	**0.0032**	**Yes**	**Exceeds background**
Barium	**7440-39-3**	**3/3**	**0.0221**	**0.169**	**0.0735**	**0.0475**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**3/3**	**0.000051**	**0.00083**	**0.000322**	**0**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**3/3**	**0.000056**	**0.0011**	**0.000439**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	3/3	6.49	27	18.5	41.4	No	Essential Nutrient
Chromium	**7440-47-3**	**3/3**	**0.0015**	**0.0264**	**0.0102**	**0**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**3/3**	**0.00067**	**0.0085**	**0.00339**	**0**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**3/3**	**0.004**	**0.0266**	**0.0116**	**0.0079**	**Yes**	**Exceeds background**
Iron	**7439-89-6**	**3/3**	**1.58**	**23.6**	**9.7**	**2.56**	**Yes**	**Exceeds background**
Lead	**7439-92-1**	**3/3**	**0.0014**	**0.024**	**0.00907**	**0**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	3/3	1.66	6.7	4.53	10.8	No	Essential Nutrient
Manganese	**7439-96-5**	**3/3**	**0.17**	**1.23**	**0.532**	**0.391**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**3/3**	**0.0024**	**0.0191**	**0.0081**	**0**	**Yes**	**Exceeds background**
Potassium	7440-09-7	3/3	1.46	5.05	2.91	3.17	No	Essential Nutrient
Selenium	**7782-49-2**	**3/3**	**0.0003**	**0.0017**	**0.000813**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	3/3	1.07	2.24	1.75	21.3	No	Essential Nutrient
Vanadium	**7440-62-2**	**3/3**	**0.0016**	**0.0416**	**0.0158**	**0**	**Yes**	**Exceeds background**
Zinc	**7440-66-6**	**3/3**	**0.0397**	**0.278**	**0.133**	**0.042**	**Yes**	**Exceeds background**
Anions								
Nitrate	**14797-55-8**	**1/3**	**0.2**	**0.2**	**0.1**	**None**	**Yes**	**Exceeds background**

[a] Background criteria for surface water from final facility-wide background values for Ravenna Army Ammunition Plant (RVAAP), published in the Final Phase II Remedial Investigation Report for Winklepeck Burning Grounds at RVAAP, Ravenna, Ohio (USACE 2001b).

[b] Facility-wide Clean-up Goals (FWCUG) for Resident Farmer Adult, Resident Farmer Child, and National Guard Trainee from Facility-wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant (USACE 2010).

[c] Screening level source:

[d] FWCUG is the most conservative (smallest) of the FWCUGs for hexavalent and trivalent chromium.

CAS = Chemical Abstract Service.

SRC = Site-related chemical.

Bold = Chemical is a chemical of potential concern.

Table 4–25. Data Summary and Designated Use for RI

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
Surface and Subsurface Soil										
LL8sb-060-5346-SO	D	03/15/10	0–1	PBA08 RI	--	X	--	X	--	
LL8sb-060-5347-SO	D	03/15/10	1–4	PBA08 RI	--	X	X	X	--	
LL8sb-060-5348-SO	D	03/15/10	4–7	PBA08 RI	--	X	X	X	--	
LL8sb-060-5349-SO	D	03/15/10	7–13	PBA08 RI	--	X	X	X	--	
LL8sb-061-5350-SO	D	03/15/10	0–1	PBA08 RI	--	X	--	X	--	
LL8sb-061-5351-SO	D	03/15/10	1–4	PBA08 RI	--	X	X	X	--	
LL8sb-061-5352-SO	D	03/15/10	4–7	PBA08 RI	--	X	X	X	--	
LL8sb-062-5354-SO	D	03/15/10	0–1	PBA08 RI	--	X	--	X	--	
LL8sb-062-5355-SO	D	03/15/10	1–4	PBA08 RI	--	X	X	X	--	
LL8sb-062-5356-SO	D	03/15/10	4–7	PBA08 RI	--	X	X	X	--	
LL8sb-062-6138-FD	D	03/15/10	4–7	PBA08 RI	X	--	--	--	--	Field duplicate.
LL8sb-063-5358-SO	D	03/15/10	0–1	PBA08 RI	--	X	--	X	--	
LL8sb-063-5359-SO	D	03/15/10	1–4	PBA08 RI	--	X	X	X	--	
LL8sb-063-5360-SO	D	03/15/10	4–7	PBA08 RI	--	X	X	X	--	
LL8sb-063-6139-FD	D	03/15/10	0–1	PBA08 RI	X	--	--	--	--	Field duplicate.
LL8sb-064-5362-SO	D	03/15/10	0–1	PBA08 RI	--	X	--	X	--	
LL8sb-064-5363-SO	D	03/15/10	1–4	PBA08 RI	--	X	X	X	--	
LL8sb-064-5364-SO	D	03/15/10	4–7	PBA08 RI	--	X	X	X	--	
LL8sb-064-6140-FD	D	03/15/10	1–4	PBA08 RI	X	--	--	--	--	Field duplicate.
LL8sb-065-5366-SO	D	03/15/10	0–1	PBA08 RI	--	X	--	X	--	
LL8sb-065-5367-SO	D	03/15/10	1–4	PBA08 RI	--	X	X	X	--	
LL8sb-065-5368-SO	D	03/15/10	4–7	PBA08 RI	--	X	X	X	--	
LL8sb-066-5369-SO	D	03/11/10	0–1	PBA08 RI	--	X	--	X	--	
LL8sb-066-5370-SO	D	03/11/10	1–4	PBA08 RI	--	X	X	X	--	
LL8sb-066-5371-SO	D	03/11/10	4–7	PBA08 RI	--	X	X	X	--	
LL8sb-067-5373-SO	D	03/11/10	0–1	PBA08 RI	--	X	--	X	--	
LL8sb-067-5374-SO	D	03/11/10	1–4	PBA08 RI	--	X	X	X	--	
LL8sb-067-5375-SO	D	03/11/10	4–7	PBA08 RI	--	X	X	X	--	
LL8sb-067-5376-SO	D	03/11/10	7–13	PBA08 RI	--	X	X	X	--	
LL8ss-001M-SO	ISM	10/27/04	0–1	14 AOCs	--	X	X	X	X	
LL8ss-002M-SO	ISM	10/27/04	0–0.5	14 AOCs	--	X	X	X	X	
LL8ss-003M-SO	ISM	10/27/04	0–0.5	14 AOCs	--	X	X	X	X	
LL8ss-004M-SO	ISM	10/29/04	0–1	14 AOCs	--	X	X	X	X	
LL8ss-005D-DUP	D	11/01/04	0–0.5	14 AOCs	X	--	--	--	--	Field duplicate.
LL8ss-005D-SO	ISM	11/01/04	0–0.5	14 AOCs	--	X	X	X	X	

Table 4–25. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
LL8ss-005M-DUP	ISM	11/01/04	0–0.5	14 AOCs	X	--	--	--	--	Field duplicate.
LL8ss-005M-SO	ISM	11/01/04	0–0.5	14 AOCs	--	X	X	X	X	
LL8ss-006M-SO	ISM	10/27/04	0–1	14 AOCs	--	X	X	X	X	
LL8ss-007M-SO	ISM	11/01/04	0–1	14 AOCs	--	X	X	X	X	
LL8ss-008M-SO	ISM	11/01/04	0–1	14 AOCs	--	X	X	X	X	
LL8ss-009M-SO	ISM	11/01/04	0–0.5	14 AOCs	--	X	X	X	X	
LL8ss-010M-DUP	ISM	11/01/04	0–1	14 AOCs	X	--	--	--	--	Field duplicate.
LL8ss-010M-SO	ISM	11/01/04	0–1	14 AOCs	--	X	X	X	X	
LL8ss-011M-SS	ISM	11/02/04	0–1	14 AOCs	--	X	X	X	X	
LL8ss-012M-SS	ISM	11/02/04	0–0.5	14 AOCs	--	X	X	X	X	
LL8ss-013M-QA	ISM	11/02/04	0–1	14 AOCs	X	--	--	--	--	Field duplicate.
LL8ss-013M-SS	ISM	11/02/04	0–1	14 AOCs	--	X	X	X	X	
LL8ss-014M-SO	ISM	11/01/04	0–1	14 AOCs	--	X	X	X	X	
LL8ss-015D-SO	ISM	11/02/04	0–1	14 AOCs	--	X	X	X	X	
LL8ss-015M-SO	ISM	11/02/04	0–1	14 AOCs	--	X	X	X	X	
LL8ss-016M-SO	ISM	11/01/04	0–1	14 AOCs	--	X	X	X	X	
LL8ss-017M-SO	ISM	10/29/04	0–1	14 AOCs	--	X	X	X	X	
LL8ss-018M-SO	ISM	11/01/04	0–1	14 AOCs	--	X	X	X	X	
LL8ss-019-SO	D	11/19/04	0–1	14 AOCs	--	X	--	X	--	
LL8ss-042M-SO	ISM	08/08/07	0–1	Subslab Sampling	--	X	X	X	X	
LL8ss-043M-SO	ISM	08/08/07	0–1	Subslab Sampling	--	X	X	X	X	
LL8ss-044M-SO	ISM	08/08/07	0–1	Subslab Sampling	--	X	X	X	X	
LL8ss-045D-SO	ISM	08/14/07	0–1	Subslab Sampling	--	X	X	X	X	
LL8ss-045M-SO	ISM	08/14/07	0–1	Subslab Sampling	--	X	X	X	X	
LL8ss-046M-SO	ISM	08/07/07	0–1	Subslab Sampling	--	X	X	X	X	
LL8ss-047D-SO	ISM	08/14/07	0–1	Subslab Sampling	--	X	X	X	X	
LL8ss-047M-QB	ISM	08/14/07	0–1	Subslab Sampling	X	--	--	--	--	Field duplicate.
LL8ss-047M-SO	ISM	08/14/07	0–1	Subslab Sampling	--	X	X	X	X	
LL8ss-048M-SO	ISM	08/07/07	0–1	Subslab Sampling	--	X	X	X	X	
LL8ss-049M-SO	ISM	08/07/07	0–1	Subslab Sampling	--	X	X	X	X	
LL8ss-050M-SO	ISM	08/08/07	0–1	Subslab Sampling	--	X	X	X	X	
LL8ss-051M-SO	ISM	08/07/07	0–1	Subslab Sampling	--	X	X	X	X	
LL8ss-052M-SO	ISM	08/07/07	0–1	Subslab Sampling	--	X	X	X	X	
LL8ss-053M-SO	ISM	08/07/07	0–1	Subslab Sampling	--	X	X	X	X	
LL8ss-054M-SO	ISM	08/14/07	0–1	Subslab Sampling	--	X	X	X	X	
LL8ss-055D-SO	D	08/14/07	0–1	Subslab Sampling	--	X	--	X	--	

Table 4–25. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
LL8ss-056M-SO	ISM	08/09/07	0–1	Subslab Sampling	X	--	--	--	--	Field duplicate.
LL8ss-057M-SO	ISM	08/14/07	0–1	Subslab Sampling	X	--	--	--	--	Field duplicate.
LL8ss-058M-SO	ISM	08/14/07	0–1	Subslab Sampling	X	--	--	--	--	Field duplicate.
LL8ss-059M-SO	ISM	08/14/07	0–1	Subslab Sampling	X	--	--	--	--	Field duplicate.
LL8ss-060D-SO	D	08/14/07	0–1	Subslab Sampling	X	--	--	--	--	Field duplicate.
LL8ss-068-5380-SO	D	03/18/10	0–1	PBA08 RI	--	X	--	X	--	Sample collected for chromium speciation analysis only.
LL8ss-069-5381-SO	D	03/18/10	0–1	PBA08 RI	--	X	--	X	--	Sample collected for chromium speciation analysis only.
LL8ss-070-5382-SO	D	03/18/10	0–1	PBA08 RI	--	X	--	X	--	Sample collected for chromium speciation analysis only.
LL8ss-071M-5386-SO	ISM	03/18/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-072-5808-SO	D	10/18/10	0–1	PBA08 RI	--	X	--	X	--	Sample collected for chromium speciation analysis only.
LL8ss-072M-5387-SO	ISM	03/18/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-073M-5388-SO	ISM	03/18/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-074M-5389-SO	ISM	03/17/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-074M-6117-FD	ISM	03/17/10	0–1	PBA08 RI	X	--	--	--	--	Field duplicate.
LL8ss-075M-5390-SO	ISM	03/18/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-076M-5392-SO	ISM	03/18/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-077M-5393-SO	ISM	03/17/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-078M-5394-SO	ISM	03/17/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-079M-5395-SO	ISM	03/17/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-080M-5396-SO	ISM	03/17/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-081M-5397-SO	ISM	03/17/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-082M-5398-SO	ISM	03/17/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-083M-5399-SO	ISM	03/17/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-084M-5400-SO	ISM	03/18/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-085M-5782-SO	ISM	03/18/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-086M-5401-SO	ISM	03/18/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-086M-6119-FD	ISM	03/18/10	0–1	PBA08 RI	X	--	--	--	--	Field duplicate.
LL8ss-087M-5402-SO	ISM	03/18/10	0–1	PBA08 RI	--	X	X	X	X	
LL8ss-088M-5403-SO	ISM	03/18/10	0–1	PBA08 RI	--	X	X	X	X	
RV-411	D	10/22/98	0–0.5	1998 RRSE	--	--	--	--	--	Used for initial evaluation of site.
RV-412	D	10/22/98	0–0.5	1998 RRSE	--	--	--	--	--	Used for initial evaluation of site.
RV-413	D	10/22/98	0–0.5	1998 RRSE	--	--	--	--	--	Used for initial evaluation of site.
RV-414	D	10/22/98	0–0.5	1998 RRSE	--	--	--	--	--	Used for initial evaluation of site.
RV-415	D	10/22/98	0–0.5	1998 RRSE	--	--	--	--	--	Used for initial evaluation of site.

Table 4–25. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
RV-416	D	10/22/98	0–0.5	1998 RRSE	--	--	--	--	--	Used for initial evaluation of site.
RV-419	D	10/22/98	subsurface	1998 RRSE	--	--	--	--	--	Used for initial evaluation of site.
Sediment										
LL8sd-001-SD	D	12/08/04	6.5–6.5	14 AOCs	--	--	--	--	--	Sample from sewer or sump location.
LL8sd-001D-SD	D	11/08/04	0–1	14 AOCs	--	--	--	--	--	Sample from sewer or sump location.
LL8sd-001M-SD	ISM	11/08/04	0–1	14 AOCs	--	X	X	X	X	
LL8sd-002M-DUP	ISM	11/08/04	0–1	14 AOCs	X	--	--	--	--	Field duplicate.
LL8sd-002M-SD	ISM	11/08/04	0–1	14 AOCs	--	X	X	X	X	
LL8sd-003M-SD	ISM	11/08/04	0–1	14 AOCs	--	X	X	X	X	
LL8sd-004D-SD	D	11/02/04	1.1–1.1	14 AOCs	--	--	--	--	--	Sample from sewer or sump location.
LL8sd-004M-SD	ISM	11/02/04	0–0.1	14 AOCs	--	X	X	X	X	
LL8sd-005-SD	D	12/08/04	6–6	14 AOCs	--	--	--	--	--	Sample from sewer or sump location.
LL8sd-005M-SD	ISM	11/02/04	0–0.5	14 AOCs	--	X	X	X	X	
LL8sd-006M-SD	ISM	11/08/04	0–1	14 AOCs	--	X	X	X	X	
LL8sd-007-DUP	D	12/09/04	6–6	14 AOCs	--	--	--	--	--	Sample from sewer or sump location.
LL8sd-007-SD	D	12/09/04	6–6	14 AOCs	--	--	--	--	--	Sample from sewer or sump location.
LL8sd-009-SD	D	12/10/04	6.1–6.1	14 AOCs	--	--	--	--	--	Sample from sewer or sump location.
LL8sd-010-SD	D	12/09/04	8–8	14 AOCs	--	--	--	--	--	Sample from sewer or sump location.
LL8sd-011-SD	D	12/09/04	8–8	14 AOCs	--	--	--	--	--	Sample from sewer or sump location.
LL8sd-090-5378-SD	D	03/01/10	0–0.5	PBA08 RI	--	X	X	X	X	
LL8sd-091-5379-SD	D	03/01/10	0–0.5	PBA08 RI	--	X	X	X	X	
LL8sd-091-6113-FD	D	03/01/10	0–0.5	PBA08 RI	X	--	--	--	--	Field duplicate.
LL8sd-092-5377-SD	D	03/01/10	0–0.5	PBA08 RI	--	X	X	X	X	
LL8ss-089M-5404-SO	ISM	03/18/10	0–1	PBA08 RI	--	X	X	X	X	
RV-417	D	10/22/98	0–0.5	1998 RRSE	--	--	--	--	--	Used for initial evaluation of site.
RV-418	D	10/22/98	0–0.5	1998 RRSE	--	--	--	--	--	Used for initial evaluation of site.

Table 4–25. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments

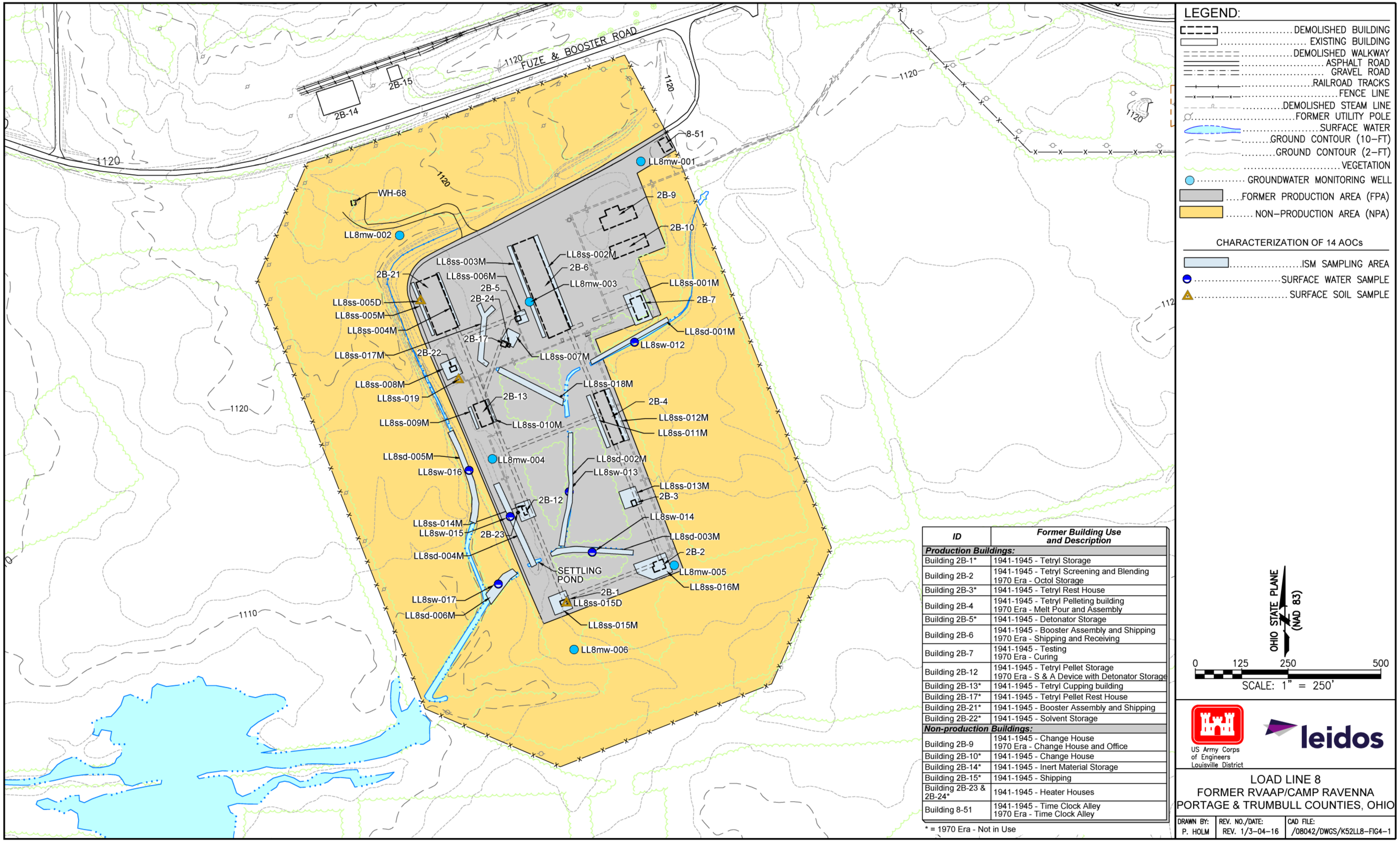
Table 4–25. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
Surface Water										
LL8sw-002-SW	D	12/08/04	5.3–5.3	14 AOCs	--	--	--	--	--	Excluded samples from sewers and sumps.
LL8sw-003-DUP	D	12/08/04	6–6	14 AOCs	--	--	--	--	--	Excluded samples from sewers and sumps.
LL8sw-003-SW	D	12/08/04	6–6	14 AOCs	--	--	--	--	--	Excluded samples from sewers and sumps.
LL8sw-004-SW	D	12/08/04	6.8–6.8	14 AOCs	--	--	--	--	--	Excluded samples from sewers and sumps.
LL8sw-005-SW	D	12/08/04	7–7	14 AOCs	--	--	--	--	--	Excluded samples from sewers and sumps.
LL8sw-007-SW	D	12/09/04	5.3–5.3	14 AOCs	--	--	--	--	--	Excluded samples from sewers and sumps.
LL8sw-008-SW	D	12/09/04	5.6–5.6	14 AOCs	--	--	--	--	--	Excluded samples from sewers and sumps.
LL8sw-009-SW	D	12/10/04	6.1–6.1	14 AOCs	--	--	--	--	--	Excluded samples from sewers and sumps.
LL8sw-010-SW	D	12/09/04	0–0.1	14 AOCs	--	--	--	--	--	Excluded samples from sewers and sumps.
LL8sw-011-SW	D	12/09/04	0–0.1	14 AOCs	--	--	--	--	--	Excluded samples from sewers and sumps.
LL8sw-012-SW	D	11/08/04	0–0.1	14 AOCs	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
LL8sw-013-DUP	D	11/08/04	1–1	14 AOCs	X	--	--	--	--	Field duplicate.
LL8sw-013-SW	D	11/08/04	1–1	14 AOCs	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
LL8sw-014-SW	D	11/02/04	0–0.1	14 AOCs	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
LL8sw-015-SW	D	11/02/04	0–0.1	14 AOCs	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
LL8sw-016-SW	D	11/02/04	0–0.1	14 AOCs	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
LL8sw-017-SW	D	11/03/04	0.5–0.5	14 AOCs	--	X	--	--	--	Sample not used for HHRA and

Table 4–25. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
										ERA because more recent sample was taken at the same location.
LL8sw-018-SW	D	11/19/04	0–0.1	14 AOCs	--	--	--	--	--	Excluded samples from sewers and sumps.
LL8sw-019-SW	D	11/19/04	0–0.1	14 AOCs	--	--	--	--	--	Excluded samples from sewers and sumps.
LL8sw-090-5384-SW	D	03/01/10	.–.	PBA08 RI	--	X	X	X	X	
LL8sw-090-5818-SW	D	04/18/11	.–.	PBA08 RI	--	X	--	X	X	Sample taken to confirm results of March 2010 sample.
LL8sw-090-6115-FD	D	03/01/10	.–.	PBA08 RI	X	--	--	--	--	Field duplicate.
LL8sw-091-5385-SW	D	03/01/10	.–.	PBA08 RI	--	X	X	X	X	
LL8sw-092-5383-SW	D	03/01/10	.–.	PBA08 RI	--	X	X	X	X	

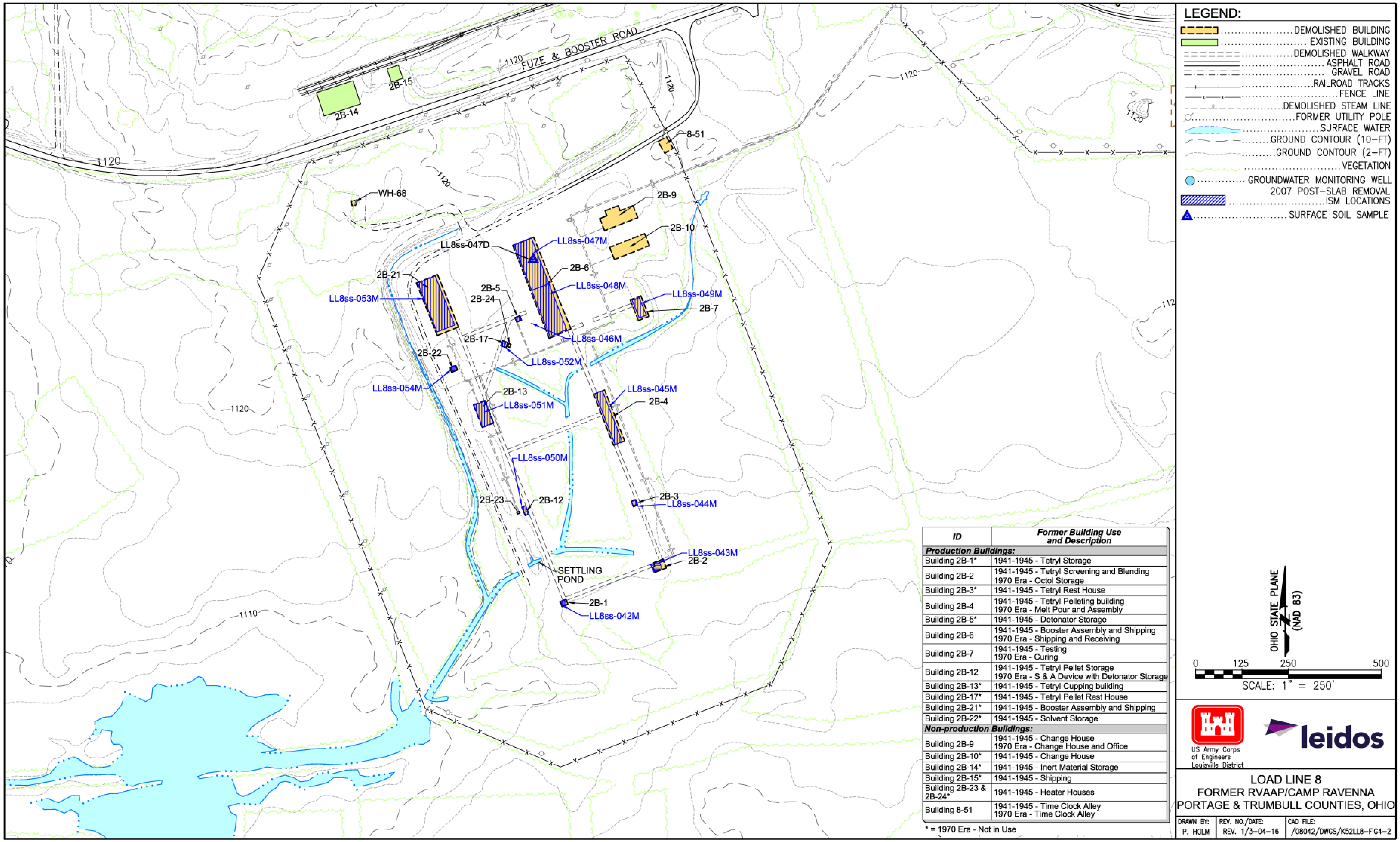
14 AOCs = Characterization of 14 AOCs.
D = Discrete.
ERA = Ecological risk assessment.
F&T = Fate and transport.
ft = Feet.
HHRA = Human health risk assessment.
ID = Identification.
ISM = Incremental sampling methodology.
N&E = Nature and extent.
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.
QC = Quality control.
RI = Remedial Investigation.
RRSE = Relative risk site evaluation.
X = Data included in selected evaluation
--=No value available.



ID	Former Building Use and Description
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

Figure 4-1. Characterization of 14 AOCs Sample Locations at Load Line 8



ID	Former Building Use and Description
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

Figure 4-2. Investigation of Under Slab Surface Soil Sample Locations at Load Line 8

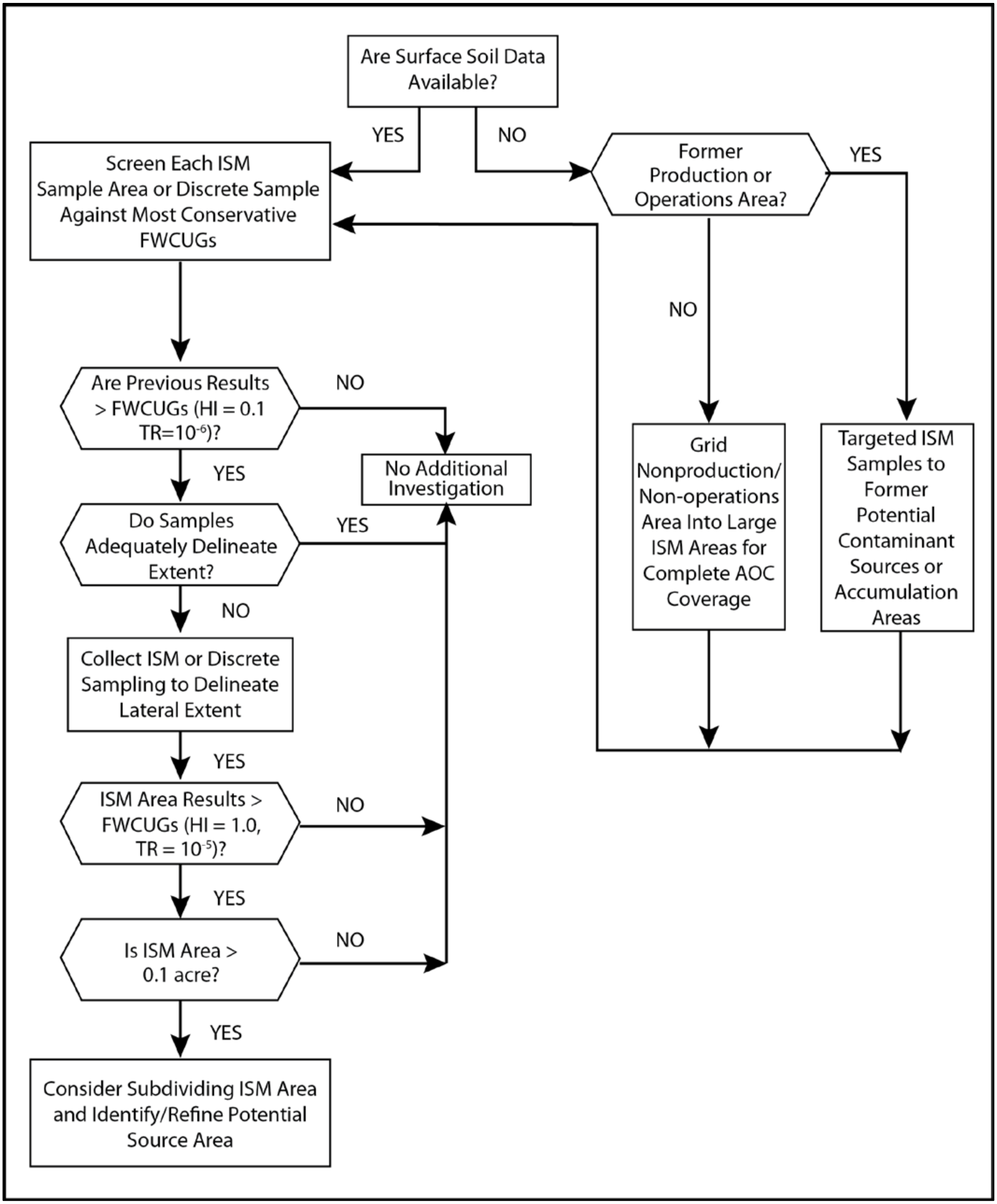


Figure 4-3. PBA08 RI Surface Soil Sampling

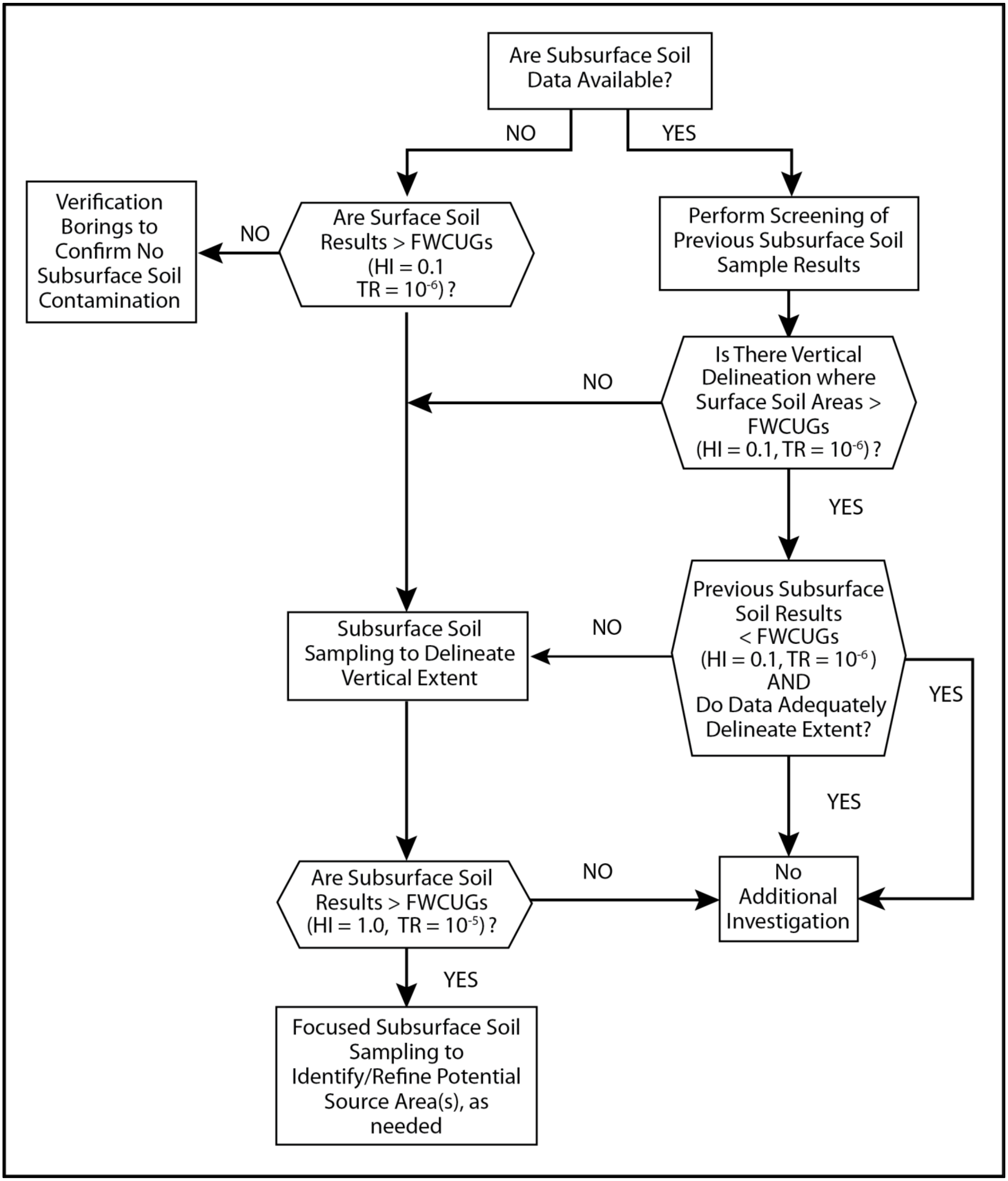
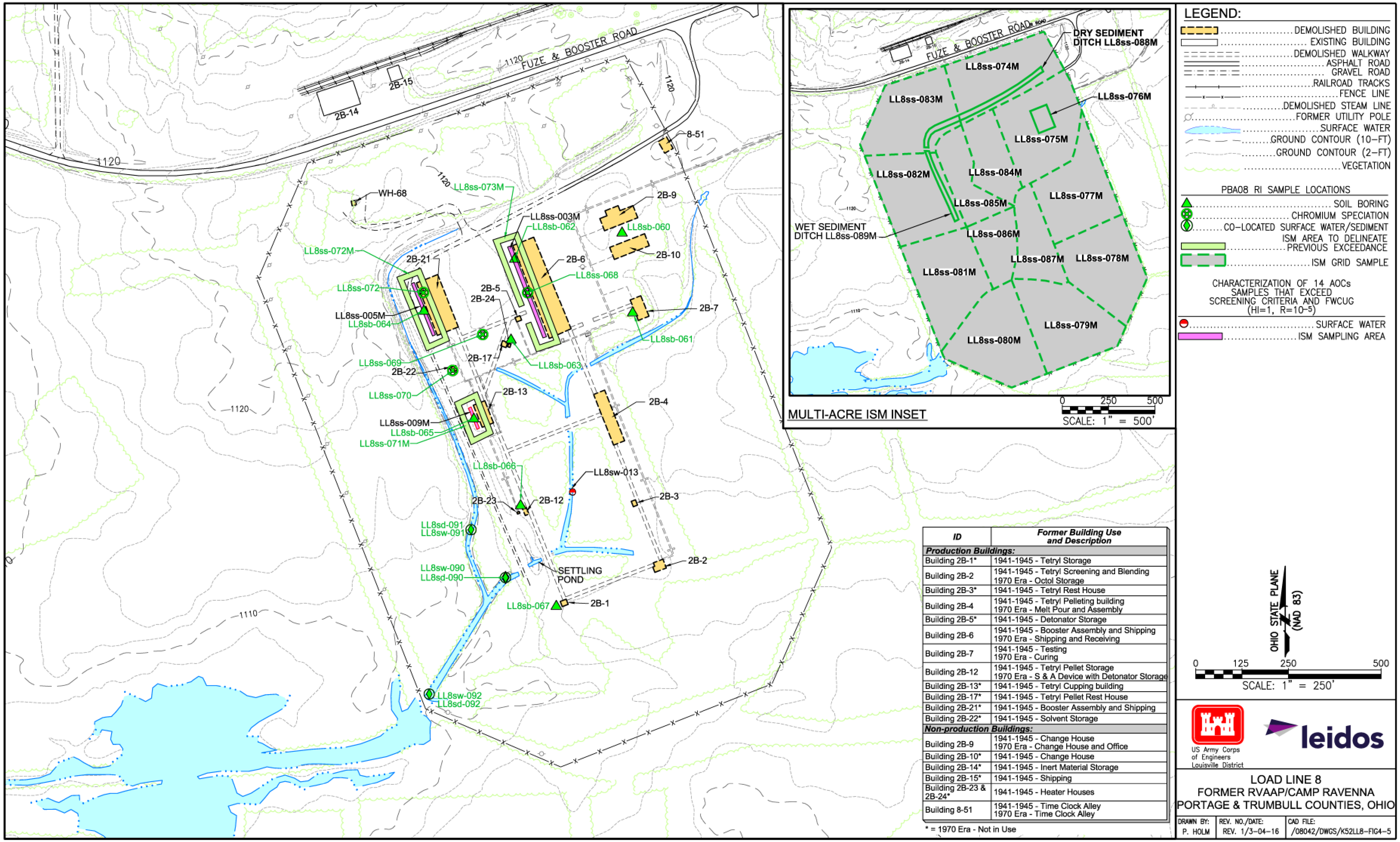


Figure 4-4. PBA08 RI Subsurface Soil Sampling



ID	Former Building Use and Description
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

Figure 4-5. 2010 PBA08 RI Sample Locations

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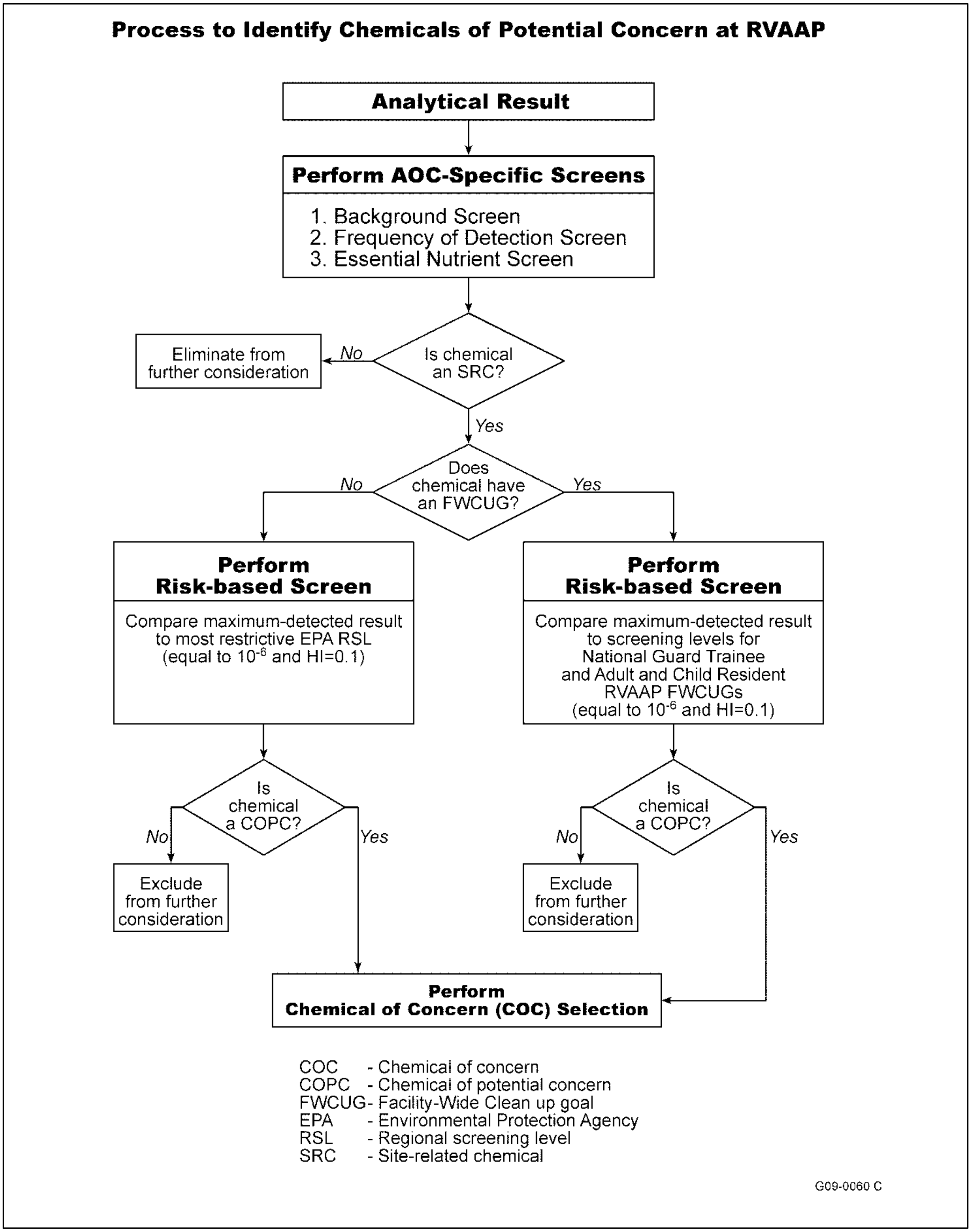

Figure 4-6. Process to Identify RVAAP COPCs in the HHRA (USACE 2010a)

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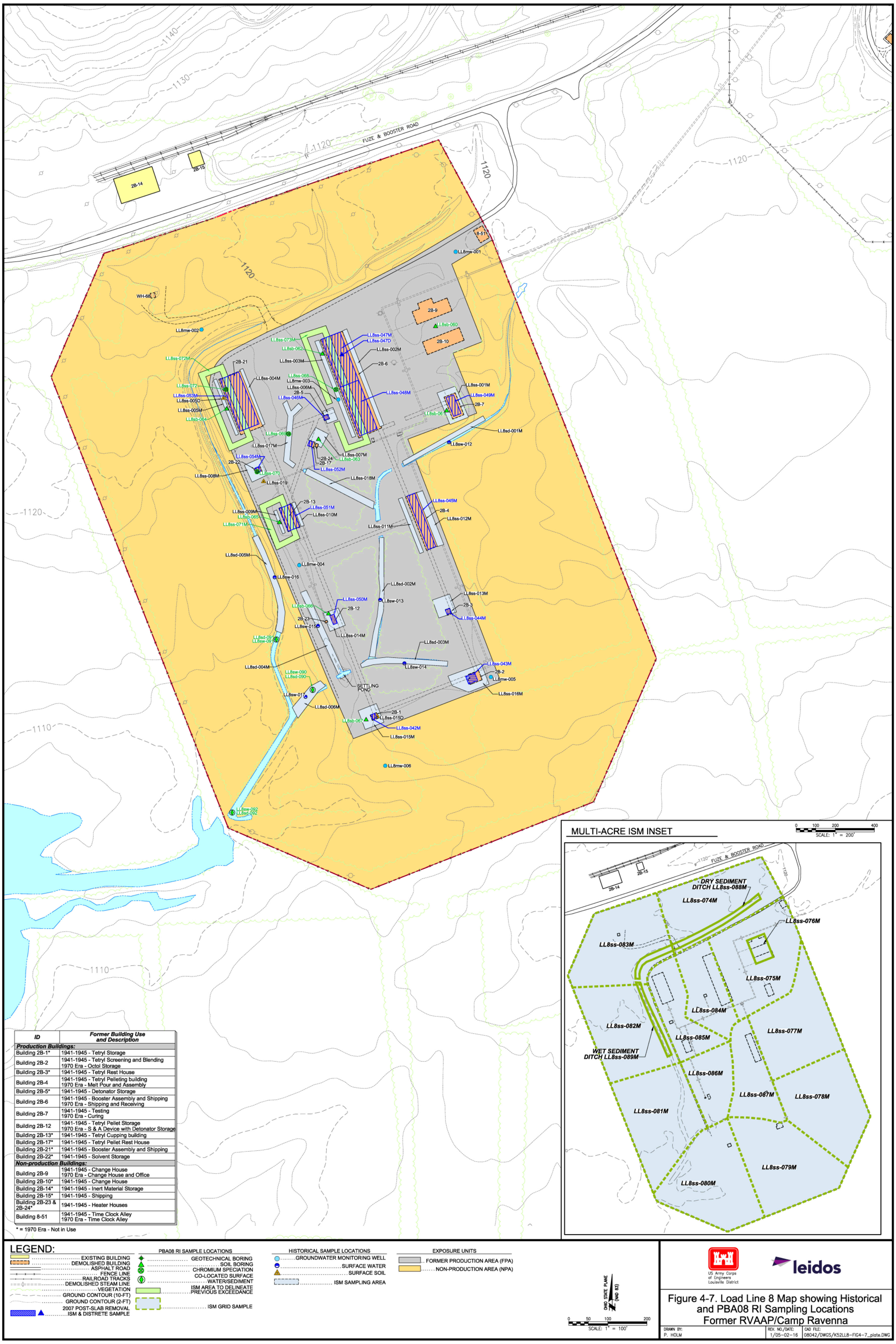

ID	Former Building Use and Description
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

Figure 4-7. All Load Line 8 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 8. 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 do not appear to have been used during historical operations but were analyzed during investigations. The evaluation discusses the nature and extent of SRCs in environmental media at Load Line 8, with a focus on chemicals previously used during operational activities, using analytical data results obtained during the 2004 Characterization of 14 AOCs, 2007 Investigation of Under Slab Surface Soil, and 2010 PBA08 RI.

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 or the USEPA Resident Soil RSL if there was no FWCUG. The following figures illustrate the concentration and distribution of SRCs that exceed SLs.

- Figure 5-1 – Detected Concentrations of Explosives and Propellants in Soil (ISM and Discrete Soil Borings)
- Figure 5-2 – Exceedances of FWCUG (HQ of 0.1, TR of 10-6) for Arsenic, Chromium, Lead, Mercury, Cobalt, Manganese, and Nickel in Soil (ISM and Discrete Soil Borings)
- Figure 5-3 – PAH Exceedances of FWCUG (HQ of 0.1, TR of 10-6) in Soil (ISM and Discrete Soil Borings)
- Figure 5-4 – Detected Concentrations of VOCs, Pesticides, and PCBs in Soil (ISM and Discrete Soil Borings)
- Figure 5-5 – Detected Concentrations of Explosives and Propellants in Surface Water and Sediment
- Figure 5-6 – Exceedances of FWCUG (HQ of 0.1, TR of 10-6) for Arsenic, Chromium, Lead, Mercury, Aluminum, Cobalt, Iron, and Manganese in Surface Water and Sediment
- Figure 5-7 – PAH Exceedances of FWCUG (HQ of 0.1, TR of 10-6) in Surface Water and Sediment
- Figure 5-8 – Detected Concentrations of VOCs, Pesticides, and PCBs 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 8. All validated Load Line 8 data from the RIs (2004 Characterization of 14 AOCs, 2007 Investigation of Under Slab Surface Soil, and 2010 PBA08 RI) 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 SURFACE SOIL DISCRETE SAMPLE RESULTS FOR CHROMIUM SPECIATION

During the PBA08 RI, surface soil samples were collected from four discrete sample locations and analyzed for hexavalent chromium and total chromium. The samples (LL8ss-068, LL8ss-069, LL8ss-070, and LL8ss-072) were collected from areas previously identified during the 2004 Characterization of 14 AOCs as having elevated total chromium concentrations. This sampling determined the contribution of hexavalent chromium to total chromium in soil at Load Line 8 for use in the HHRA (Section 7.2).

Chromium speciation results are shown in Table 5-1. Two of the four samples had a total chromium concentration at or below the facility-wide background concentration of 17.4 mg/kg. Two samples (LL8ss-069 and LL8ss-072) had a total chromium concentration (18.3 and 23.3 mg/kg) exceeding the facility-wide background concentration. The range of hexavalent chromium concentrations was 0.41J to 2 mg/kg and did not appear to be correlated to total chromium values. A detailed assessment of the speciation results respective to the HHRA is presented in Section 7.2.4.1.

5.2 CONTAMINANT NATURE AND EXTENT OF SURFACE SOIL

Table 4-19 presents the results of the SRC screening for surface soil at Load Line 8. The following subsections discuss the concentration and distribution of ISM surface soil results.

5.2.1 Explosives and Propellants

Figure 5-1 presents locations that had detectable concentrations of explosives and propellants. HMX and tetryl were identified as SRCs and as potentially related to previous AOC operations. HMX was detected in PBA08 RI ISM samples LL8ss-073M and LL8ss-076M at estimated concentrations of 0.015J and 0.013J mg/kg, respectively. Tetryl was detected at concentrations ranging from 0.015J to 0.63 mg/kg in 7 of 49 samples with the maximum detection at location LL8ss-012M. The maximum concentrations of HMX and tetryl were below their respective SLs (359 and 16 mg/kg) and were not considered to be COPCs.

In addition to the explosive contaminants identified as being used historically, the propellant nitrocellulose was detected in all seven of the samples analyzed for propellants. The estimated concentrations ranged from 1.1J (multi-acre ISM sample LL8ss-080M) to 4J mg/kg (LL8ss-045M). The maximum concentration of nitrocellulose was below its respective SL (19,000,000 mg/kg); therefore, it was not considered a COPC.

5.2.2 Inorganic Chemicals

Arsenic, chromium, lead, and mercury were identified as potential inorganic SRCs and as potentially related to previous site use. Three of the four inorganic chemicals had maximum detections in exceedance of their background concentration, as summarized in the list below.

- Arsenic was not detected above its background concentration in any of the ISM surface soil samples.
- Chromium was detected above its background concentration (17.4 mg/kg) in 45 of 49 ISM surface soil samples, with a maximum detection of 39 mg/kg at historical sample location LL8ss-003M that evaluated former Building 2B-6.
- Lead was detected above its background concentration (26.1 mg/kg) in 30 of 49 ISM surface soil samples, with a maximum detection of 210 mg/kg at historical sample location LL8ss-004M that evaluated former Building 2B-21.
- Mercury was detected above its background concentration (0.036 mg/kg) in 25 of 49 ISM surface soil samples, with a maximum detection of 0.87 mg/kg at historical sample location LL8ss-011M that evaluated former Building 2B-4.

None of the inorganic chemicals listed above exceeded their respective SLs and, therefore, were not considered to be COPCs in surface soil.

Although not identified as previously used during historical operations, nine other inorganic chemicals were identified as SRCs from the RVAAP screening process, as presented in Table 4-19. Of these nine inorganic chemicals, three (cobalt, manganese, and nickel) exceeded their respective SLs and background concentrations. Figure 5-2 presents the exceedances of the SL for these inorganic chemicals in the source area and multi-acre ISM samples. Observations regarding these SRCs in Load Line 8 surface soil are presented below:

- Cobalt was detected above its background concentration (10.4 mg/kg) and SL (7.03 mg/kg) in 2 of 49 ISM surface soil samples. Cobalt had a maximum detection of 11.2 mg/kg at PBA08 RI sample location LL8ss-088M that evaluated the northern portion of the drainage ditch.
- Manganese was detected above its background concentration (1,450 mg/kg) and SL (35.1 mg/kg) in 3 of 49 ISM surface soil samples, with a maximum detection of 2,400 mg/kg at historical sample location LL8ss-003M that evaluated former Building 2B-6.
- Nickel exceeded its SL (155 mg/kg) in 1 of 49 ISM surface soil samples, with a maximum detection of 162 mg/kg at historical sample location LL8ss-046M that evaluated former Building 2B-5.

No apparent spatial trend in the distribution of inorganic chemicals throughout the AOC is evident.

5.2.3 Semi-volatile Organic Compounds

SVOCs were identified as potential organic contaminants from previous site use at former Buildings 2B-23 and 2B-24 that were formerly used for heater houses. SVOCs do not have background concentrations for comparison to chemical results; consequently, a large number of SVOCs were identified as SRCs. A total of 22 SVOC SRCs were identified in the data screening; five PAHs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene] exceeded their respective SLs and were identified as COPCs. Figure 5-3 presents the PAH exceedances of the SLs in source area and multi-acre ISM samples.

- With the exception of five sample locations, all PAH concentrations detected in ISM surface soil samples collected in 2004, 2007, and 2010 were below the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1.
- Five locations exceeded the Resident Receptor (Adult) FWCUG at a TR of 1E-05, HQ of 1 for benzo(a)pyrene (0.221 mg/kg): LL8ss-071M (0.24 mg/kg), LL8ss-072M (1.3 mg/kg), LL8ss-073M (1.2 mg/kg), LL8ss-076M (0.4 mg/kg), and LL8ss-085M (0.46 mg/kg).
- Although SVOC detections were widely distributed in surface soil, the maximum detections of all five PAHs identified as COPCs were observed at ISM surface soil sample location LL8ss-072M. The detections of benzo(a)pyrene (1.3 mg/kg) and dibenzo(a,h)anthracene (0.29 mg/kg) exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Sample location LL8ss-072M is immediately adjacent to the western perimeter road.
- Sample location LL8ss-073M had a concentration of benzo(a)pyrene (1.2 mg/kg) that exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1 (0.221 mg/kg).
- Large ISM samples LL8ss-084M and LL8ss-086M contained the location of the former heater houses (Buildings 2B-23 and 2B-24). These sample locations did not exceed SLs for any SVOCs.

5.2.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

VOCs and PCBs were identified as potential contaminants from previous site use. Figure 5-4 presents detected concentrations of VOCs, pesticides, and PCBs in surface soil. Surface soil samples analyzed for VOCs had non-detectable concentrations, except two low estimated concentrations of 2-butanone. The VOC 2-butanone was detected in PBA08 RI multi-acre ISM samples LL8ss-074M and LL8ss-088M at concentrations of 0.002J and 0.0024J mg/kg, respectively.

Sample LL8ss-055D was collected to evaluate VOC concentrations in surface soil at the location of former Building 2B-22, which was formerly used for solvent storage. This surface soil sample did not have any detectable VOC concentrations.

PCB-1254 was detected at three sample locations (LL8ss-005M, LL8ss-015M, and LL8ss-045M) at concentrations ranging from 0.019J and 0.1 mg/kg. The detections were below the SL (0.12 mg/kg).

Four pesticides [4,4’-dichlorodiphenyldichloroethane (DDD), 4,4’-dichlorodiphenyldichloroethylene (DDE), 4,4’-dichlorodiphenyltrichloroethane (DDT), and beta-hexachlorocyclohexane (BHC)] were detected in one of eight samples in the SRC screening data set. Pesticides 4,4’-DDD, 4,4’-DDE, and 4,4’-DDT were detected in PBA08 RI multi-acre ISM sample LL8ss-088M at concentrations of 0.014J, 0.024, and 0.0083J mg/kg, respectively. Beta-BHC was detected in one sample (LL8ss-005M) at a concentration of 0.0027 mg/kg. All pesticide concentrations were detected below their respective SLs.

5.3 CONTAMINANT NATURE AND EXTENT IN SUBSURFACE SOIL

As discussed in Section 4.0, data from subsurface samples were screened to identify SRCs representing subsurface conditions at Load Line 8. Subsurface soil samples were not collected during the previous investigations at the AOC; therefore, the SRC screening data set was comprised of 18 discrete samples collected during the 2010 PBA08 RI. All 1-4 and 4-7 ft bgs subsurface samples were analyzed for TAL metals, explosives, and PAHs; four samples were analyzed for RVAAP full-suite analytes.

The collected 7-13 ft bgs samples were archived pending analysis of the 4-7 ft bgs samples. Two samples (LL8sb-060-5349-SO and LL8sb-067-5376-SO) were submitted for analysis of TAL metals, explosives, and PAHs in order to characterize the subsurface soil in accordance with the DQOs. Table 4-21 presents the results of the SRC screening for subsurface soil samples at Load Line 8.

5.3.1 Explosives and Propellants

No explosives or propellants were detected in subsurface soil at Load Line 8.

5.3.2 Inorganic Chemicals

Arsenic, chromium, lead, and mercury were identified as potential inorganic SRCs and as potentially related to previous site use. Two of the four inorganic chemicals had a maximum detection above of its background concentration, as summarized in the list below.

- Arsenic was detected above its background concentration (19.8 mg/kg) in 1 of 18 subsurface soil samples. The detected concentration of 26.9 mg/kg was observed in the 4-7 ft bgs interval of PBA08 RI sample location LL8sb-060.
- Chromium was not detected above its background concentration in any samples.
- Lead was detected above its background concentration (19.1 mg/kg) in 1 of 18 subsurface samples, with the maximum detection of 20.3 mg/kg from the 4-7 ft bgs interval at PBA08 RI sample location LL8sb-060.
- Mercury was not detected above its background concentration in any samples.

Figure 5-2 presents the arsenic SL exceedance at sample location LL8sb-060. The detected lead concentrations did not exceed the SL; therefore, lead is not considered a COPC.

Although not identified as previously used during historical operations, three other inorganic chemicals (cadmium, selenium, and silver) were identified as SRCs from the RVAAP screening process, as presented in Table 4-21. Observations regarding the other individual inorganic SRCs in Load Line 8 subsurface soil area presented below:

- Cadmium has no background concentration. All the samples either had non-detectable concentrations or the concentrations were below laboratory reporting levels and estimated.

The maximum concentration of cadmium detected was 0.093J mg/kg from the 1-4 ft bgs interval of PBA08 RI sample location LL8sb-061.

- Selenium was detected above its background concentration in 1 of 18 subsurface soil samples, with a maximum detection of 1.6 mg/kg from the 4-7 ft bgs interval of PBA08 RI sample location LL8sb-065.
- Silver has no background concentration. All the samples either had non-detectable concentrations or the concentrations were below laboratory reporting levels and estimated. The maximum concentration of silver detected was 0.046J mg/kg from the 1-4 ft bgs interval of PBA08 RI sample location LL8sb-060.

Of these three inorganic chemicals, none exceeded their respective SLs. No apparent spatial trend in the distribution of inorganic chemicals throughout the AOC is evident.

5.3.3 Semi-volatile Organic Compounds

SVOCs do not have background concentrations for comparison with chemical results; consequently, nine SVOCs were identified as SRCs. Figure 5-3 presents PAH exceedances of SLs in the subsurface soil. Of the nine SVOC SRCs identified, concentrations of benzo(a)pyrene exceeded its respective SL and was identified as a COPC.

Benzo(a)pyrene was detected from the 1-4 ft bgs interval at PBA08 RI sample locations LL8sb-060 and LL8sb-062 at concentrations of 0.023 and 0.026J mg/kg, respectively. The concentrations were below the Resident Receptor FWCUG at a TR of 1E-05, HQ of 1. Also, these sample locations are not located near former Buildings 2B-23 and 2B-24 that were formerly used as heater houses. All of the subsurface samples collected adjacent to or near the former heater houses had non-detectable SVOC concentrations except one subsurface sample. Concentrations of benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were detected below SLs in the 4-7 ft bgs interval at LL8sb-066.

5.3.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

Figure 5-4 presents the detected concentrations of VOCs, pesticides, and PCBs in the soil borings. Pesticides and PCBs were not detected in the subsurface soil at Load Line 8. One VOC (acetone) was identified as an SRC in subsurface soil, as shown in Table 4-21. Acetone was detected in the 1-4 ft bgs interval at PBA08 RI sample location LL8sb-065 at a concentration of 0.015J mg/kg. Sample location LL8sb-065 was collected to evaluate former Building 2B-13. Acetone was not detected in the underlying 4-7 ft bgs interval.

None of the VOCs, pesticides, or PCBs identified as SRCs in surface soil were detected in the subsurface soil samples.

5.4 CONTAMINANT NATURE AND EXTENT IN SEDIMENT

Three co-located surface water and sediment discrete samples (LL8sd/sw-090, LL8sd/sw-091, and LL8sd/sw-092) were collected during the 2010 PBA08 RI from the ditches exiting the AOC. The samples collected from location LL8sd-091 were analyzed for RVAAP full-suite analytes, and the other two locations were analyzed for TAL metals, explosives, and SVOCs. No historical discrete sediment samples were collected at Load Line 8. Table 4-23 presents the results of the SRC screening for discrete sediment samples. Figures 5-5 to 5-8 present the locations and concentrations of SRCs identified in the discrete sediment samples.

Data from all eligible historical samples and the single PBA08 RI sediment ISM sample were combined and screened. During the PBA08 RI, one ISM surface soil sample location (LL8ss-089M) was collected from a ditch containing surface water; therefore, the sample was identified as sediment instead of surface soil. As a result, this sample was screened with the historical ISM sediment samples. The PBA08 RI ISM sediment sample was analyzed for TAL metals, explosives, and PAHs. Table 4-22 presents the results of the SRC screening for ISM sediment samples. Figures 5-5 through 5-8 also present the location and concentrations of SRCs identified in the ISM sediment samples.

5.4.1 Explosives and Propellants

No explosives or propellants were detected in the discrete sediment samples. However, as shown on Figure 5-5, one propellant and one explosive were detected at two ISM sample locations (LL8sd-004M and LL8ss-089M) in sediment. Nitrocellulose was detected in sample location LL8sd-004M at 1.1 mg/kg. Tetryl was detected in sample location LL8ss-089M at 0.014J mg/kg. Both detections were below their respective SLs.

5.4.2 Inorganic Chemicals

The distribution of inorganic SRCs in both discrete and ISM sediment samples are shown in Figure 5-6. Arsenic, chromium, lead, and mercury were identified as potential inorganic contaminants from previous site use. The list below summarizes the discrete and ISM sediment sampling results for these four inorganic constituents.

- Arsenic was not detected above its background concentration in any of the discrete or ISM sediment samples collected at Load Line 8.
- Chromium was not detected above its background concentration in any of the discrete sediment samples collected at Load Line 8. Chromium was detected above its background concentration (18.1 mg/kg) in 1 of 7 ISM sediment samples, with the maximum detection of 20.3 mg/kg at LL8ss-089M.
- Lead was not detected above its background concentration in any of the discrete sediment samples. Lead was detected above its background concentration (27.4 mg/kg) in 4 of 7 ISM sediment samples, with a maximum detection of 38 mg/kg at LL8sd-001M.

- Mercury was not detected in any of the discrete sediment samples. Mercury was detected above its background concentration (0.059 mg/kg) in 5 of 7 ISM sediment samples, with the maximum detection of 0.26 at LL8sd-002M.

None of the four inorganic chemicals discussed above exceeded background or the SL (when total chromium was screened against the SL for trivalent chromium).

Four inorganic chemicals not previously associated with historical operations (aluminum, beryllium, cadmium, and silver) were identified as SRCs from the RVAAP discrete sediment sample screening process, as shown in Table 4-23. Cadmium was detected above background concentrations at all three sample locations ranging from 0.024J to 0.14J mg/kg. Beryllium also was detected above its background concentration at two sample locations: 0.43 mg/kg at LL8sd-090 and 0.41 mg/kg at LL8sd-092. Aluminum and silver were detected above background concentrations at only one sample location (LL8sd-090) at concentrations of 15,700 and 0.018J mg/kg, respectively. All concentrations were below SLs except aluminum.

Six additional inorganic chemicals (barium, beryllium, cadmium, cobalt, nickel, selenium) were identified as SRCs in the ISM sediment samples, as shown in Table 4-22. While some of the SRCs were detected in all seven ISM sediment samples, only four sample locations (LL8ss-089M, LL8sd-001M, LL8sd-002M, and LL8sd-003M) had the maximum concentrations for the six additional inorganic SRCs. Sample location LL8sd-002M had three inorganic chemicals (barium, beryllium, and cobalt) detected at their maximum concentrations of 140 mg/kg, 1.3 mg/kg, and 16 mg/kg, respectively. Sample location LL8sd-001M also had two inorganic chemicals, beryllium and selenium, detected at their maximum concentrations of 1.3 and 2.3J mg/kg, respectively. Nickel was detected at the maximum concentration of 29.4J mg/kg at sample location LL8ss-089M. Sample location LL8sd-003M only had cadmium detected at its maximum concentration of 2.6 mg/kg. Cobalt exceeded its background and SL in 5 of 7 ISM sediment samples.

5.4.3 Semi-volatile Organic Compounds

The distribution of SVOC SRCs in discrete and ISM sediment samples are shown in Figure 5-7.

Four SVOCs (all PAHs) were identified as SRCs in the discrete sediment samples at Load Line 8, as shown in Table 4-23. All four SRCs [benz(a)anthracene (0.05J mg/kg), fluoranthene (0.06J mg/kg), phenanthrene (0.043J mg/kg), and pyrene (0.049J mg/kg)] were detected below their respective SLs at sample location LL8sd-092.

As shown in Table 4-22, 11 SVOCs (all PAHs) were identified as SRCs in the ISM sediment samples at Load Line 8, with only 3 of the 7 locations (LL8sd-001M, LL8sd-004M, and LLss-089M) being analyzed for the SVOC SRCs. Sample location LL8sd-001M had 10 of the 11 SRCs detected at their maximum concentrations. A total of 8 of the 11 SRCs were detected at sample location LL8ss-089M, with only naphthalene detected at its maximum concentration of 0.014 mg/kg. Additionally, 2 of the 11 SRCs were detected at sample location LL8sd-004M. Benzo(a)pyrene was detected at LL8sd-001M at a concentration of 0.092J mg/kg, which is above the SL and is therefore considered a COPC.

5.4.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

The distribution of VOC, pesticide, and PCB SRCs in discrete and ISM sediment samples are shown in Figure 5-8. One VOC (toluene) was identified as an SRC in discrete sediment, as shown in Table 4-23. Toluene was detected in discrete sample LL8sd-091 at a low concentration of 0.00059J mg/kg. The toluene concentration was below the SL. No pesticides or PCBs were detected in the discrete samples collected in Load Line 8 sediment.

As shown in Table 4-22, three pesticides (4,4’-DDD, 4,4’-DDE, and 4,4-DDT) were identified as SRCs in the ISM sediment samples. All three pesticides were detected at sample location LL8sd-001M and the maximum concentrations were below their respective SLs. No VOCs or PCBs were detected in ISM sediment samples.

5.5 CONTAMINANT NATURE AND EXTENT IN SURFACE WATER

Three co-located surface water and sediment samples (LL8sd/sw-090, LL8sd/sw-091, and LL8sd/sw-092) were collected during the PBA08 RI from the ditches exiting the AOC. The surface water grab samples were analyzed for RVAAP full-suite analytes. No historical surface water samples were included in the SRC screening for Load Line 8. Table 4-24 presents the results of the SRC screening for surface water. Figures 5-5 through 5-8 present the location and concentrations of SRCs identified in surface water.

An additional surface water sample was collected at sample location LL8sw-090 in order to further evaluate the 2010 sampling results, as the original sample had elevated concentrations of aluminum, barium, and iron. This additional sample is discussed qualitatively in this section.

5.5.1 Explosives and Propellants

No propellants or explosives were detected in surface water at Load Line 8.

5.5.2 Inorganic Chemicals

Aluminum, arsenic, chromium, cobalt, iron, lead, and manganese exceeded their respective SLs and background concentrations in the 2010 PBA08 RI surface water sample collected at sample location LL8sw-090, as shown in Table 4-24. The distribution of these SRCs in the surface water samples are shown in Figure 5-6.

The sample location was resampled in 2011 following receipt of the analytical results. The 2011 sample indicated a significant decrease in concentrations of aluminum, barium, and iron.

Arsenic, chromium, lead, and mercury were identified as potential inorganic contaminants from previous site use; however, mercury was not detected in the surface water samples collected at Load Line 8. In addition, the concentrations of arsenic were detected above the background concentration only in the sample taken in 2010 at LL8sw-090. Lead and chromium were detected above their respective background concentrations (0 mg/L) in all three surface water samples; however, the maximum concentrations detected were below the SLs except for the sample taken in 2010 at LL8sw-090.

As shown in Table 4-24, 12 other inorganic chemicals were identified as SRCs that were not associated with historical operations, the concentrations detected in the Load Line 8 surface water samples were above the background concentrations. All the inorganic chemicals were below SLs except for aluminum, cobalt, iron, and manganese. Cobalt exceeded the SL (0.0006 mg/L) in all three surface water samples. The concentrations of aluminum, cobalt, iron, and manganese exceeded the SL in the sample taken in 2010 at LL8sw-090 but not in the sample taken in 2011.

5.5.3 Semi-volatile Organic Compounds

No SVOCs were detected in surface water at Load Line 8.

5.5.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

No VOCs, pesticides, or PCBs were detected in surface water at Load Line 8.

5.6 SUMMARY OF CONTAMINANT NATURE AND EXTENT

Data from the 2004 Characterization of 14 AOCs, 2007 Investigation of Under Slab Surface Soil, and 2010 PBA08 RI provide effective characterization of 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 the lowest FWCUG for the Resident Receptor (Adult and Child) and National Guard Trainee at a target of 0.1 or TR of 1E-06, as presented in the FWCUG Report or the USEPA Resident Receptor (Adult and Child) and soil RSL if there was no FWCUG. 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 8.

Sites where explosives were identified as potential contaminants from previous use (TNT, RDX, HMX, and tetryl) were thoroughly evaluated, including around former process buildings and across the AOC as a whole. TNT and RDX were not detected in any of the environmental media sampled at Load Line 8, and HMX and tetryl were not detected in subsurface soil or surface water. The maximum concentrations of HMX and tetryl detected in the ISM surface soil samples were below their respective SLs and were not considered COPCs. In addition, tetryl was detected in one ISM sediment sample below the SL and was not considered a COPC.

Arsenic, chromium, lead, and mercury were identified as potential inorganic SRCs and as potentially related to previous site use. Arsenic was detected below its background concentration in surface soil at Load Line 8. An arsenic concentration (26.9 mg/kg) detected in the subsurface soil interval from 4-7 ft bgs at LL8sb-060 exceeded the subsurface soil background concentration (19.8 mg/kg). The concentration decreased below the background concentration in 7-13 ft bgs interval at LL8sb-060.

Chromium, lead, and mercury had concentrations above their background concentrations, but all concentrations were below their respective SLs in soil and sediment samples. Lastly, all detections of these four inorganic chemicals in surface water were below their respective SLs in the most recent samples of surface water at Load Line 8.

Three other inorganic chemicals (cobalt, manganese, and nickel) exceeded their respective SLs in surface soil. The exceeding concentrations of these inorganic chemicals were below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1 except manganese at three ISM surface soil locations (LL8ss-003M, LL8ss-005M, and LL8ss-009M). No other inorganic chemicals exceeded their respective SLs in the subsurface soil at Load Line 8.

Aluminum exceeded its SL at discrete sediment sample location LL8sd-090; however, the concentration was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Cobalt was detected at concentrations exceeding the SL at LL8sw-091 and LL8sw-092; however, the concentrations were below the RSL at a TR of 1E-05, HQ of 1.

PAHs were identified as potential contaminants from previous site use at former Buildings 2B-23 and 2B-24 that were used for heater houses; however, concentrations detected in surface soil and the other environmental media adjacent to or surrounding these former buildings were less than the SLs. PAHs were widely distributed in surface soil throughout the AOC; however, the maximum detections of the five PAHs identified as COPCs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene] were observed at sample location LL8ss-072M, which is in the vicinity of former Building 2B-21. At sample location LL8ss-072M, the detections of benzo(a)pyrene and dibenzo(a,h)anthracene exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Five surface soil locations (LL8ss-071M, LL8ss-072M, LL8ss-073M, LL8ss-076M, and LL8ss-085M) slightly exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1 for benzo(a)pyrene. In addition, benzo(a)pyrene was detected at ISM sediment sample location LL8sd-001M above the SL and is therefore was considered a COPC.

Former Building 2B-22 was the only building at Load Line 8 whose purpose was solvent storage. The sample (LL8ss-019) associated with Building 2B-22 had no detectable VOC concentrations in surface soil. One VOC (2-butanone) was identified as an SRC in surface soil, as estimated concentrations were reported from PBA08 RI multi-acre ISM samples LL8ss-074M (0.002J mg/kg) and LL8ss-088M (0.0024J mg/kg). In addition, the VOC acetone was detected in one discrete subsurface sample at a low, estimated concentration. One VOC (toluene) was detected at a low concentration in one discrete sediment sample. All detected VOC concentrations were below their respective SLs.

One PCB (PCB-1254) and four pesticides (4,4’-DDD, 4,4’-DDE, 4,4’-DDT, and beta-BHC) were identified as SRCs in surface soil. Three of the four pesticides (4,4’-DDD, 4,4’-DDE, and 4,4’-DDT) were identified as SRCs in surface soil and sediment. None of the detections exceeded their respective SLs. No pesticides or PCBs were detected in subsurface soil or surface water, and no PCBs were detected in sediment.

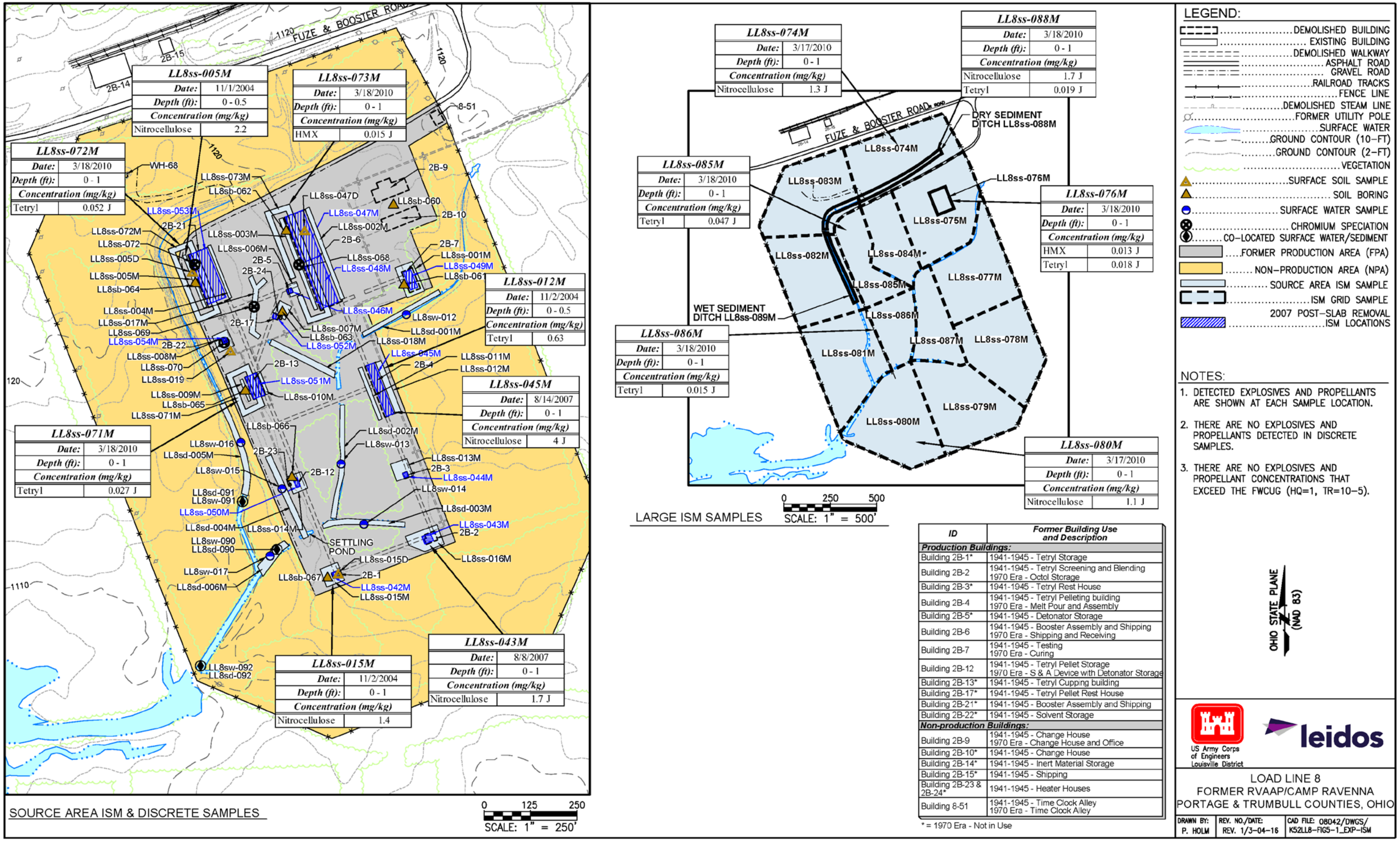
Table 5-1. Chromium Speciation Results

Sample Location	Hexavalent Chromium Concentration (mg/kg)	Total Chromium Concentration[a] (mg/kg)	Hexavalent Chromium (%)
LL8ss-068	0.86J	11.2	7.7
LL8ss-069	2	18.3	10.9
LL8ss-070	2	8.4	23.8
LL8ss-072	0.41J	23.3	1.8

[a] Background screening value for total chromium = 17.4 mg/kg. No background concentration is available for hexavalent chromium.

J = Estimated value is less than reporting limits.

mg/kg = Milligram per kilogram.



LL8ss-005M	
Date:	11/1/2004
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Nitrocellulose	2.2

LL8ss-073M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
HMX	0.015 J

LL8ss-072M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Tetryl	0.052 J

LL8ss-012M	
Date:	11/2/2004
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Tetryl	0.63

LL8ss-045M	
Date:	8/14/2007
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	4 J

LL8ss-071M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Tetryl	0.027 J

LL8ss-043M	
Date:	8/8/2007
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	1.7 J

LL8ss-015M	
Date:	11/2/2004
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	1.4

LL8ss-074M	
Date:	3/17/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	1.3 J

LL8ss-088M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	1.7 J
Tetryl	0.019 J

LL8ss-085M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Tetryl	0.047 J

LL8ss-076M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
HMX	0.013 J
Tetryl	0.018 J

LL8ss-086M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Tetryl	0.015 J

LL8ss-080M	
Date:	3/17/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	1.1 J

ID	*Former Building Use and Description*
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

NOTES:

1. DETECTED EXPLOSIVES AND PROPELLANTS ARE SHOWN AT EACH SAMPLE LOCATION.
2. THERE ARE NO EXPLOSIVES AND PROPELLANTS DETECTED IN DISCRETE SAMPLES.
3. THERE ARE NO EXPLOSIVES AND PROPELLANT CONCENTRATIONS THAT EXCEED THE FWCUG (HQ=1, TR=10–5).

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LOAD LINE 8
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

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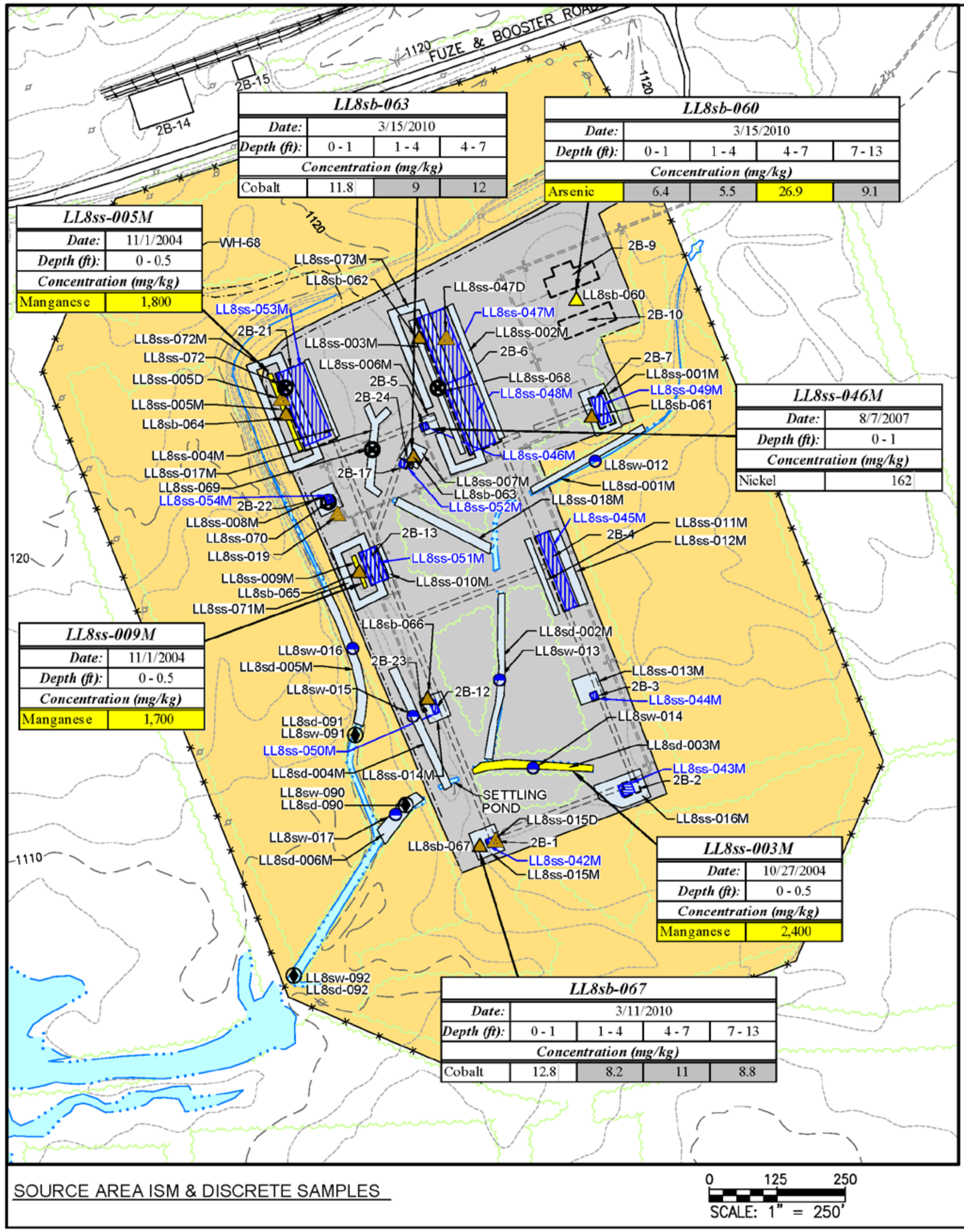
P. HOLM	REV. 1/3–04–16	K52LL8–FIG5–1_EXP–ISM

Figure 5-1. Detected Concentrations of Explosives and Propellants in Soil (ISM and Discrete Soil Borings)



SOURCE AREA ISM & DISCRETE SAMPLES

LL8sb-063			
Date:	3/15/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Cobalt	11.8	9	12

LL8sb-060				
Date:	3/15/2010			
Depth (ft):	0 - 1	1 - 4	4 - 7	7 - 13
Concentration (mg/kg)				
Arsenic	6.4	5.5	26.9	9.1

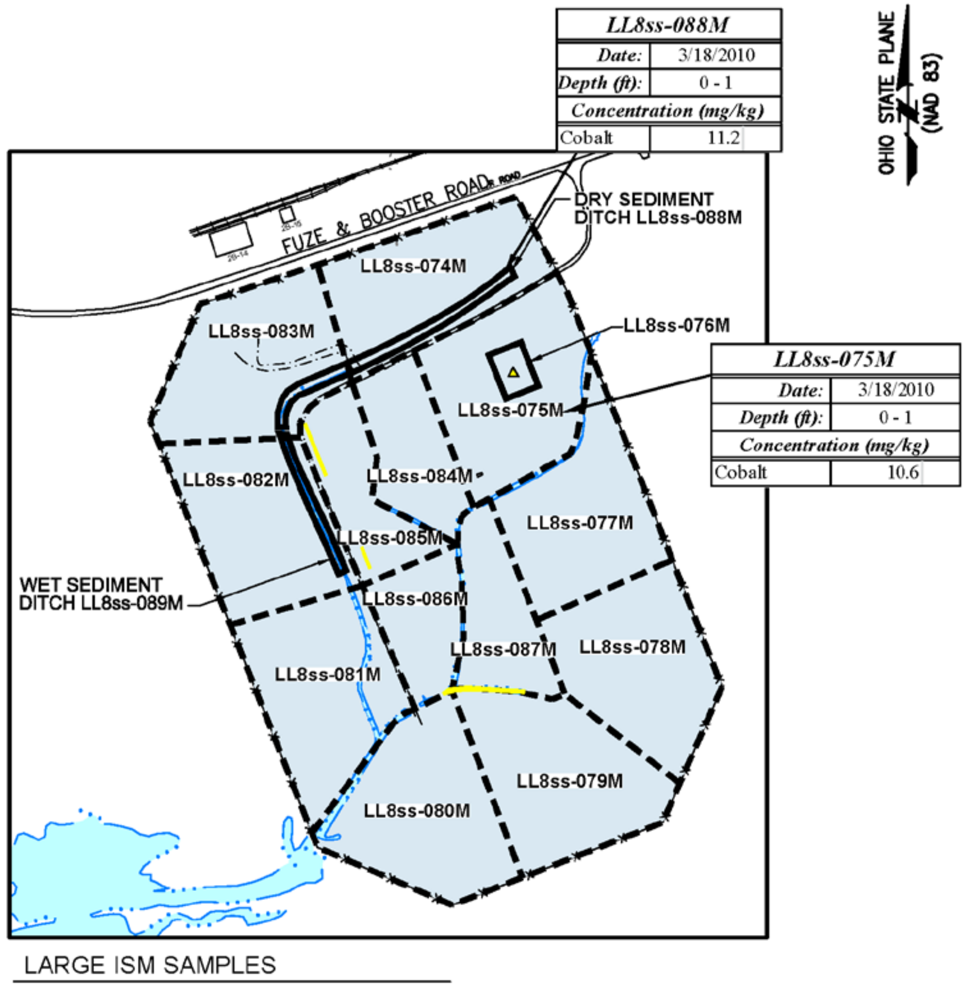
LL8ss-005M	
Date:	11/1/2004
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Manganese	1,800

LL8ss-046M	
Date:	8/7/2007
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nickel	162

LL8ss-009M	
Date:	11/1/2004
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Manganese	1,700

LL8ss-003M	
Date:	10/27/2004
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Manganese	2,400

LL8sb-067				
Date:	3/11/2010			
Depth (ft):	0 - 1	1 - 4	4 - 7	7 - 13
Concentration (mg/kg)				
Cobalt	12.8	8.2	11	8.8



LARGE ISM SAMPLES

LL8ss-088M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	11.2

LL8ss-075M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	10.6

ID	Former Building Use and Description
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

LEGEND:

⌐- - -¬	DEMOLISHED BUILDING
▭	EXISTING BUILDING
= = = =	DEMOLISHED WALKWAY
═	ASPHALT ROAD
=·=·=	GRAVEL ROAD
—+—+—	RAILROAD TRACKS
—x—x—	FENCE LINE
- - -	DEMOLISHED STEAM LINE
⌀	FORMER UTILITY POLE
▬	SURFACE WATER
— —	GROUND CONTOUR (10–FT)
- - -	GROUND CONTOUR (2–FT)
∿	VEGETATION
▲	SURFACE SOIL SAMPLE
▲	SOIL BORING
◒	SURFACE WATER SAMPLE
⊗	CHROMIUM SPECIATION
◈	CO–LOCATED SURFACE WATER/SEDIMENT
■	FORMER PRODUCTION AREA (FPA)
■	NON–PRODUCTION AREA (NPA)
▭	SOURCE AREA ISM SAMPLE
⌐- -¬	ISM GRID SAMPLE
▨	2007 POST–SLAB REMOVAL ISM LOCATIONS
■ △	CONCENTRATION EXCEEDS FWCUG (HQ=1, TR=10–5)

NOTES:

1. CONCENTRATIONS OF ARSENIC, CHROMIUM, LEAD, MERCURY, COBALT, MANGANESE, AND NICKEL ARE SHOWN ONLY WHEN THEY EXCEEDED BACKGROUND AND THE FWCUG (HQ=0.1, TR=10–6).
2. CONCENTRATIONS BELOW BACKGROUND OR THE FWCUG (HQ=0.1, TR=10–6) ARE SHADED GRAY.
3. CONCENTRATIONS OF CHROMIUM, LEAD, AND MERCURY NEVER EXCEEDED THE FWCUG SO THEY ARE NOT DISPLAYED IN THE FIGURE.
4. TOTAL CHROMIUM CONCENTRATIONS WERE SCREENED AGAINST THE FWCUG FOR TRIVALENT CHROMIUM SINCE THE CONCENTRATION OF HEXAVALENT CHROMIUM DID NOT EXCEED THE FWCUG.
5. LEAD CONCENTRATIONS WERE SCREENED AGAINST RESIDENTIAL RSL (400 mg/kg).

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LOAD LINE 8
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

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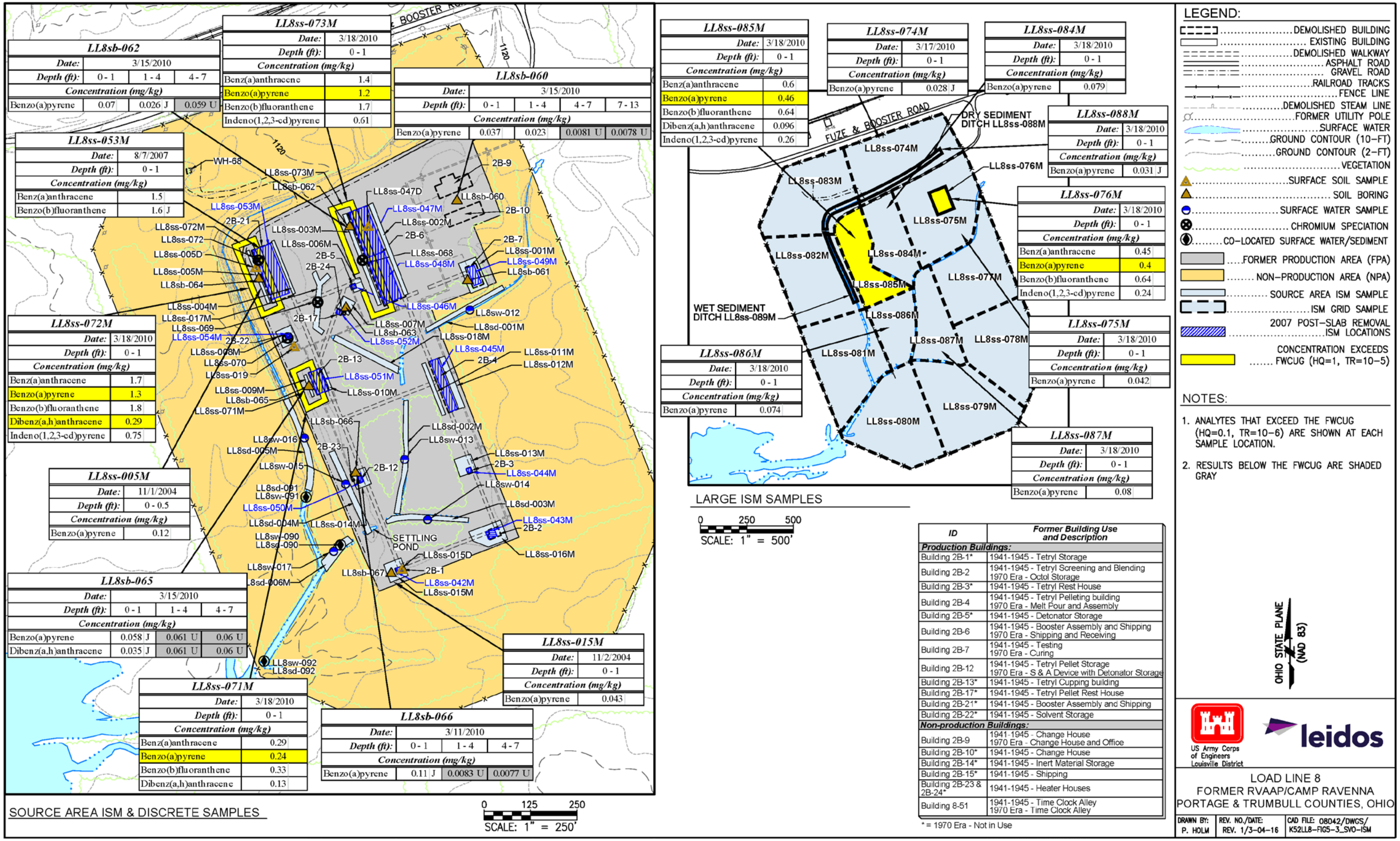
P. HOLM	REV. 1/3–04–16	08042/DWGS/ K52LL8–FIG5–2_MET–ISM

Figure 5-2. Exceedances of FWCUG (HQ of 0.1, TR of 10-6) for Arsenic, Chromium, Lead, Mercury, Cobalt, Manganese, and Nickel in Soil (ISM and Discrete Soil Borings)



LL8sb-062			
Date:	3/15/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benzo(a)pyrene	0.07	0.026 J	0.059 U

LL8ss-073M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	1.4
Benzo(a)pyrene	1.2
Benzo(b)fluoranthene	1.7
Indeno(1,2,3-cd)pyrene	0.61

LL8sb-060				
Date:	3/15/2010			
Depth (ft):	0 - 1	1 - 4	4 - 7	7 - 13
Concentration (mg/kg)				
Benzo(a)pyrene	0.037	0.023	0.0081 U	0.0078 U

LL8ss-053M	
Date:	8/7/2007
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	1.5
Benzo(b)fluoranthene	1.6 J

LL8ss-072M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	1.7
Benzo(a)pyrene	1.3
Benzo(b)fluoranthene	1.8
Dibenz(a,h)anthracene	0.29
Indeno(1,2,3-cd)pyrene	0.75

LL8ss-005M	
Date:	11/1/2004
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Benzo(a)pyrene	0.12

LL8sb-065			
Date:	3/15/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benzo(a)pyrene	0.058 J	0.061 U	0.06 U
Dibenz(a,h)anthracene	0.035 J	0.061 U	0.06 U

LL8ss-015M	
Date:	11/2/2004
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.043

LL8ss-071M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	0.29
Benzo(a)pyrene	0.24
Benzo(b)fluoranthene	0.33
Dibenz(a,h)anthracene	0.13

LL8sb-066			
Date:	3/11/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benzo(a)pyrene	0.11 J	0.0083 U	0.0077 U

LL8ss-085M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	0.6
Benzo(a)pyrene	0.46
Benzo(b)fluoranthene	0.64
Dibenz(a,h)anthracene	0.096
Indeno(1,2,3-cd)pyrene	0.26

LL8ss-074M	
Date:	3/17/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.028 J

LL8ss-084M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.079

LL8ss-088M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.031 J

LL8ss-076M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	0.45
Benzo(a)pyrene	0.4
Benzo(b)fluoranthene	0.64
Indeno(1,2,3-cd)pyrene	0.24

LL8ss-075M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.042

LL8ss-086M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.074

LL8ss-087M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.08

ID	Former Building Use and Description
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

LEGEND:

⊏⊐	DEMOLISHED BUILDING
▭	EXISTING BUILDING
═ ═ ═	DEMOLISHED WALKWAY
═	ASPHALT ROAD
═:═:═	GRAVEL ROAD
─┼─┼─	RAILROAD TRACKS
─x─x─	FENCE LINE
- - -	DEMOLISHED STEAM LINE
⌀	FORMER UTILITY POLE
▬	SURFACE WATER
─ ─ ─	GROUND CONTOUR (10–FT)
- - -	GROUND CONTOUR (2–FT)
～～	VEGETATION
▲	SURFACE SOIL SAMPLE
▲	SOIL BORING
◒	SURFACE WATER SAMPLE
⊗	CHROMIUM SPECIATION
◈	CO–LOCATED SURFACE WATER/SEDIMENT
▬	FORMER PRODUCTION AREA (FPA)
▬	NON–PRODUCTION AREA (NPA)
▭	SOURCE AREA ISM SAMPLE
⊏⊐	ISM GRID SAMPLE
▨	2007 POST–SLAB REMOVAL ISM LOCATIONS
▬	CONCENTRATION EXCEEDS FWCUG (HQ=1, TR=10–5)

NOTES:

1. ANALYTES THAT EXCEED THE FWCUG (HQ=0.1, TR=10–6) ARE SHOWN AT EACH SAMPLE LOCATION.
2. RESULTS BELOW THE FWCUG ARE SHADED GRAY

US Army Corps of Engineers Louisville District

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LOAD LINE 8
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

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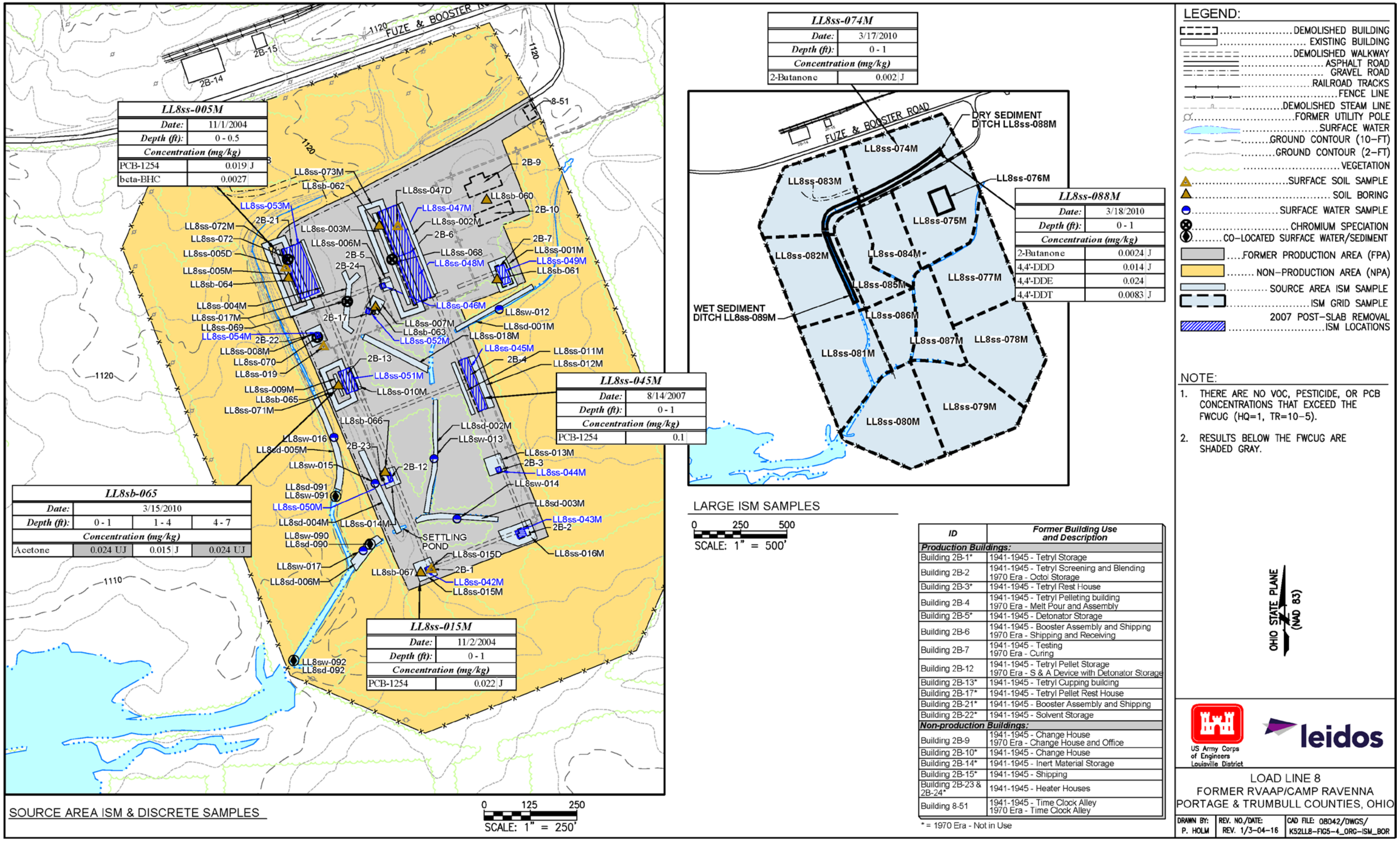
P. HOLM	REV. 1/3–04–16	08042/DWGS/ K52LL8–FIG5–3_SVO–ISM

Figure 5-3. PAH Exceedances of FWCUG (HQ of 0.1, TR of 10-6) in Soil (ISM and Discrete Soil Borings)



LL8ss-005M

Date:	11/1/2004
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
PCB-1254	0.019 J
beta-BHC	0.0027

LL8sb-065

Date:	3/15/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Acetone	0.024 UJ	0.015 J	0.024 UJ

LL8ss-045M

Date:	8/14/2007
Depth (ft):	0 - 1
Concentration (mg/kg)	
PCB-1254	0.1

LL8ss-015M

Date:	11/2/2004
Depth (ft):	0 - 1
Concentration (mg/kg)	
PCB-1254	0.022 J

SOURCE AREA ISM & DISCRETE SAMPLES

LL8ss-074M

Date:	3/17/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
2-Butanone	0.002 J

LL8ss-088M

Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
2-Butanone	0.0024 J
4,4'-DDD	0.014 J
4,4'-DDE	0.024
4,4'-DDT	0.0083 J

LARGE ISM SAMPLES

ID	Former Building Use and Description
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

LEGEND:

- ......DEMOLISHED BUILDING
- ......EXISTING BUILDING
- ......DEMOLISHED WALKWAY
- ......ASPHALT ROAD
- ......GRAVEL ROAD
- ......RAILROAD TRACKS
- ......FENCE LINE
- ......DEMOLISHED STEAM LINE
- ......FORMER UTILITY POLE
- ......SURFACE WATER
- ......GROUND CONTOUR (10-FT)
- ......GROUND CONTOUR (2-FT)
- ......VEGETATION
- ▲......SURFACE SOIL SAMPLE
- ▲......SOIL BORING
- ●......SURFACE WATER SAMPLE
- ⊗......CHROMIUM SPECIATION
- ●......CO-LOCATED SURFACE WATER/SEDIMENT
- ▨......FORMER PRODUCTION AREA (FPA)
- 🟨......NON-PRODUCTION AREA (NPA)
- ▭......SOURCE AREA ISM SAMPLE
- ▭......ISM GRID SAMPLE
- ▨......2007 POST-SLAB REMOVAL ISM LOCATIONS

NOTE:

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

LOAD LINE 8
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

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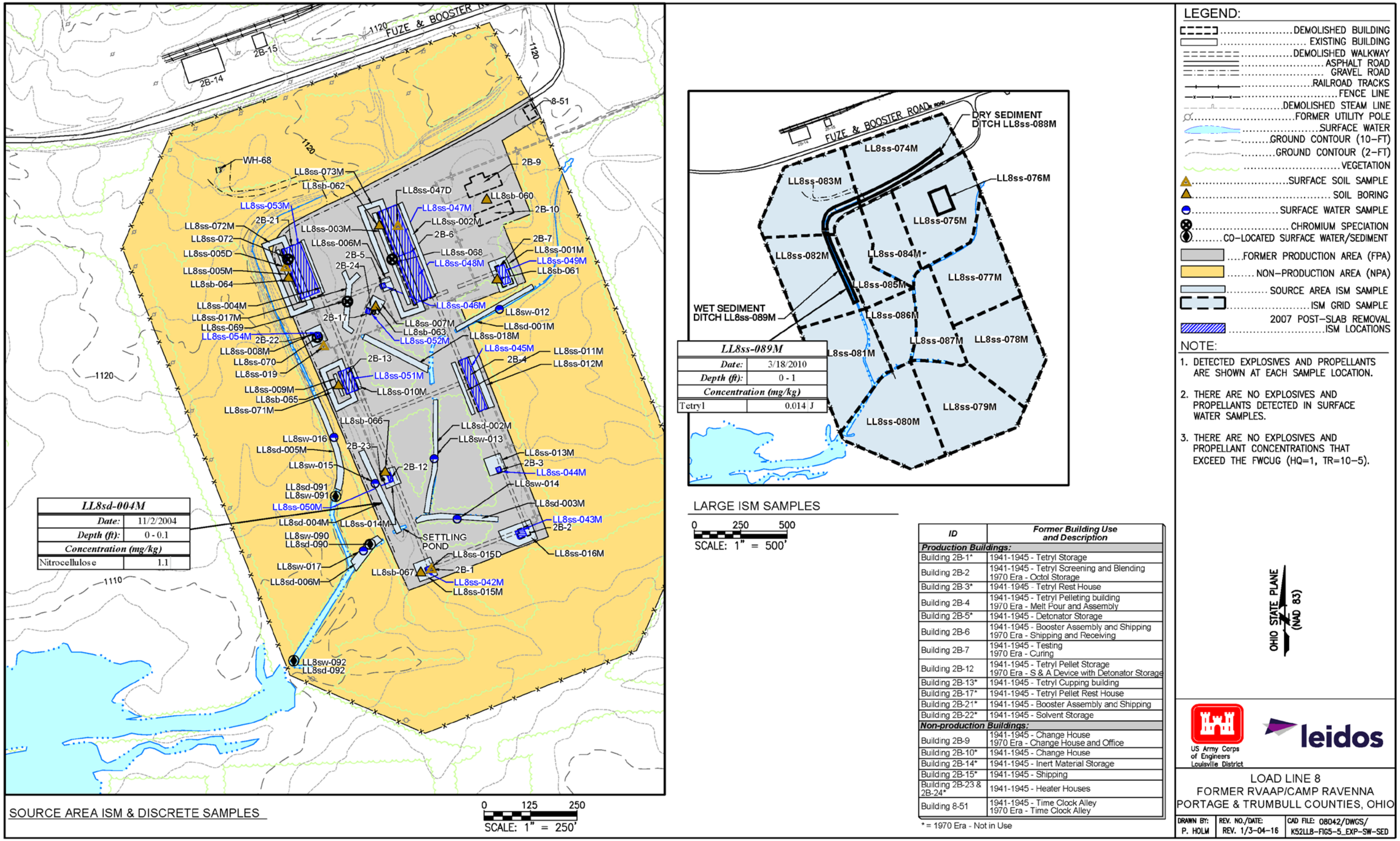
P. HOLM	REV. 1/3-04-16	K52LL8-FIG5-4_ORG-ISM_BOR

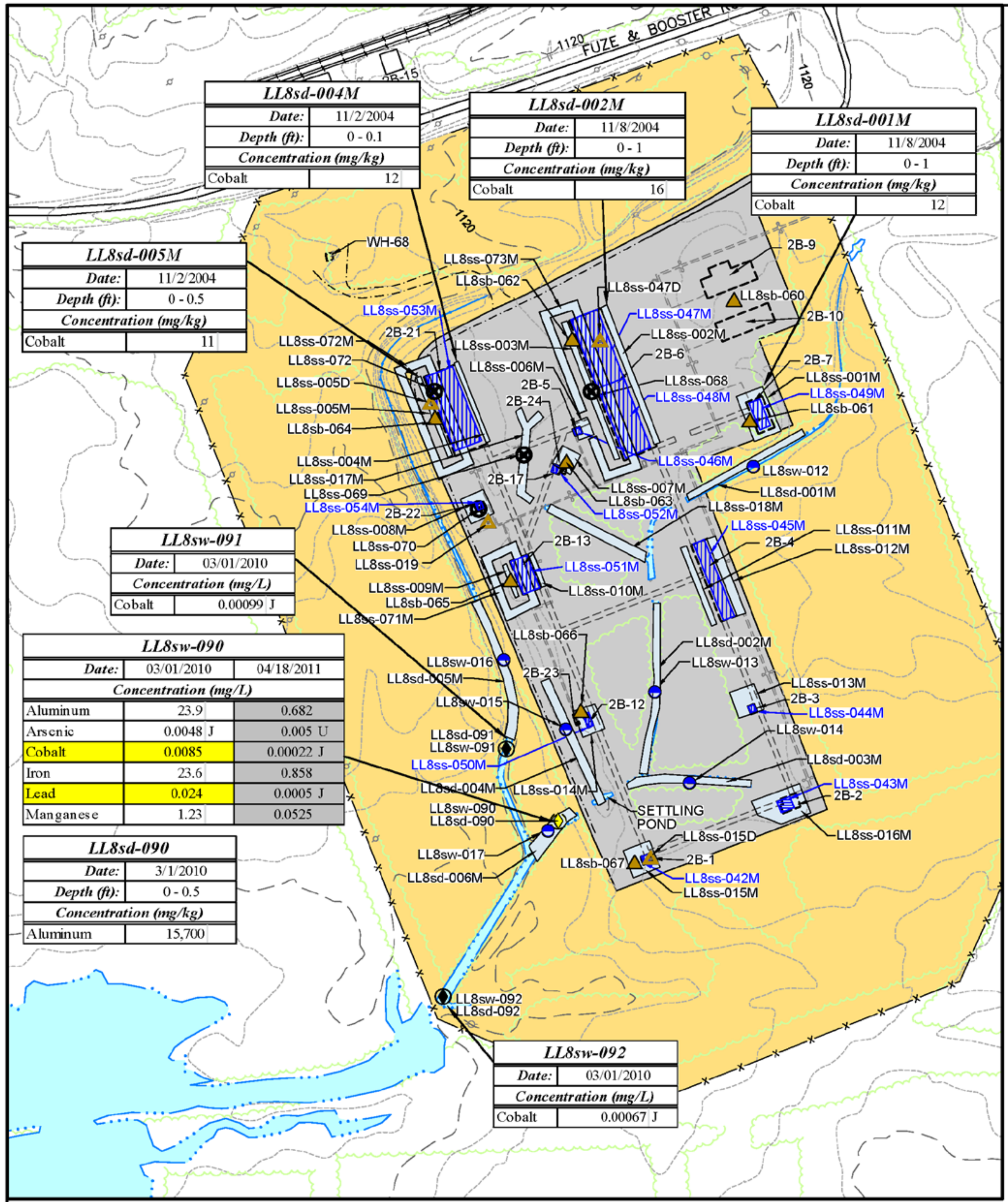
Figure 5-4. Detected Concentrations of VOCs, Pesticides, and PCBs in Soil (ISM and Discrete Soil Borings)



ID	Former Building Use and Description
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

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



LL8sd-004M	
Date:	11/2/2004
Depth (ft):	0 - 0.1
Concentration (mg/kg)	
Cobalt	12

LL8sd-002M	
Date:	11/8/2004
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	16

LL8sd-001M	
Date:	11/8/2004
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	12

LL8sd-005M	
Date:	11/2/2004
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Cobalt	11

LL8sw-091	
Date:	03/01/2010
Concentration (mg/L)	
Cobalt	0.00099 J

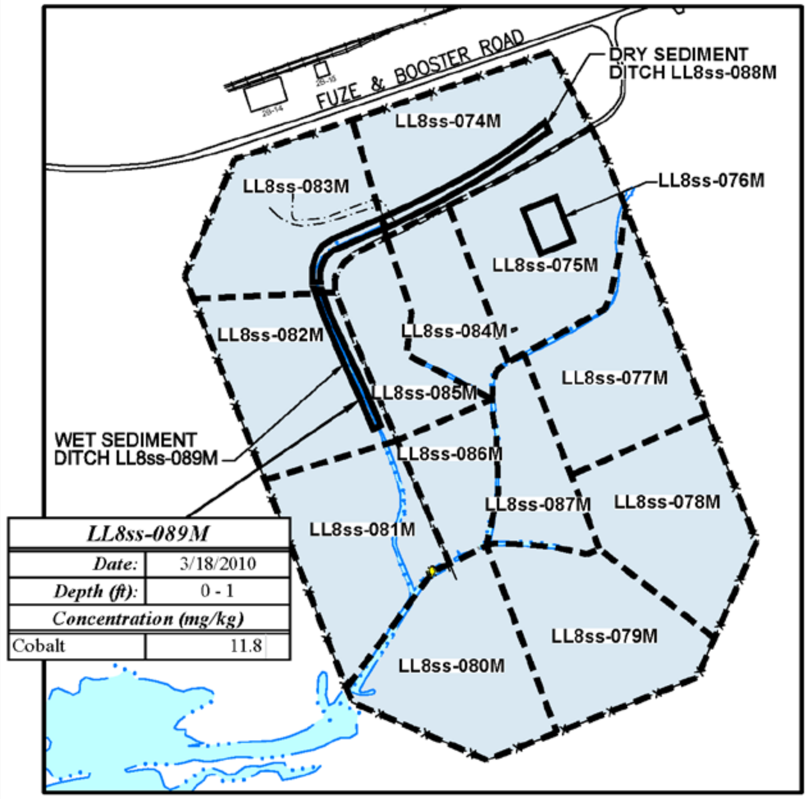
LL8sw-090		
Date:	03/01/2010	04/18/2011
Concentration (mg/L)		
Aluminum	23.9	0.682
Arsenic	0.0048 J	0.005 U
Cobalt	0.0085	0.00022 J
Iron	23.6	0.858
Lead	0.024	0.0005 J
Manganese	1.23	0.0525

LL8sd-090	
Date:	3/1/2010
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Aluminum	15,700

LL8sw-092	
Date:	03/01/2010
Concentration (mg/L)	
Cobalt	0.00067 J

SOURCE AREA ISM & DISCRETE SAMPLES

0 125 250
SCALE: 1" = 250'



LL8ss-089M	
Date:	3/18/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	11.8

LARGE ISM SAMPLES

0 250 500
SCALE: 1" = 500'

ID	Former Building Use and Description
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

LEGEND:

▭	DEMOLISHED BUILDING
▭	EXISTING BUILDING
	DEMOLISHED WALKWAY
	ASPHALT ROAD
	GRAVEL ROAD
	RAILROAD TRACKS
	FENCE LINE
	DEMOLISHED STEAM LINE
	FORMER UTILITY POLE
	SURFACE WATER
	GROUND CONTOUR (10–FT)
	GROUND CONTOUR (2–FT)
	VEGETATION
▲	SURFACE SOIL SAMPLE
▲	SOIL BORING
●	SURFACE WATER SAMPLE
⊗	CHROMIUM SPECIATION
◐	CO–LOCATED SURFACE WATER/SEDIMENT
▭	FORMER PRODUCTION AREA (FPA)
▭	NON–PRODUCTION AREA (NPA)
▭	SOURCE AREA ISM SAMPLE
▭	ISM GRID SAMPLE
▨	2007 POST–SLAB REMOVAL ISM LOCATIONS
▭	CONCENTRATION EXCEEDS FWCUG (HQ=1, TR=10–5)

NOTE:

1. CONCENTRATIONS OF ARSENIC, CHROMIUM, LEAD, MERCURY, ALUMINUM, COBALT, IRON, AND MANGANESE ARE SHOWN ONLY WHEN THEY EXCEEDED BACKGROUND AND THE FWCUG (HQ=0.1, TR=10–6).
2. CONCENTRATIONS OF CHROMIUM AND MERCURY DID NOT EXCEED THE FWCUG, AND CONCENTRATIONS OF LEAD IN SEDIMENT DID NOT EXCEED RESIDENTIAL RSL.
3. TOTAL CHROMIUM CONCENTRATIONS WERE SCREENED AGAINST THE FWCUG FOR TRIVALENT CHROMIUM BASED ON AN ASSESSMENT OF HEXAVALENT CHROMIUM IN SOIL.
4. RESULTS BELOW THE FWCUG ARE SHADED GRAY.

OHIO STATE PLANE (NAD 83)

US Army Corps of Engineers Louisville District

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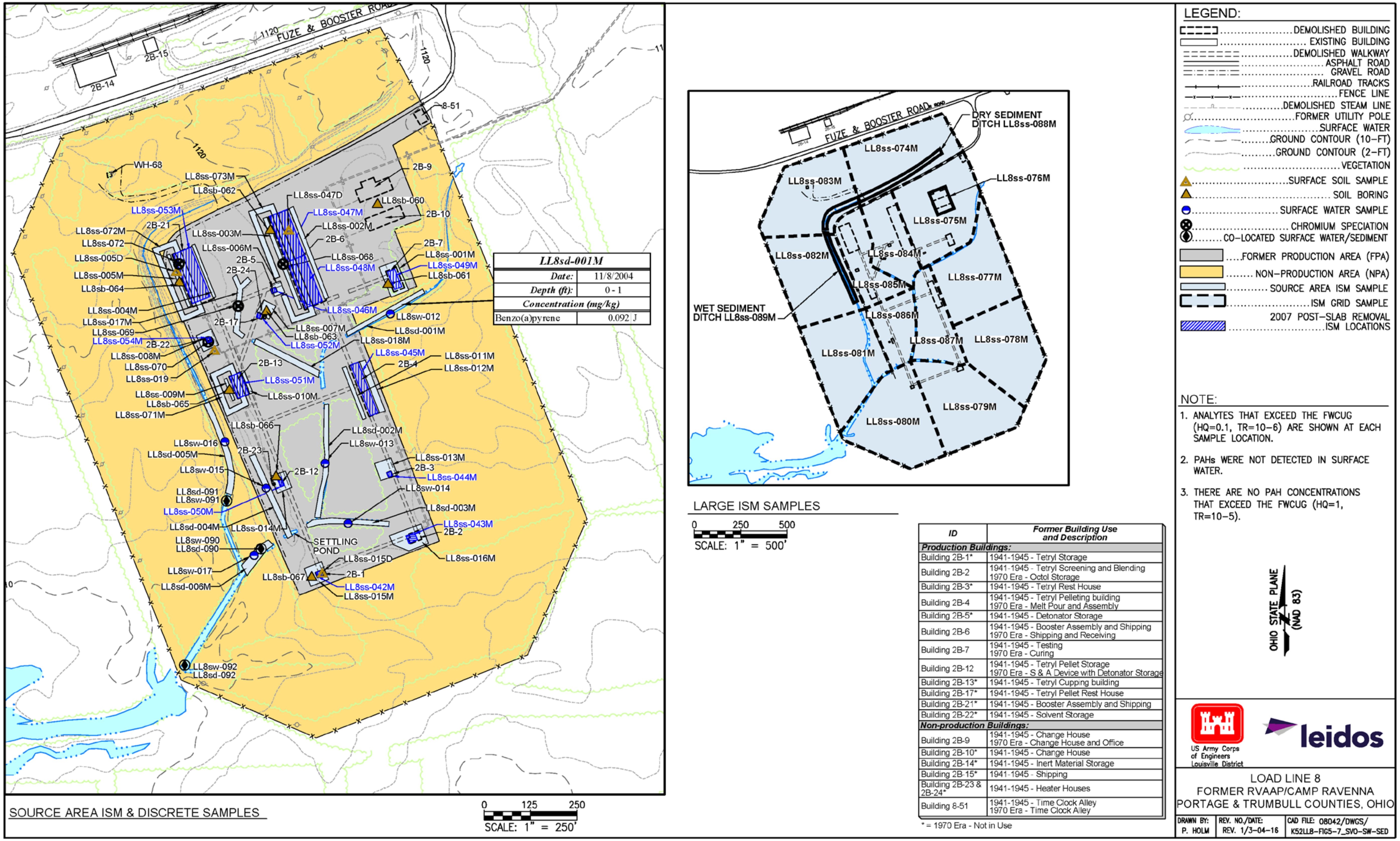
LOAD LINE 8
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE: 08042/DWGS/
P. HOLM	REV. 1/3–04–16	K52LL8–FIG5–6_MET–SW–SED

Figure 5-6. Exceedances of FWCUG (HQ of 0.1, TR of 10-6) for Arsenic, Chromium, Lead, Mercury, Aluminum, Cobalt, Iron, and Manganese in Surface Water and Sediment



LL8sd-001M	
Date:	11/8/2004
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.092 J

LEGEND:

DEMOLISHED BUILDING
EXISTING BUILDING
DEMOLISHED WALKWAY
ASPHALT ROAD
GRAVEL ROAD
RAILROAD TRACKS
FENCE LINE
DEMOLISHED STEAM LINE
FORMER UTILITY POLE
SURFACE WATER
GROUND CONTOUR (10-FT)
GROUND CONTOUR (2-FT)
VEGETATION
▲ SURFACE SOIL SAMPLE
▲ SOIL BORING
● SURFACE WATER SAMPLE
⊗ CHROMIUM SPECIATION
CO-LOCATED SURFACE WATER/SEDIMENT
FORMER PRODUCTION AREA (FPA)
NON-PRODUCTION AREA (NPA)
SOURCE AREA ISM SAMPLE
ISM GRID SAMPLE
▨ 2007 POST-SLAB REMOVAL ISM LOCATIONS

NOTE:

1. ANALYTES THAT EXCEED THE FWCUG (HQ=0.1, TR=10−6) ARE SHOWN AT EACH SAMPLE LOCATION.
2. PAHs WERE NOT DETECTED IN SURFACE WATER.
3. THERE ARE NO PAH CONCENTRATIONS THAT EXCEED THE FWCUG (HQ=1, TR=10−5).

ID	*Former Building Use and Description*
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

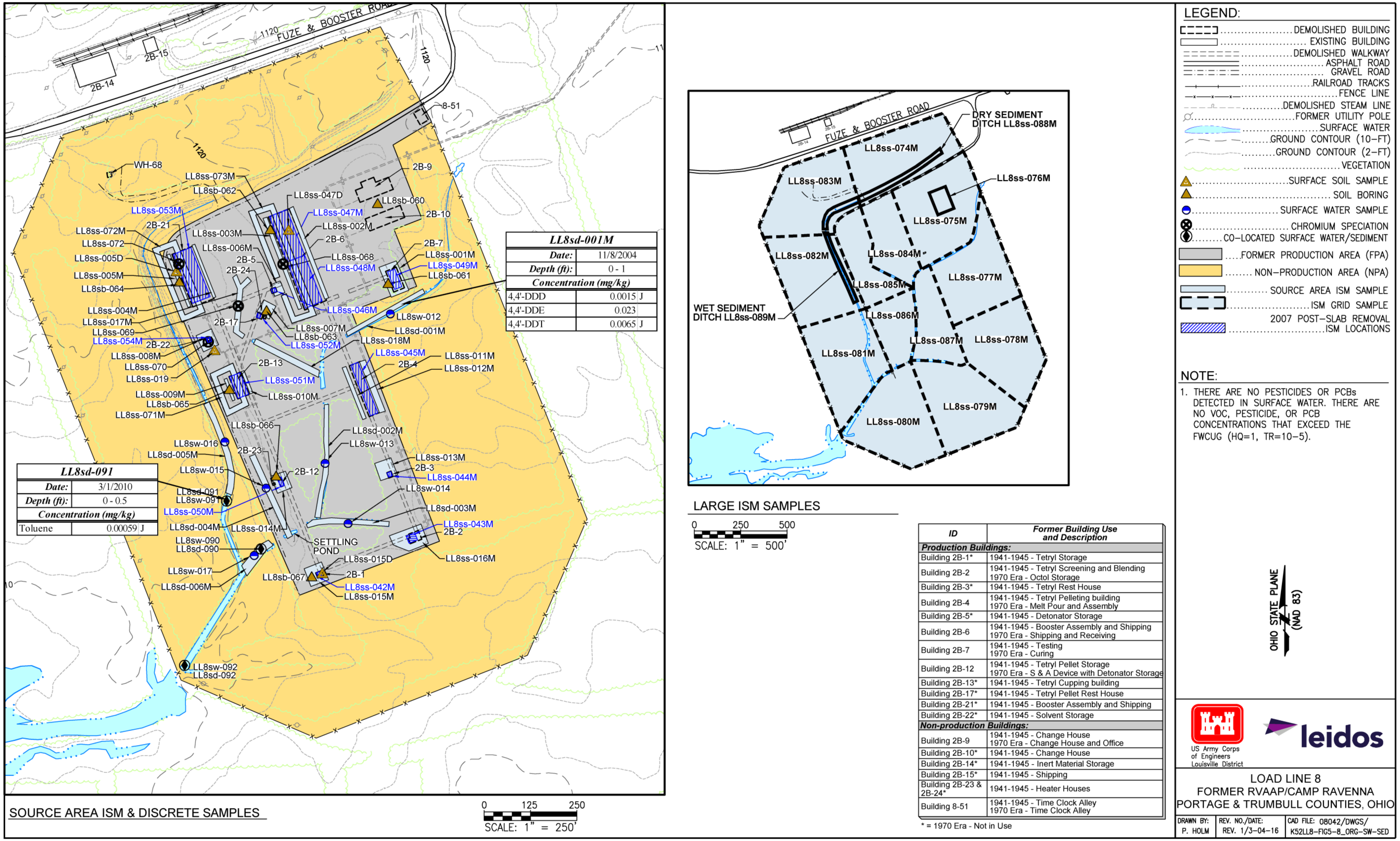
US Army Corps
of Engineers
Louisville District

leidos

LOAD LINE 8
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE: 08042/DWGS/
P. HOLM	REV. 1/3-04-16	K52LL8-FIG5-7_SVO-SW-SED

Figure 5-7. PAH Exceedances of FWCUG (HQ of 0.1, TR of 10-6) in Surface Water and Sediment



LL8sd-001M	
Date:	11/8/2004
Depth (ft):	0 - 1
Concentration (mg/kg)	
4,4'-DDD	0.0015 J
4,4'-DDE	0.023
4,4'-DDT	0.0065 J

LL8sd-091	
Date:	3/1/2010
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Toluene	0.00059 J

NOTE:

1. THERE ARE NO PESTICIDES OR PCBs DETECTED IN SURFACE WATER. THERE ARE NO VOC, PESTICIDE, OR PCB CONCENTRATIONS THAT EXCEED THE FWCUG (HQ=1, TR=10–5).

ID	*Former Building Use and Description*
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

Figure 5-8. Detected Concentrations of VOCs, Pesticides, and PCBs 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 8 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 major contaminants of the former RVAAP are TNT, composition B (a combination of TNT and RDX), sulfates, nitrates, lead styphnate, and lead azide. Additional site-specific contaminants at Load Line 8 include tetryl, Octol (a mixture of TNT and HMX), and heavy metals (lead, chromium, mercury, and arsenic) from munitions assembly activities; VOCs from former Building 2B-22 that was utilized for solvent storage; PCBs from on-site transformers; and PAHs from former Buildings 2B-23 and 2B-24 that were used as heater houses.

The evaluation of contaminant fate and transport not only includes chemicals identified as potential contaminants from previous use but also includes chemicals that were evaluated as part of the overall RI. The comprehensive list of surface and subsurface soil SRCs (15 inorganic chemicals and 33 organic chemicals) and sediment SRCs (11 inorganic chemicals and 17 organic chemicals) were detailed in Section 4.0 and are summarized below:

- Inorganic SRCs in surface and subsurface soil: arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, thallium, and zinc.
- Inorganic SRCs in sediment: aluminum, barium, beryllium, cadmium, chromium, cobalt, lead, mercury, nickel, selenium, and silver.
- Organic SRCs in surface and subsurface soil: 2-butanone; 2-methylnaphthalene; 4,4’-DDD; 4,4’-DDE; 4,4’-DDT; acenaphthene; acenaphthylene; acetone; anthracene; benz(a)anthracene; benzenemethanol; benzo(a)pyrene; benzo(b)fluoranthene; benzo(ghi)perylene; benzo(k)fluoranthene; beta-BHC; bis(2-ethylhexyl)phthalate; chrysene; di-n-butyl phthalate; dibenz(a,h)anthracene; dibenzofuran; diethyl phthalate; fluoranthene;

fluorene; HMX; indeno(1,2,3-cd)pyrene; naphthalene; nitrocellulose; PCB-1254; phenanthrene; phenol; pyrene; and tetryl.

- Organic SRCs in sediment: 4,4'-DDD; 4,4'-DDE; 4,4'-DDT; benz(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(ghi)perylene; benzo(k)fluoranthene; chrysene; fluoranthene; indeno(1,2,3-cd)pyrene; naphthalene; nitrocellulose; phenanthrene; pyrene; tetryl; and toluene.

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 Appendix E, Tables E-1 and E-2. 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 Sections 6.1.1 through 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 8. 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). Appendix E, Figure E-1 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 CSM, which defines the framework for fate and transport modeling, describes conditions at Load Line 8, 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 soil) 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 8 ranges from approximately 1,125 ft amsl near the northwestern boundary of the AOC to approximately 1,109 ft amsl near the southwestern portion of the AOC toward the unnamed tributary to Hinkley Creek. Surface water drainage associated with heavy rainfall events follows the topography and flow overland and drains into ditches that flow to the southwest to an unnamed tributary to Hinkley Creek (Figure 3-1).
- Soil beneath the AOC consists of silt loam that exhibits seasonal wetness, rapid runoff, and low permeability (USDA 2010). Bedrock was encountered at 12-20 ft bgs during monitoring well installation (wells LL8mw-005 and LL8mw-006 under the Characterization of 14 AOCs (MKM 2007).
- Six groundwater monitoring wells were installed at the AOC to an average depth of approximately 24 ft bgs. Wells LL8mw-001, LL8mw-002, LL8mw-003 and LL8mw-004 monitor the unconsolidated zone. Wells LL8mw-005 and LL8mw-006 monitor the bedrock zone. Bedrock underneath the AOC consists of weathered Homewood Sandstone.
- Water level elevations at the AOC range from 1104.46–1109.47 ft amsl (approximately 11 ft bgs) with the highest elevation at the unconsolidated well LL8mw-001 (Figure 3-1). Potentiometric data indicate the groundwater table occurs within the unconsolidated zone throughout the AOC. The flow direction is from northeast to southwest with a hydraulic gradient of 0.0058 ft/ft (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 Hinkley Creek southwest of Load Line 8);
- Contaminated sediment transported to potential downstream receptors;
- Contaminated surface water migrating to potential downstream receptors;
- Contaminated sediment within wet ditches 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 8. 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 Appendix E, Table E-3 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 1996b, 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 levels (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 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 acenaphthene for acenaphthylene and pyrene for benzo(ghi)perylene and phenanthrene.

The initial CMCOPC screen, as presented in Appendix E, Table E-4, eliminates 3 inorganic chemicals and 20 organic chemicals from further consideration. A total of 12 inorganic and 13 organic SRCs exceeded their GSSLs and 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 levels (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 DAF. Direct partitioning is used to derive 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 1996b), 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)

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

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 Appendix E, Table E-5. 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 2.14, beryllium, copper, thallium, tetryl, benzo(k)fluoranthene, chrysene, and 4,4’-DDD were 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 Appendix E, Table E-6.

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 Appendix E, Table E-7,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 seven organic SRCs 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 (SESOIL) Model are listed in Table 6-1.

In the fifth step (Figure 6-2), the initial CMCOPCs (presented in Table 6-1) 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 1996b). 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 Model (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.

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), 3 inorganic SRCs (aluminum, beryllium, and silver) and 13 organic SRCs [nitrocellulose, tetryl, benzo(a)pyrene, benzo(ghi)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, toluene, 4,4'-DDD, and 4,4'-DDT] were eliminated from further evaluation. The remaining eight inorganic SRCs (barium, cadmium, chromium, cobalt, lead, mercury, nickel, and selenium) and four organic SRCs [4,4'-DDE, benz(a)anthracene, benzo(b)fluoranthene, and naphthalene] were identified as sediment CMCOPCs and were evaluated with the AT123D model described in Section 6.5.

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 SESOIL) through the overburden to the water table and horizontal transport (evaluated with AT123D) 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 ISM sampling areas 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 AT123D 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. AT123D (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

SESOIL 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: 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.

SESOIL 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. 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 Appendix E, Table E-9. 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 SESOIL (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. For Load Line 8, AOC-specific data represent the average results of geotechnical samples collected from the nearby AOCs (i.e., Load Lines 7, 10, and 11) as these parameters were not included in the geotechnical analyses conducted for Load Line 8 during the Characterization of 14 AOCs. There is, however, no measurement method for the soil disconnectedness index or a measured value of the Freundlich exponent. The soil disconnectedness index is a parameter that relates the soil permeability to the moisture content, and the Freundlich exponent relates to the concentration of a solute on the surface of an adsorbent to the concentration of the solute in the liquid with which it is in contact. 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. All the samples collected at different depth intervals were compiled to provide a detailed loading option for SESOIL. The maximum soil concentrations for each CMCOPC, listed in Table 6-1, were used as source term concentrations for SESOIL.

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 Appendix E, Table E-11.

Each model was arranged in four layers. The top layer (Layer 1) for each model consisted of the loading zone and was 1 ft thick.

Layer 2 was 6 ft thick and served as a loading zone for inorganic chemicals (arsenic and selenium) and as a leaching zone for organic chemicals (naphthalene and beta-BHC), and contained two sublayers. The thickness of Layer 3 varied between the models for each chemical but served as a leaching zone in each and did not contain sublayers. The fourth layer (Layer 4) was 0.25 ft thick for inorganic chemicals and was 0.5 ft thick for organic chemicals 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).

6.5.3 SESOIL Modeling Results

SESOIL modeling was performed for initial CMCOPCs (i.e., arsenic, selenium, naphthalene, and beta-BHC) 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. None of initial CMCOPCs were eliminated based on the SESOIL modeling results; therefore, all the initial CMCOPCs were selected as the final CMCOPCs for evaluation using AT123D model. Appendix E, Figures E-2 through E-5 show the leachate mass flux versus time plots generated by SESOIL to be used as input to AT123D modeling.

Arsenic, selenium, naphthalene, and beta-BHC 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 Appendix E, Table E-12. A discussion of model assumptions and limitations is presented in Section 6.5.6.

Appendix E, Figures E-6 through E-21 show the predicted concentration versus time curves based on AT123D modeling for final CMCOPCs for 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 Hinkley Creek southwest of Load Line 8). 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 arsenic, selenium, naphthalene, and beta-BHC 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 Hinkley Creek southwest of Load Line 8). The identified sediment CMCOPCs [barium, cadmium, chromium, cobalt, lead, mercury, nickel, selenium, 4,4'-DDE, benz(a)anthracene, benzo(b)fluoranthene, and naphthalene] were also predicted by analytical solutions to exceed screening criteria in groundwater beneath their source and were retained for lateral transport modeling using the AT123D model.

Lateral transport modeling showed the maximum predicted concentrations of final soil CMCOPCs (arsenic, selenium, naphthalene, and beta-BHC) did not exceed the screening criteria at their downgradient receptor location (unnamed tributary to Hinkley Creek southwest of Load Line 8). Beta-BHC did not exceed the screening criteria in groundwater beneath the source area and was eliminated as a soil CMCOC. However, arsenic, selenium, and naphthalene exceeded screening criteria in groundwater beneath their respective source areas and were retained for further evaluation. None of the sediment CMCOPCs were predicted to exceed screening criteria at their downgradient receptor (unnamed tributary to Hinkley Creek), but all 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. The detailed input and output of the SESOIL and AT123D modeling are provided on a CD ROM included in Attachments 1 and 2, respectively, of Appendix E.

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 of background concentration data available or having limited or slight exceedances of 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 1996b)].

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) 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

Arsenic. Of the 75 surface and subsurface soil samples collected, only one sample (LL8sb-060-5348-SO) exceeded the subsurface soil background concentration of 19.8 mg/kg at a concentration of 26.9 mg/kg. Arsenic was not considered a COPC in the HHRA. Although arsenic has been detected in the AOC groundwater samples collected from 2009-2010, the MDC is below its MCL (Table 6-5). Using the maximum soil concentration, arsenic modeling results indicate it would take nearly 150 years for a breakthrough in groundwater beneath the source at a concentration above the MCL (0.01 mg/L), and arsenic is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (see Table 6-5). However, it should be noted here that the background concentration of arsenic in unconsolidated groundwater also exceeds the MCL. Therefore, if arsenic is detected in groundwater above its MCL, it should be considered background related, and not due to contamination from the site.

Selenium. Of the 75 surface and subsurface soil samples collected, only one sample (LL8sb-065-5368-SO) exceeded the subsurface soil background concentration of 1.5 mg/kg at a concentration of 1.6 mg/kg. Selenium was not considered a COPC in the HHRA. This MDC is well below the RSL of 39 mg/kg. Although selenium has been detected in the AOC groundwater samples collected from 2009-2010, the maximum detection (0.0048 mg/L) was below its MCL of 0.05 mg/L (Table 6-5). Using the maximum soil concentration, selenium modeling results indicate it would take about 45 years for a breakthrough in groundwater beneath the source at a concentration above its MCL (0.050 mg/L), and selenium is not predicted to migrate to the downgradient receptor location at concentrations exceeding its MCL within 1,000 years (see Table 6-5). Therefore, if selenium is detected in groundwater above its MCL, it should be considered background related, and not due to contamination from the site.

Naphthalene. The maximum soil concentration for naphthalene was 0.26 mg/kg at LL8ss-072M-5387-SO, which was below the Resident Receptor Adult FWCUG at a TR of 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 maximum concentration indicate it would take nearly 100 years for a breakthrough in groundwater beneath the source at a concentration above its RSL (0.00017 mg/L). Naphthalene has not been detected in the AOC groundwater samples collected from 2009-2010 (Table 6-5). Also, naphthalene is not predicted to migrate to the downgradient receptor location at concentrations exceeding its MCL within 1,000 years (see 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.

6.6.2 Evaluation of Remaining Sediment CMCOPCs

Barium. The maximum sediment concentration for barium (140 mg/kg) was below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (8,966 mg/kg), and barium was not identified as a sediment COPC in the HHRA. Although barium was detected in the AOC groundwater samples collected from 2009-2010, the maximum detection (0.0409 mg/L) was well below the MCL (2.0 mg/L) (Table 6-5).

Although the maximum detection of barium in groundwater is well below the MCL, the conservative model that assumes an equilibrium partitioning between the sediment and groundwater provides a predicted maximum groundwater concentration beneath the source of 3.4 mg/L (i.e., above the MCL of 2 mg/L). Even with the results of this conservative model, predicted barium concentrations beneath the source decrease to below its MCL in less than four years and continue to decrease into the future. In addition, barium is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5).

It should be noted here that the reason barium is predicted to be in groundwater is because the modeling assumed that the sediment sample is directly in contact with the underlying groundwater. Therefore, this evaluation concludes that the model-predicted concentrations are conservative and barium would be expected to be below its MCL based on accounting for the vertical leaching distance.

Cadmium. The maximum sediment concentration for cadmium (2.6 mg/kg) was below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (22.3 mg/kg), and cadmium was not identified as a sediment COPC in the HHRA. Cadmium was not detected in the AOC groundwater samples collected from 2009-2010 (Table 6-5).

Although cadmium was not detected in groundwater, the conservative model that assumes an equilibrium partitioning between the sediment and groundwater provides a predicted maximum groundwater concentration beneath the source of 0.035 mg/L (i.e., above the MCL of 0.005 mg/L). Even with the results of this conservative model, predicted cadmium concentrations beneath the source decrease to below its MCL after about the first 50 years and continue to decrease into the future. In addition, cadmium is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5).

It should be noted here that the reason cadmium is predicted to be in groundwater is because the modeling assumed that the sediment sample is directly in contact with the underlying groundwater. Therefore, this evaluation concludes that the model-predicted concentrations are conservative and cadmium would be expected to be below its MCL based on accounting for the vertical leaching distance.

Chromium. The maximum sediment concentration for chromium (20.3 mg/kg) was below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1, and chromium was not identified as a sediment COC in the HHRA. Although chromium was detected in the AOC groundwater samples collected from 2009-2010, the maximum detection (0.0014 mg/L) was well below the MCL of 0.1 mg/L (Table 6-5).

Although the maximum detection of chromium in groundwater is well below the MCL, the conservative model that assumes an equilibrium partitioning between the sediment and groundwater provides a predicted maximum groundwater concentration beneath the source of 1.05 mg/L (i.e., above the MCL of 0.1 mg/L). Even with the results of this conservative model, predicted chromium concentrations beneath the source decrease to below its MCL after about 50 years and continue to decrease into the future. In addition, chromium is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5).

It should be noted here that the reason chromium is predicted to be in groundwater is because the modeling assumed that the sediment sample is directly in contact with the underlying groundwater. Therefore, this evaluation concludes that the model-predicted concentrations are conservative and chromium would be expected to be below its MCL based on accounting for the vertical leaching distance.

Cobalt. The maximum sediment concentration for cobalt (16 mg/kg) was well below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (803 mg/kg), and cobalt was not identified as a sediment COC in the HHRA. Although cobalt was detected in the AOC groundwater samples collected from 2009-2010, the maximum detection (0.0023 mg/L) was below its RSL of 0.006 mg/L (Table 6-5).

Although the maximum detection of cobalt in groundwater is well below the MCL, the conservative model that assumes an equilibrium partitioning between the sediment and groundwater provides a predicted maximum groundwater concentration beneath the source of 0.355 mg/L (i.e., above the RSL of 0.006 mg/L). Even with the results of this conservative model, cobalt is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5).

It should be noted here that the reason cobalt is predicted to be in groundwater is because the modeling assumed that the sediment sample is directly in contact with the underlying groundwater.

Therefore, this evaluation concludes that the model-predicted concentrations are conservative and cobalt would be expected to be below its RSL based on accounting for the vertical leaching distance.

Lead. Lead does not have a Resident Receptor Adult FWCUG for comparison. Lead was not identified as a sediment COPC in the HHRA. Lead was not detected in the AOC groundwater samples collected from 2009-2010 (Table 6-5).

Although lead was not detected in groundwater, the conservative model that assumes an equilibrium partitioning between the sediment and groundwater provides a predicted maximum groundwater concentration beneath the source of 0.042 mg/L (i.e., above the MCL of 0.015 mg/L). Even with the results of this conservative model, predicted lead concentrations beneath the source decrease to below its MCL within 10 years and continue to decrease into the future. In addition, lead is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5).

It should be noted here that the reason lead is predicted to be in groundwater is because the modeling assumed that the sediment sample is directly in contact with the underlying groundwater. Therefore, this evaluation concludes that the model-predicted concentrations are conservative and lead would be expected to be below its MCL based on accounting for the vertical leaching distance.

Mercury. The maximum sediment concentration for mercury (0.26 mg/kg) was below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (16.5 mg/kg), and mercury was not identified as a sediment COPC in the HHRA. Mercury was not detected in the AOC groundwater samples collected from 2009-2010 (Table 6-5).

Although mercury was not detected in groundwater, the conservative model that assumes an equilibrium partitioning between the sediment and groundwater provides a predicted maximum groundwater concentration beneath the source of 0.005 mg/L (i.e., above the MCL of 0.002 mg/L). Even with the results of this conservative model, predicted mercury concentrations beneath the source decrease to below its MCL after about the first five years and continue to decrease into the future. In addition, mercury is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5).

It should be noted here that the reason mercury is predicted to be in groundwater is because the modeling assumed that the sediment sample is directly in contact with the underlying groundwater. Therefore, this evaluation concludes that the model-predicted concentrations are conservative and mercury would be expected to be below its MCL based on accounting for the vertical leaching distance.

Nickel. The maximum sediment concentration for nickel (29.4 mg/kg) was below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (1,346 mg/kg), and nickel was not identified as a sediment COPC in the HHRA.

Although nickel was detected in the AOC groundwater samples collected from 2009-2010, the maximum detection (0.0077 mg/L) was below its RSL of 0.39 mg/L (Table 6-5). Although the maximum detection of nickel in groundwater is well below the RSL, the conservative model that assumes an equilibrium partitioning between the sediment and groundwater provides a predicted maximum groundwater concentration beneath the source of 0.452 mg/L (i.e., above the RSL of 0.39 mg/L). Even with the results of this conservative model, predicted nickel concentrations beneath the source decrease to below its RSL after about the first year and continue to decrease into the future. In addition, nickel is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5).

It should be noted here that the reason nickel is predicted to be in groundwater is because the modeling assumed that the sediment sample is directly in contact with the underlying groundwater. Therefore, this evaluation concludes that the model-predicted concentrations are conservative and nickel would be expected to be below its RSL based on accounting for the vertical leaching distance.

Selenium. Selenium was detected above background in sediment in only two of five samples, and does not have a Resident Receptor Adult FWCUG for comparison. Selenium was not identified as a sediment COPC in the HHRA. Although selenium was detected in the AOC groundwater samples collected from 2009-2010, the maximum detection (0.0048 mg/L) was below its MCL of 0.05 mg/L (Table 6-5).

Although the maximum detection of selenium in groundwater is well below the MCL, the conservative model that assumes an equilibrium partitioning between the sediment and groundwater provides a predicted maximum groundwater concentration beneath the source of 0.458 mg/L (i.e., above the MCL of 0.05 mg/L). Even with the results of this conservative model, predicted selenium concentrations beneath the source decrease to below its MCL after about 35 years and continue to decrease into the future. In addition, selenium is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5).

It should be noted here that the reason selenium is predicted to be in groundwater is because the modeling assumed that the sediment sample is directly in contact with the underlying groundwater. Therefore, this evaluation concludes that the model-predicted concentrations are conservative and selenium would be expected to be below its MCL based on accounting for the vertical leaching distance.

Benz(a)anthracene. The maximum sediment concentration for benz(a)anthracene (0.1 mg/kg) was below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (0.221 mg/kg), and benz(a)anthracene was not identified as a sediment COC in the HHRA. Benz(a)anthracene was not detected in the AOC groundwater samples collected from 2009-2010 (Table 6-5).

Although benz(a)anthracene was not detected in groundwater, the conservative model that assumes an equilibrium partitioning between the sediment and groundwater provides a predicted maximum groundwater concentration beneath the source of 0.00047 mg/L (i.e., above the RSL of 0.000012 mg/L). Even with the results of this conservative model, benz(a)anthracene is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5).

It should be noted here that the reason benz(a)anthracene is predicted to be in groundwater is because the modeling assumed that the sediment sample is directly in contact with the underlying groundwater and that no biodegradation is occurring. Therefore, this evaluation concludes that the model-predicted concentrations are conservative and benz(a)anthracene would be expected to be below its RSL based on its estimated site-specific biodegradation rate and accounting for the vertical leaching distance and its estimated site-specific biodegradation rate.

Benzo(b)fluoranthene. The maximum sediment concentration for benzo(b)fluoranthene (0.18 mg/kg) was below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (0.221 mg/kg), and benzo(b)fluoranthene was not identified as a sediment COPC in the HHRA. Benzo(b)fluoranthene was not detected in the AOC groundwater samples collected from 2009-2010 (Table 6-5).

Although benzo(b)fluoranthene was not detected in groundwater, the conservative model that assumes an equilibrium partitioning between the sediment and groundwater provides a predicted maximum groundwater concentration beneath the source of 0.00025 mg/L (i.e., above the RSL of 0.000034 mg/L). Even with the results of this conservative model, predicted benzo(b)fluoranthene concentrations beneath the source decrease to below its RSL after about 50 years and continue to decrease into the future. In addition, benzo(b)fluoranthene is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5).

It should be noted here that the reason benzo(b)fluoranthene is predicted to be in groundwater is because the modeling assumed that the sediment sample is directly in contact with the underlying groundwater and that no biodegradation is occurring. Therefore, this evaluation concludes that the model-predicted concentrations are conservative and benzo(b)fluoranthene would be expected to be below its RSL based on accounting for the vertical leaching distance and its estimated site-specific biodegradation rate.

Naphthalene. The maximum sediment concentration for naphthalene (0.014 mg/kg) was below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (368 mg/kg), and naphthalene was not identified as a sediment COPC in the HHRA. Naphthalene was not detected in the AOC groundwater samples collected from 2009-2010 (Table 6-5).

Although naphthalene was not detected in groundwater, the conservative model that assumes an equilibrium partitioning between the sediment and groundwater provides a predicted maximum groundwater concentration beneath the source of 0.0076 mg/L (i.e., above the RSL of 0.00017 mg/L). Even with the results of this conservative model, predicted naphthalene concentrations beneath the source decrease to below the RSL after about 100 years and continue to decrease into the future. Although naphthalene migrates to the downgradient receptor location in about 250 years, it is not predicted to be above the RSL within 1,000 years (Table 6-5).

It should be noted here that the reason naphthalene is predicted to be in groundwater is because the modeling assumed that the sediment sample is directly in contact with the underlying groundwater and that no biodegradation is occurring. Therefore, this evaluation concludes that the model-predicted concentrations are highly conservative and naphthalene would be expected to be below its RSL based on accounting for the vertical leaching distance and its estimated site-specific biodegradation rate.

4,4’-DDE. The maximum sediment concentration for 4,4’-DDE (0.023 mg/kg) was below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (4.08 mg/kg), and 4,4’-DDE was not identified as a sediment COPC in the HHRA. 4,4’-DDE was not detected in the AOC groundwater samples collected from 2009-2010 (Table 6-5).

Although 4,4’-DDE was not detected in groundwater, the conservative model that assumes an equilibrium partitioning between the sediment and groundwater provides a predicted maximum groundwater concentration beneath the source of 0.00016 mg/L (i.e., above the RSL of 0.000046 mg/L). Even with the results of this conservative model, predicted 4,4’-DDE concentrations beneath the source decrease to below its RSL after 12 years and continue to decrease into the future. In addition, 4,4’-DDE is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5).

It should be noted here that the reason 4,4’-DDE is predicted to be in groundwater is because the modeling assumed that the sediment sample is directly in contact with the underlying groundwater and that no biodegradation is occurring. Therefore, this evaluation concludes that the model-predicted concentrations are highly conservative and 4,4’-DDE would be expected to be below its RSL based on accounting for the vertical leaching distance and its estimated site-specific biodegradation rate.

This qualitative assessment concludes that the soil and sediment contaminants identified as CMCOCs for evaluation, due to predicted groundwater concentrations beneath a source only (none of the CMCOCs migrate to the downgradient receptor location at concentrations exceeding their respective MCLs/RSLs), 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 were not identified for Load Line 8, 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 8. 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 8 were evaluated through the stepwise fate and transport evaluation. Evaluation of modeling results with respect to current AOC groundwater data and model limitations identified the following CMCOPCs for soil and sediment:

- Arsenic, selenium, and naphthalene in soil were predicted to exceed the screening criteria in groundwater beneath the source area; however, none of these constituents were predicted to exceed the screening criteria in groundwater at the downgradient receptor location.
- Barium; cadmium; chromium; cobalt; lead; mercury; nickel; selenium; benz(a)anthracene; benzo(b)fluoranthene; naphthalene; and 4,4'-DDE in sediment were predicted to exceed the screening criteria in groundwater beneath the source area; however, none 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 8 that may potentially impact groundwater at Load Line 8 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

SRC	Maximum Concentration (mg/kg)	Discrete or ISM Sample Location	Sample Depth (ft bgs)	Leachate Modeling? (Yes/No)
Inorganic chemicals				
Arsenic	2.69E+01	LL8sb-060-5348-SO	4-7	Yes
Selenium	1.60E+00	LL8sb-065-5368-SO	4-7	Yes
Semi-volatile organic compounds				
Naphthalene	2.60E-01	LL8ss-072M-5387-SO	0-1	Yes
PCBs/Pesticides				
beta-BHC	2.70E-03	LL8ss-005M-SO	0-1	Yes

bgs = Below ground surface.
BHC = Hexachlorocyclohexane.
CMCOPC = Contaminant migration chemical of potential concern.
Ft = Feet.
ISM = Incremental sampling methodology.
mg/kg = Milligrams per kilogram.
PCB = Polychlorinated biphenyl.
SESOIL = Seasonal Soil Compartment Model.
SRC = Site-related contaminant.

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Table 6–2. Sediment Screening Results for Load Line 8

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)
Inorganic Chemicals														
Aluminum	7429-90-5	1.39E+04	1.57E+04	LL8sd-090-5378-SD	NA	-	1.50E+03	f	1.05E+01	1	1.05E+01	2.00E+01	RSL	No
Barium	**7440-39-3**	**1.23E+02**	**1.40E+02**	**LL8sd-002M-SD**	**NA**	**-**	**4.10E+01**	**f**	**3.41E+00**	**1**	**3.41E+00**	**2.00E+00**	**MCL**	**Yes**
Beryllium	7440-41-7	3.80E-01	1.30E+00	LL8sd-001M-SD, LL8sd-002M-SD	NA	-	7.90E+02	f	1.65E-03	1	1.65E-03	4.00E-03	MCL	No
Cadmium	**7440-43-9**	**0.00E+00**	**2.60E+00**	**LL8sd-003M-SD**	**NA**	**-**	**7.50E+01**	**f**	**3.47E-02**	**1**	**3.47E-02**	**5.00E-03**	**MCL**	**Yes**
Chromium	**7440-47-3**	**1.81E+01**	**2.03E+01**	**LL8ss-089M-5404-SO**	**NA**	**-**	**1.90E+01**	**f**	**1.07E+00**	**1**	**1.07E+00**	**1.00E-01**	**MCL**	**Yes**
Cobalt	**7440-48-4**	**9.10E+00**	**1.60E+01**	**LL8sd-002M-SD**	**NA**	**-**	**4.50E+01**	**f**	**3.56E-01**	**1**	**3.56E-01**	**6.00E-03**	**RSL**	**Yes**
Lead	**7439-92-1**	**2.74E+01**	**3.80E+01**	**LL8sd-001M-SD**	**NA**	**-**	**9.00E+02**	**f**	**4.22E-02**	**1**	**4.22E-02**	**1.50E-02**	**MCL**	**Yes**
Mercury	**7439-97-6**	**5.90E-02**	**2.60E-01**	**LL8sd-002M-SD**	**NA**	**-**	**5.20E+01**	**f**	**5.00E-03**	**1**	**5.00E-03**	**2.00E-03**	**MCL**	**Yes**
Nickel	**7440-02-0**	**1.77E+01**	**2.94E+01**	**LL8ss-089M-5404-SO**	**NA**	**-**	**6.50E+01**	**f**	**4.52E-01**	**1**	**4.52E-01**	**3.90E-01**	**RSL**	**Yes**
Selenium	**7782-49-2**	**1.70E+00**	**2.30E+00**	**LL8sd-001M-SD**	**NA**	**-**	**5.00E+00**	**f**	**4.60E-01**	**1**	**4.60E-01**	**5.00E-02**	**MCL**	**Yes**
Silver	7440-22-4	0.00E+00	1.80E-02	LL8sd-090-5378-SD	NA	-	8.30E+00	f	2.17E-03	1	2.17E-03	9.40E-02	RSL	No
Explosives														
Nitrocellulose	9004-70-0	None	1.10E+00	LL8sd-004M-SD	1.00E+01	f	1.20E-02	**g**	9.17E+01	1	9.17E+01	6.00E+04	RSL	No
Tetryl	479-45-8	None	1.40E-02	LL8ss-089M-5404-SO	4.61E+03	f	5.53E+00	**g**	2.53E-03	1	2.53E-03	3.90E-02	RSL	No
Semi-volatile Organic Compounds														
Benz(*a*)anthracene	**56-55-3**	**None**	**1.00E-01**	**LL8sd-001M-SD**	**1.77E+05**	**f**	**2.12E+02**	**g**	**4.71E-04**	**1**	**4.71E-04**	**1.20E-05**	**RSL**	**Yes**
Benzo(*a*)pyrene	50-32-8	None	9.20E-02	LL8sd-001M-SD	5.87E+05	f	7.05E+02	g	1.31E-04	1	1.31E-04	2.00E-04	MCL	No
Benzo(*b*)fluoranthene	**205-99-2**	**None**	**1.80E-01**	**LL8sd-001M-SD**	**5.99E+05**	**f**	**7.19E+02**	**g**	**2.50E-04**	**1**	**2.50E-04**	**3.40E-05**	**RSL**	**Yes**
Benzo(*ghi*)perylene[d]	191-24-2	None	1.20E-01	LL8sd-001M-SD	1.07E+07	h	1.28E+04	g	9.35E-06	1	9.35E-06	1.20E-01	RSL	No
Benzo(*k*)fluoranthene	207-08-9	None	7.90E-02	LL8sd-001M-SD	5.87E+05	f	7.05E+02	g	1.12E-04	1	1.12E-04	3.40E-04	RSL	No
Chrysene	218-01-9	None	1.10E-01	LL8sd-001M-SD	1.81E+05	f	2.17E+02	g	5.08E-04	1	5.08E-04	3.40E-03	RSL	No
Fluoranthene	206-44-0	None	1.60E-01	LL8sd-001M-SD	5.55E+04	f	6.65E+01	g	2.40E-03	1	2.40E-03	8.00E-01	RSL	No
Indeno(1,2,3-*cd*)pyrene	193-39-5	None	6.40E-02	LL8sd-001M-SD	1.95E+06	f	2.34E+03	g	2.73E-05	1	2.73E-05	3.40E-05	RSL	No
Naphthalene	**91-20-3**	**None**	**1.40E-02**	**LL8ss-089M-5404-SO**	**1.54E+03**	**f**	**1.85E+00**	**g**	**7.58E-03**	**1**	**7.58E-03**	**1.70E-04**	**RSL**	**Yes**
Phenanthrene[e]	85-01-8	None	5.90E-02	LL8sd-001M-SD	1.82E+04	h	2.18E+01	g	2.70E-03	1	2.70E-03	1.20E-01	RSL	No
Pyrene	129-00-0	None	1.60E-01	LL8sd-001M-SD	5.43E+04	f	6.52E+01	g	2.45E-03	1	2.45E-03	1.20E-01	RSL	No
Volatile Organic Compounds														
Toluene	108-88-3	None	5.90E-04	LL8sd-091-5379-SD	2.34E+02	f	2.81E-01	g	2.10E-03	2	1.05E-03	1.00E+00	MCL	No
Pesticides/PCBs														
4,4'-DDD	72-54-8	None	1.50E-03	LL8sd-001M-SD	1.18E+05	f	1.41E+02	g	1.06E-05	1	1.06E-05	3.10E-05	RSL	No
4,4'-DDE	**72-55-9**	**None**	**2.30E-02**	**LL8sd-001M-SD**	**1.18E+05**	**f**	**1.41E+02**	**g**	**1.63E-04**	**1**	**1.63E-04**	**4.60E-05**	**RSL**	**Yes**
4,4'-DDT	50-29-3	None	6.50E-03	LL8sd-001M-SD	1.69E+05	f	2.0E+02	g	3.21E-05	1	3.21E-05	2.30E-04	RSL	No

[a] Background criteria for sediment from final facility-wide background values for the 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 exposure unit-specific DAF was calculated by dividing the calculated groundwater concentration by the co-located surface water concentration. The lowest calculated DAF for each co-located sample location (i.e., 1 for all incremental sampling methodology areas and locations LL8sd-090 and 2 for LL8sd-091) was used for analytes that did not have an exposure unit-specific DAF.

[d] Pyrene RSL was used as a surrogate for benzo(*ghi*)perylene.

[e] Pyrene RSL was used as a surrogate for phenanthrene.

[f] U.S. Environmental Protection Agency (USEPA) RSL generic tables June 2015; found at: < http://www2.epa.gov/risk/risk-based-screening-table-generic-tables>.

[g] K_d value for organic chemicals calculated by multiplying K_{oc} by foc of 0.0012 (average geotechnical data from Load Line 7, Load Line 10, and Load Line 11).

[h] USEPA 1994. Risk Reduction Engineering Laboratory Treatability Database, Ver. 5.0, Office of Research and Development, Cincinnati, Ohio.

CAS = Chemical Abstract Service.
CMCOPC = Contaminant migration chemical of potential concern.
DAF = Dilution attenuation factor.
DDD = Dichlorodiphenyldichloroethane.
DDE = Dichlorodiphenyldichloroethylene.
DDT = Dichlorodiphenyltrichloroethane.
ID = Identification.
K_d = Distribution coefficient.
K_{oc} = Organic carbon distribution coefficient.
L/kg = Liters per kilogram.
MCL = Maximum contaminant level.
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 model.

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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	1.20E-03	Average from the PBA08 RI Geotechnical Samples from Load Lines 7, 10, and 11
Bulk Density	ρ_b	kg/L	1.7	
Moisture Content	w	wt %	18.3	
Water-filled Soil Porosity	Tw	unitless	0.311	
Air-filled Soil Porosity	Ta	unitless	0.068	
Porosity – total	n_T	unitless	0.379	
Vadose Zone Thickness	Vz	m	1.8 to 3.7	Based on average ground surface elevation and depth to water table from Figure 3-1
Leaching Zone Thickness	Th	m	0.3 to 3.4	Based on vadose zone thickness and results for CMCOPCs in soil
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	2.04E-04	Average K from Table 3-1 for LL8mw-001 through LL8mw-004 of Load Line 8
Hydraulic Gradient	i	unitless	5.80E-03	Average gradient determined from Figure 3-1

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 α_L
Dispersivity, vertical	α_V	m	0.3	0.01 α_L
Retardation factor	R_d	unitless	chemical-specific	Presented in Table E-7 in Appendix E

USACE 2003b. Phase II Remedial Investigation Report for the Load Line 1 at the Ravenna Army Ammunition Plant, Ravenna, Ohio. June 2003.

USEPA 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.
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 bb percent.

Table 6–4. Summary of SESOIL Modeling Results

Initial CMCOPC	Maximum Soil Concentration (mg/kg)	Discrete Sample Location	Maximum Depth of Contamination (ft bgs)	Depth to Groundwater (ft bgs)	Predicted $C_{L, max}$ Beneath Source (mg/L)	Time Required to Reach $C_{L, max}$ (years)	MCL/RSL (mg/L)	Resident Receptor Adult FWCUG[a] (mg/L)	Facility-wide Background Unconsolidated Groundwater (mg/L)	Final CMCOPC?[b] (yes/no)
Inorganic Chemicals										
Arsenic	**2.69E+01**	**LL8sb-060-5348-SO**	**9.0**	**9.0**	**8.80E-01**	**251**	**1.00E-02**	**5.60E-05**	**1.17E-02**	**Yes**
Selenium	**1.60E+00**	**LL8sb-065-5368-SO**	**7.0**	**8.0**	**3.99E-01**	**51**	**5.00E-02**	**None**	**0.00E+00**	**Yes**
Semi-volatile Organic Compounds										
Naphthalene	**2.60E-01**	**LL8ss-072M-5387-SO**	**1.0**	**12.0**	**1.91E-02**	**67**	**1.70E-04**	**None**	**None**	**Yes**
PCBs/Pesticides										
beta-BHC	**2.70E-03**	**LL8ss-005M-SO**	**1.0**	**12.0**	**1.35E-04**	**119**	**2.50E-05**	**4.70E-05**	**None**	**Yes**

[a] The facility-wide cleanup goal (FWCUG) is based on a target risk of 10^{-6} and a hazard quotient of 0.1.

[b] The final CMCOPC was identified comparing predicted maximum leachate concentration to MCL/RSL, FWCUGs, and facility-wide background. A constituent is an initial 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.
BHC = Hexachlorocyclohexane.
ft = Feet.
MCL= Maximum contaminant level.
$C_{L, max}$ =Maximum leachate concentration
mg/kg = Milligram per kilogram.
mg/L = Milligram per liter.
PCB = Polychlorinated biphenyl.
RSL=Regional screening level.
SESOIL = Seasonal soil compartment model.
Bold = CMCOPCs exceeding MCL/RSL, FWCUGs, and facility-wide background concentrations.

Table 6–5. Summary of AT123D Modeling Results

Final CMCOPC	Maximum Leachate Concentration, $C_{L, max}$ [a] (mg/L)	Predicted Max Groundwater Concentration[b] ($C_{gw,MAX}$) Beneath Source (mg/L)	Predicted Max Groundwater Concentration[b] ($C_{R,MAX}$) Downgradient Receptor (mg/L)	Distance to Downgradient Receptor (ft)	Observed Maximum Groundwater Concentrations[c] (mg/L)	MCL/RSL (mg/L)	Resident Receptor Adult FWCUG[d] (mg/L)	Facility-wide Background Unconsolidated Groundwater (mg/L)	CMCOC for Further WOE Evaluation?[e] (yes/no)
Final CMCOPCs in Soil									
Inorganic chemicals									
Arsenic	8.80E-01	6.56E-01	0.00E+00	1,340	3.60E-03	1.00E-02	5.60E-05	1.17E-02	Yes
Selenium	3.99E-01	2.14E-01	6.52E-06	725	4.80E-03	5.00E-02	None	0.00E+00	Yes
Semi-volatile Organic Compounds									
Naphthalene	1.91E-02	1.07E-02	5.93E-06	1,048	ND	1.70E-04	None	None	Yes
Pesticides/PCBs									
beta-BHC	1.35E-04	1.52E-05	0.00E+00	1,090	2.30E-05	2.50E-05	4.70E-05	None	No
Final CMCOPCs in Sediment									
Inorganic chemicals									
Barium	3.41E+00	3.40E+00	0.00E+00	1,053	4.09E-02	2.00E+00	7.06E-01	8.21E-02	Yes
Cadmium	3.47E-02	3.46E-02	0.00E+00	534	ND	5.00E-03	1.47E-03	0.00E+00	Yes
Chromium	1.07E+00	1.05E+00	0.00E+00	832	1.40E-03	1.00E-01	3.69E+00	7.30E-03	Yes
Cobalt	3.56E-01	3.55E-01	0.00E+00	1,053	2.30E-03	6.00E-03	7.29E-02	0.00E+00	Yes
Lead	4.22E-02	4.21E-02	0.00E+00	994	ND	1.50E-02	None	0.00E+00	Yes
Mercury	5.00E-03	4.99E-03	0.00E+00	1,053	ND	2.00E-03	None	0.00E+00	Yes
Nickel	4.52E-01	4.52E-01	0.00E+00	832	7.70E-03	3.90E-01	7.29E-02	0.00E+00	Yes
Selenium	4.60E-01	4.58E-01	2.01E-09	994	4.80E-03	5.00E-02	None	0.00E+00	Yes
Semi-volatile Organic Compounds									
Benz(a)anthracene	4.71E-04	4.70E-04	0.00E+00	994	ND	1.20E-05	4.00E-06	None	Yes
Benzo(b)fluoranthene	2.50E-04	2.49E-04	0.00E+00	994	ND	3.40E-05	2.00E-06	None	Yes
Naphthalene	7.58E-03	7.58E-03	3.64E-06	832	ND	1.70E-04	None	None	Yes

Table 6–5. Summary of AT123D Modeling Results (continued)

Final CMCOPC	Maximum Leachate Concentration, $C_{L,\ max}$ [a] (mg/L)	Predicted Max Groundwater Concentration[b] ($C_{gw,MAX}$) Beneath Source (mg/L)	Predicted Max Groundwater Concentration[b] ($C_{R,MAX}$) Downgradient Receptor (mg/L)	Distance to Downgradient Receptor (ft)	Observed Maximum Groundwater Concentrations[c] (mg/L)	MCL/RSL (mg/L)	Resident Receptor Adult FWCUG[d] (mg/L)	Facility-wide Background Unconsolidated Groundwater (mg/L)	CMCOC for Further WOE Evaluation?[e] (yes/no)
Pesticides/PCBs									
4,4’-DDE	1.63E-04	1.63E-04	0.00E+00	994	ND	4.60E-05	4.70E-05	None	Yes

[a] Represents seasonal soil compartment model (SESOIL) predicted maximum leachate concentration just above the water table for soil CMCOPCs and the maximum groundwater concentration divided by the dilution attenuation factor for sediment CMCOPCs.

[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 through 2010.

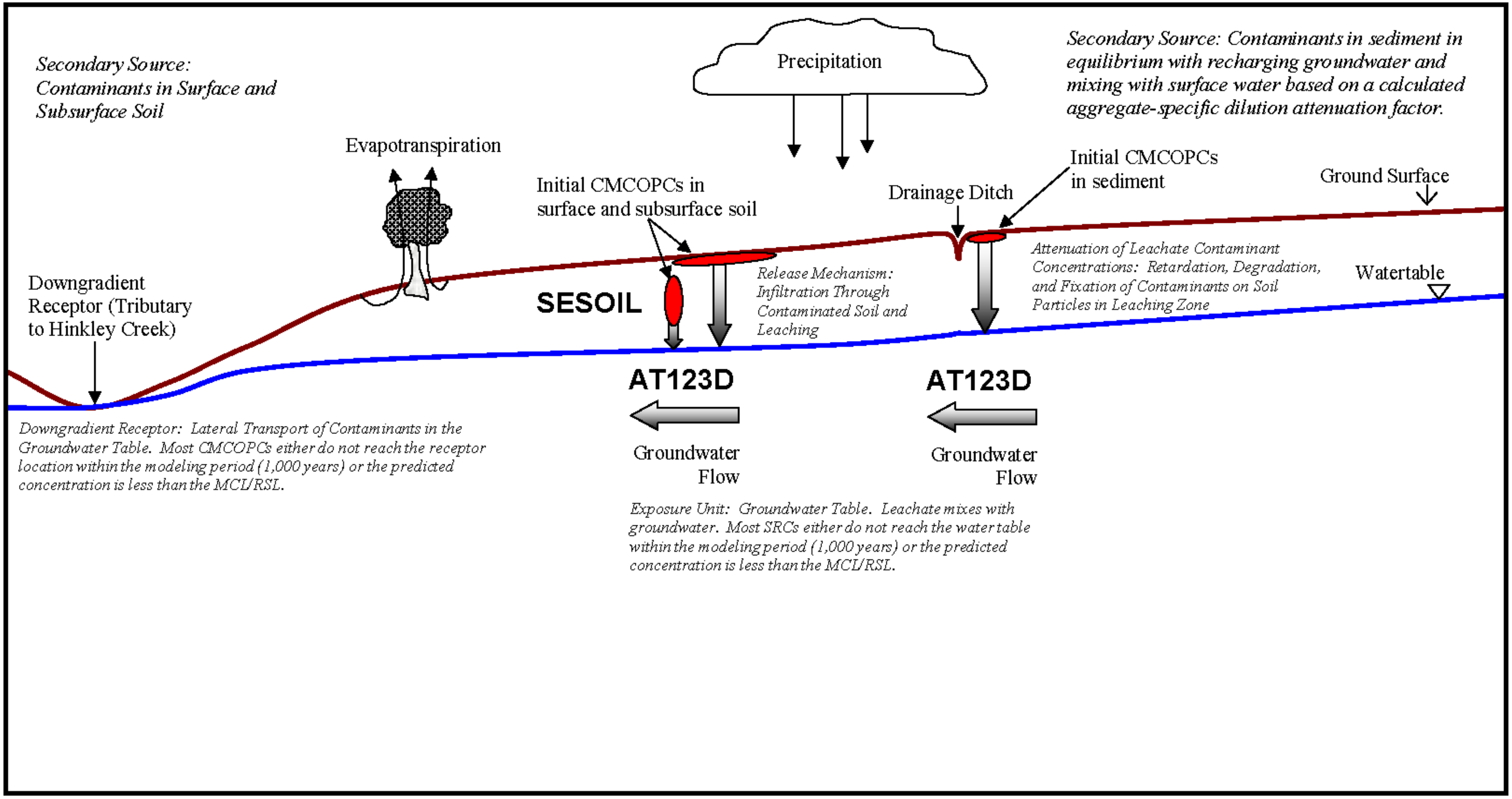
[d] The Resident Receptor Adult FWCUG is based on a target risk of 10^{-6} and a hazard quotient of 0.1.

[e] The CMCOC was identified by comparing predicted concentration in groundwater beneath the source 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.
$C_{L,\ max}$ =Maximum leachate concentration
$C_{R,\ max}$ =Maximum groundwater concentration
Ft = Feet.
FWCUG = Facility-wide cleanup goal.
MCL = Maximum contaminant level.
mg/L = Milligrams per liter.
ND = Not detected.
BHC = hexachlorocyclohexane
DDE = Dichlorodiphenyldichloroethylene.
RSL = Regional screening level.
WOE = Weight-of-evidence.

Not to scale



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 Soil 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

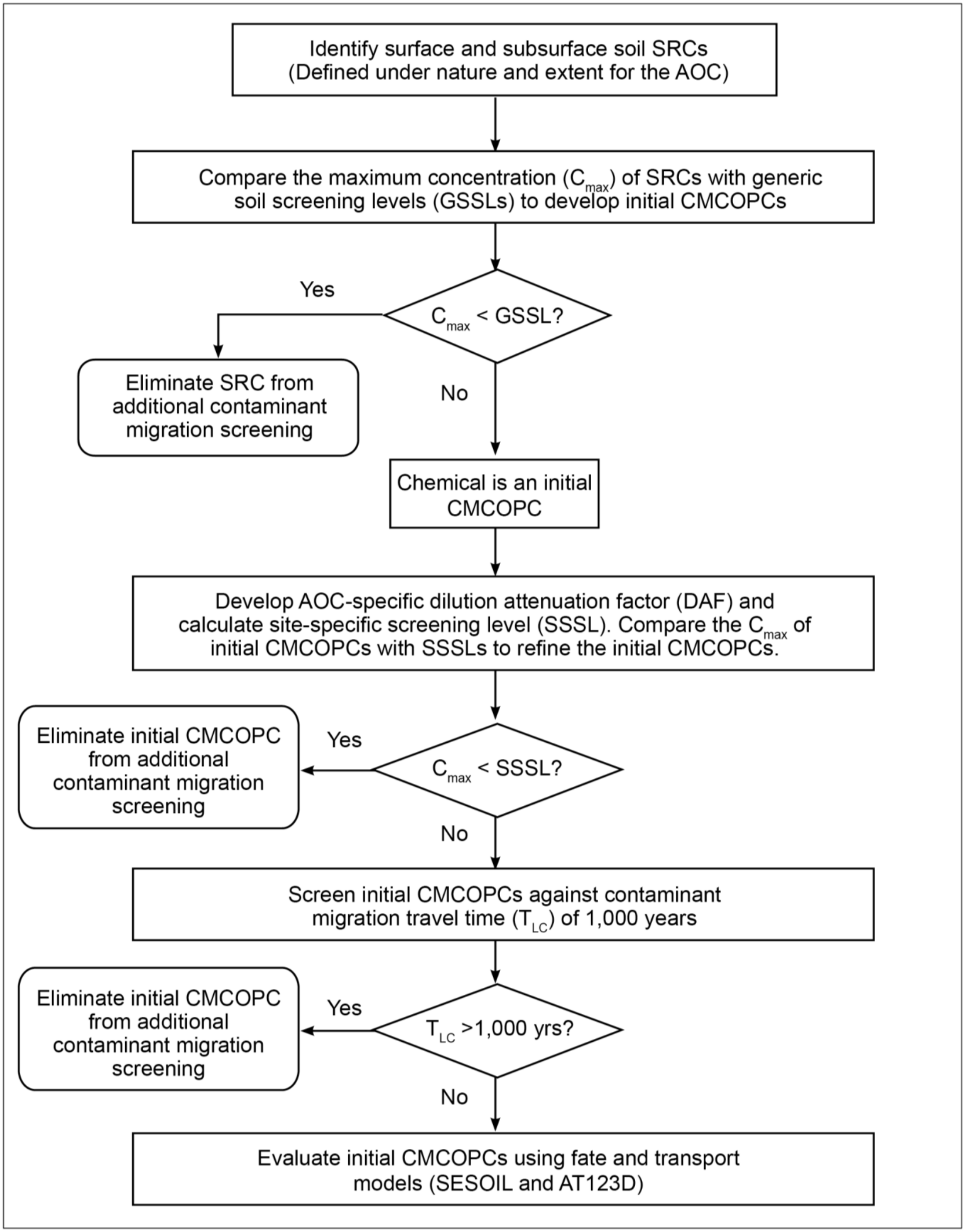


Figure 6-2. Initial CMCOPCs Identified in Soil Screening Analysis for SESOIL Evaluation

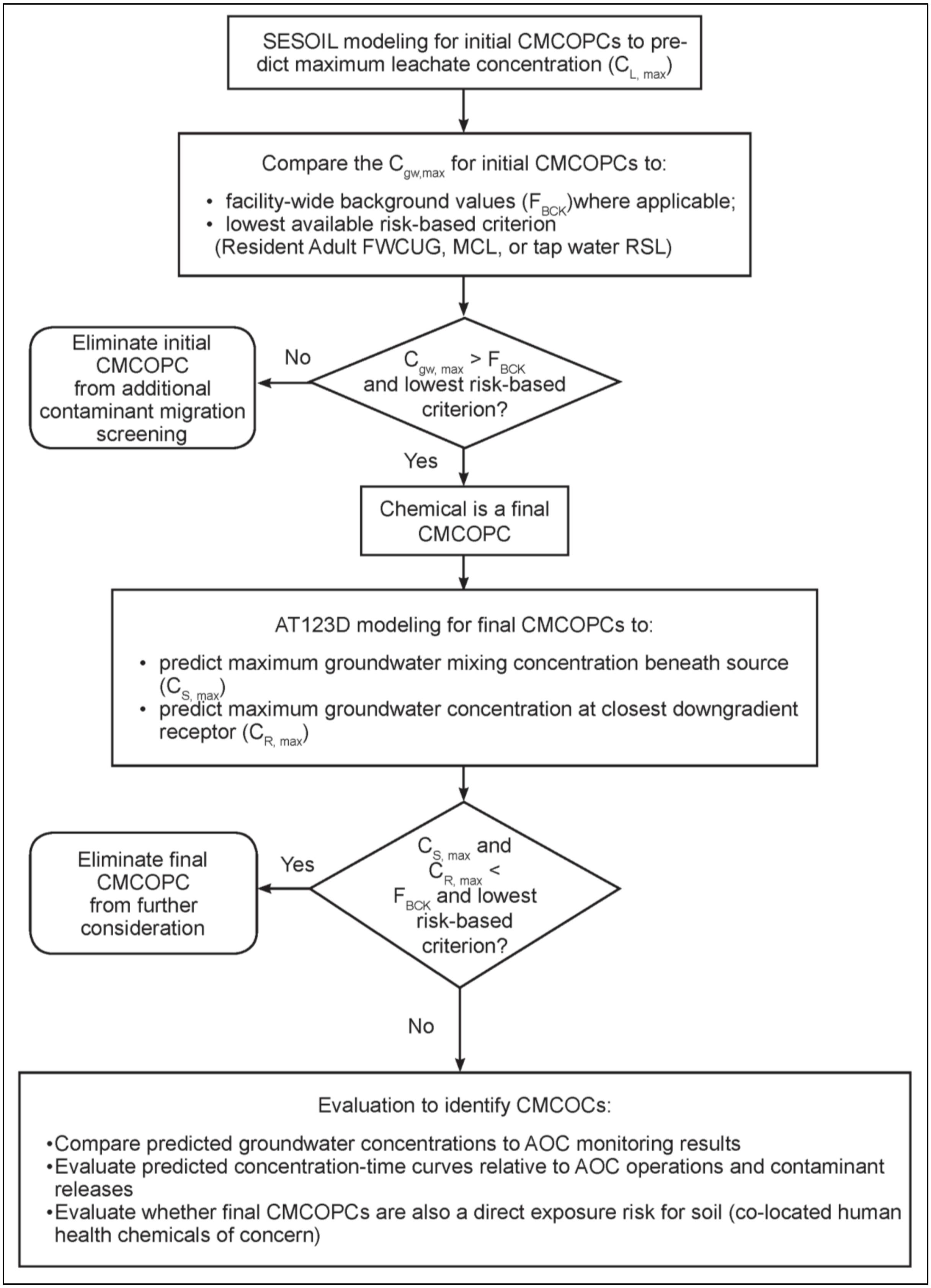


Figure 6-2. Initial CMCOPCs Identified in Soil Screening Analysis for SESOIL Evaluation (continued)

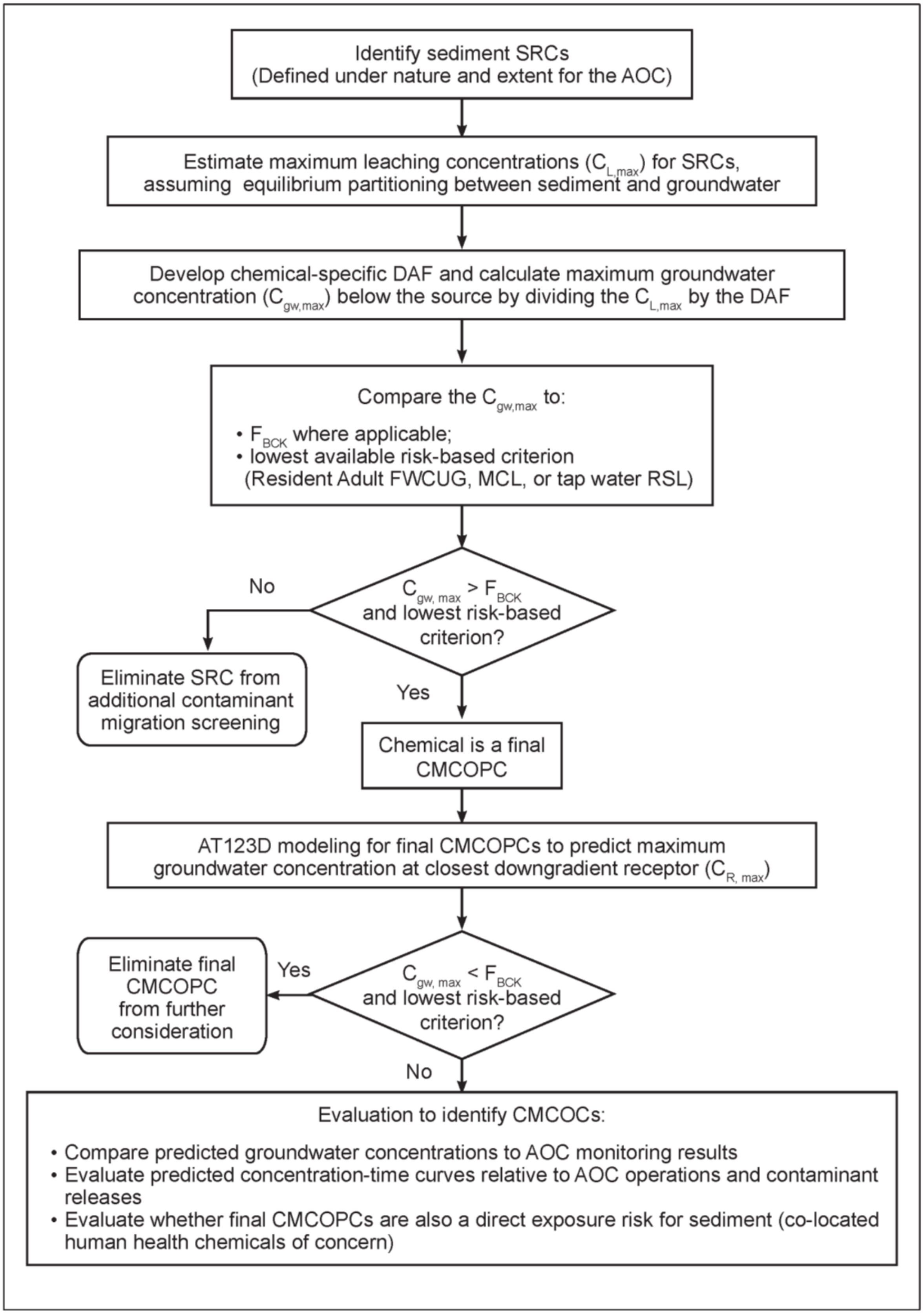


Figure 6-3. AOC Fate and Transport Modeling Approach - Sediment

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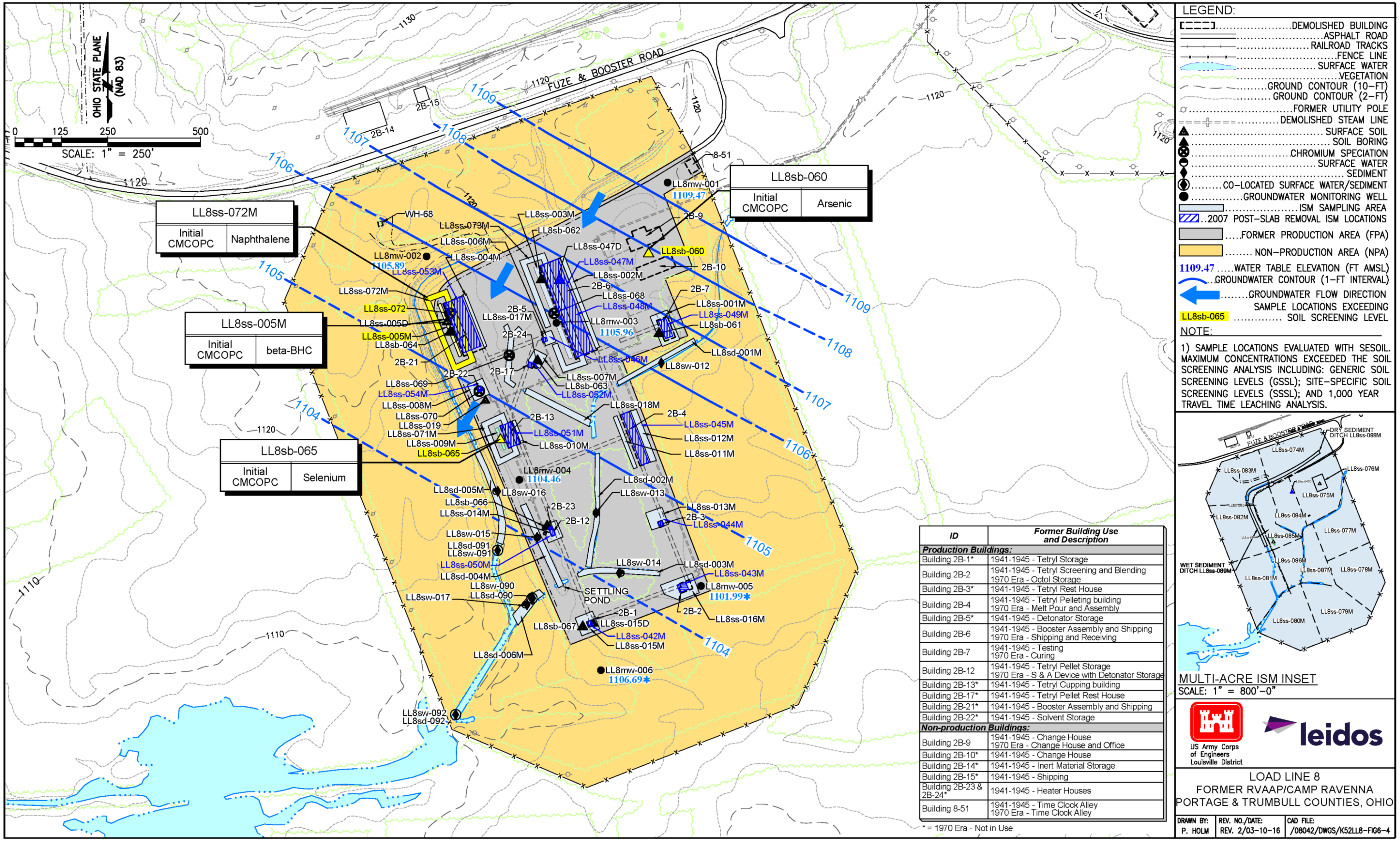
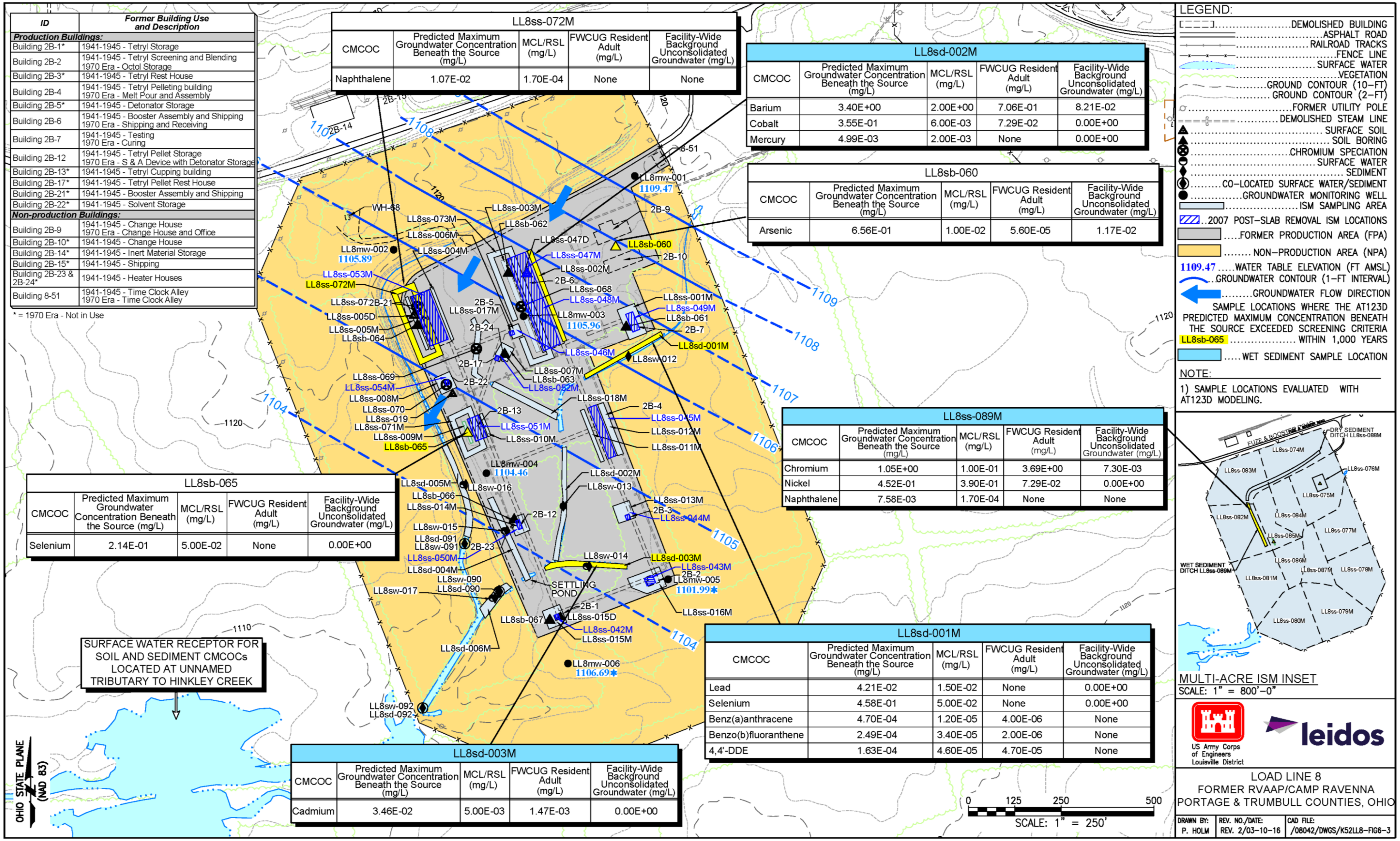


ID	Former Building Use and Description
Production Buildings:	
Building 2B-1*	1941-1945 - Tetryl Storage
Building 2B-2	1941-1945 - Tetryl Screening and Blending 1970 Era - Octol Storage
Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

Figure 6–4. Initial CMCOPCs Identified in Soil Screening Analysis for SESOIL Evaluation



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Building 2B-3*	1941-1945 - Tetryl Rest House
Building 2B-4	1941-1945 - Tetryl Pelleting building 1970 Era - Melt Pour and Assembly
Building 2B-5*	1941-1945 - Detonator Storage
Building 2B-6	1941-1945 - Booster Assembly and Shipping 1970 Era - Shipping and Receiving
Building 2B-7	1941-1945 - Testing 1970 Era - Curing
Building 2B-12	1941-1945 - Tetryl Pellet Storage 1970 Era - S & A Device with Detonator Storage
Building 2B-13*	1941-1945 - Tetryl Cupping building
Building 2B-17*	1941-1945 - Tetryl Pellet Rest House
Building 2B-21*	1941-1945 - Booster Assembly and Shipping
Building 2B-22*	1941-1945 - Solvent Storage
Non-production Buildings:	
Building 2B-9	1941-1945 - Change House 1970 Era - Change House and Office
Building 2B-10*	1941-1945 - Change House
Building 2B-14*	1941-1945 - Inert Material Storage
Building 2B-15*	1941-1945 - Shipping
Building 2B-23 & 2B-24*	1941-1945 - Heater Houses
Building 8-51	1941-1945 - Time Clock Alley 1970 Era - Time Clock Alley

* = 1970 Era - Not in Use

LL8ss-072M

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Resident Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Naphthalene	1.07E-02	1.70E-04	None	None

LL8sd-002M

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Resident Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Barium	3.40E+00	2.00E+00	7.06E-01	8.21E-02
Cobalt	3.55E-01	6.00E-03	7.29E-02	0.00E+00
Mercury	4.99E-03	2.00E-03	None	0.00E+00

LL8sb-060

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Resident Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Arsenic	6.56E-01	1.00E-02	5.60E-05	1.17E-02

LL8ss-089M

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Resident Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Chromium	1.05E+00	1.00E-01	3.69E+00	7.30E-03
Nickel	4.52E-01	3.90E-01	7.29E-02	0.00E+00
Naphthalene	7.58E-03	1.70E-04	None	None

LL8sb-065

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Resident Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Selenium	2.14E-01	5.00E-02	None	0.00E+00

LL8sd-001M

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Resident Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Lead	4.21E-02	1.50E-02	None	0.00E+00
Selenium	4.58E-01	5.00E-02	None	0.00E+00
Benz(a)anthracene	4.70E-04	1.20E-05	4.00E-06	None
Benzo(b)fluoranthene	2.49E-04	3.40E-05	2.00E-06	None
4,4'-DDE	1.63E-04	4.60E-05	4.70E-05	None

LL8sd-003M

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Resident Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Cadmium	3.46E-02	5.00E-03	1.47E-03	0.00E+00

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 to use for the HHRA and ERA. Load Line 8 data were evaluated to establish data aggregates and identify a list of SRCs.

7.1.1 Data Aggregates

Section 4.0 provides a summary of available data. Data collected at Load Line 8 were grouped (aggregated) by environmental medium and exposure depth (e.g., surface soil), EU, and sample type (i.e., discrete or ISM). 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. A description of the data aggregates for the media for which human and ecological receptors are potentially exposed are provided in the following sections followed by a summary of SRCs.

7.1.1.1 Soil Data

EUs were established at Load Line 8 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 extent of potential contamination within a given area. In establishing EUs at Load Line 8, 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 2-3.
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, surface soil (0–1 ft bgs) ISM samples collected during the November 2004 Characterization of 14 AOCs (MKM 2007), August 2007 Investigation of Under Slab Surface Soil (USACE 2009a), and March and October 2010 for the PBA08 RI were used to characterize surface soil. The buildings at Load Line 8 were demolished and removed in 2006, after the 2004 Characterization of 14 AOCs. Soil in the vicinity of the former production buildings was extensively disturbed during building demolition activities). It is likely that some of the areas sampled during the 2004 Characterization of 14 AOCs were disturbed during demolition activities. The 2007 surface soil data consist of samples collected during the Investigation of Under Slab Surface Soil (USACE 2009a) from the footprint areas of the former buildings following demolition. For surface soil ISM samples, each sample result was evaluated as an individual decision unit. VOCs and hexavalent chromium speciation were evaluated using results from discrete soil samples. All other discrete surface soil samples collected in 2010 were not used for risk assessment screening purposes because (1) the entire AOC was sampled using ISM, (2) all discrete samples were collected from within the area of small ISM sampled areas, and (3) ISM and discrete data should not be combined into a single statistical analysis. For surface soil ISM samples, each sample result was evaluated as an individual decision unit. Discrete sample data were used to supplement the evaluation of ISM results and are included in the uncertainty assessment.

- 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 March 2010 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 Sediment and Surface Water Data

Surface water drainage at Load Line 8 generally follows the topography at the AOC, flowing into ditch conveyances and along the north and west side of the production area (Figure 3-1). The surface drainage flows toward an unnamed perennial stream located at the southwest corner of the AOC and flows west to Hinkley Creek.

Three co-located surface water and discrete sediment samples at locations LL8sd/sw-090, LL8sd/sw-091, LL8sd/sw-092 collected in 2010 from the ditches in the southwest portion of Load Line 8 where surface water exits the AOC, were used to characterize risk from exposure to chemicals in these media. Six ISM sediment samples collected in 2004 from the ditches inside the production area at Load Line 8 and one ISM sediment sample collected in 2010 from the ditch along the west side of the production area were also used to characterize risk from exposure to chemicals in sediment. It is inappropriate to combine the ISM and discrete sample data due to different levels of variability in these two data types. Therefore, discrete and ISM sediment samples were evaluated separately. Surface water samples were also collected in 2004 from the ISM sediment locations; however, the surface water samples were not used in the quantitative risk assessment because surface water is a transient medium and these samples are more than six years old. Since the 2010 surface water samples were collected downgradient of the locations sampled in 2004, the 2010 data will reflect any contamination flowing from these areas. The 2004 surface water data were used in evaluating the nature and extent of contamination (Section 5.0) and were addressed in the qualitative evaluation of contaminant trends over time.

Surface water sample (LL8sw-090) was re-collected in April 2011 from the southeast drainage ditch for RVAAP full-suite analyses because the previous surface water sample collected in March 2010 indicated elevated concentrations of aluminum, barium, and iron; however, the concentrations of these metals (and other analytes) were much lower in the March 2010 field duplicate, which may indicate the presence of some suspended solids in the primary sample. The April 2011 sample is used in this assessment for qualitative purposes only.

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 reflect the small size of this EU.

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 to be TNT, composition B (a combination of TNT and RDX), sulfates, nitrates, lead styphnate, and lead azide. Additional site-specific contaminants at Load Line 8 include tetryl, Octol (a mixture of TNT and HMX), and heavy metals (lead, chromium, mercury, and arsenic) from munitions assembly activities; VOCs from former Building 2B-22 that was utilized for solvent storage; PCBs from on-site transformers; and PAHs from former Buildings 2B-23 and 2B-24 that were used as heater houses. The evaluation of historical chemical contamination is not limited to these chemicals; rather, this evaluation is expanded to include all eligible chemical data that is available.

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 (USACE 2010a). Inorganic chemicals 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 so long as they are: (1) present at low concentrations (i.e., only slightly elevated above naturally occurring levels) and (2) toxic at 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 Position Paper for Human Health CUGs (USACE 2012b), analytes detected in less than 5% of the samples are screened out from further consideration, with the exception of explosives and propellants. However, for this AOC, no frequency-of-detection screening was performed for subsurface soil, sediment, or surface water because fewer than 20 discrete samples were available for these data sets. Frequency-of-detection screening was not applied to ISM samples.

Details of the SRC screening for each exposure medium are provided in Appendix G, Tables G-1 through G-4. The SRCs identified for Load Line 8 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 8. The 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 (Figure 4-6); a TR of 1E-06, HQ of 0.1 to identify COPCs; and a TR of 1E-05, 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:

1. ***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.
2. ***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 8 are presented in Section 4.0.
3. ***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 8 to identify SRCs are presented in Sections 4.0 and 5.0 and are summarized in Section 7.1.
4. ***Identification of COCs*** **-** Compare EPCs to FWCUGs to determine COCs.

5. ***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: 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 8 are surface and subsurface soil, sediment, and surface water, as defined in Section 7.1.1. Groundwater is present at this AOC and will be evaluated (including a risk assessment) in a separate document, as explained 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 MDCs of all SRCs were screened against the most stringent chemical-specific FWCUG of all RVAAP receptors at a cancer TR 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 acenaphthylene, benzo(ghi)perylene, and phenanthrene; therefore, the RSL for pyrene was used for these PAHs (NDEP 2006).

Hexavalent chromium was detected in all four discrete surface soil samples collected at Load Line 8 for chromium speciation. Since hexavalent chromium was detected as part of the conservative screening approach for identifying COPCs, the FWCUG for hexavalent chromium (the more toxic of the two chromium species evaluated) was used at this stage.

Details of the COPC screening for each exposure medium are provided in Appendix G, Tables G-1 through G-4. The COPCs identified for the media of concern at Load Line 8 are presented in Table 7-6 and are summarized below.

7.2.2.1 COPCs in Surface Soil

A total of 55 chemicals were detected in surface soil (0-1 ft bgs) ISM samples; 45 of these chemicals (13 inorganic chemicals, 23 SVOCs, 1 PCB, 4 pesticides, 3 explosives, and 1 VOC) were identified as SRCs. Risk-based screening identified four inorganic chemicals (chromium, cobalt, manganese, and nickel) and five SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] as COPCs in surface soil.

7.2.2.2 COPCs in Subsurface Soil

A total of 33 chemicals were detected in discrete subsurface soil samples collected from the 1–13 ft bgs exposure depth. Fifteen of these chemicals (five inorganic chemicals, nine SVOCs, and one VOC) were identified as SRCs. Risk-based screening identified one inorganic chemical (arsenic) and one SVOC [benzo(a)pyrene] as COPCs for subsurface soil (1-13 ft bgs).

7.2.2.3 COPCs in Sediment

A total of 25 chemicals were detected in discrete sediment samples collected from ditches at Load Line 8. Nine of these chemicals (four inorganic chemicals, four SVOCs, and one VOC) were identified as SRCs. Risk-based screening identified only one inorganic chemical (aluminum) as a COPC in discrete sediment samples. A total of 37 chemicals were detected in ISM sediment samples collected from ditches at Load Line 8; 25 of these chemicals (9 inorganic chemicals, 3 pesticides, 11 SVOCs, and 2 explosives) were identified as SRCs. Risk-based screening identified three COPCs in sediment from ISM samples: two inorganic chemicals (chromium and cobalt) and one SVOC [benzo(a)pyrene].

7.2.2.4 COPCs in Surface Water

A total of 20 chemicals were detected in surface water samples collected from ditches at Load Line 8; 16 of these chemicals, all inorganic chemicals, were identified as SRCs. Risk-based screening identified seven inorganic chemicals (aluminum, arsenic, chromium, cobalt, iron, lead, and manganese) as COPCs in surface water.

7.2.3 Land Use and Representative Receptors

Camp Ravenna is a controlled-access facility. Load Line 8 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.
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 (ARNG 2014), if an AOC fails to meet 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, target HQ of 1 using the most stringent of the Resident Receptor (Adult and 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 the 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 EPC/FWCUG for all carcinogens.
- Identify the COPC as a COC for a given receptor if:
    - The EPC exceeds the most stringent of the Resident Receptor (Adult and Child) FWCUGs for either the cancer TR of 1E-05 or the target HQ of 1; 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 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, 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 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 Resident Receptor (Adult and 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). These FWCUGs, provided in Tables 7-7 (soil and sediment) and 7-8 (surface water), are the lower of the Resident Receptor (Adult and Child) values for each COPC and endpoint (non-cancer and cancer). The critical effect or target organ associated with the toxicity values used to calculate the FWCUGs are also provided in this table.

The SLs provided in Tables 7-7 and 7-8 for the Resident Receptor (Adult and Child) are the FWCUGs corresponding to a TR of 1E-05, target HQ of 1. If no FWCUG is available for a COPC, the residential RSLs, adjusted to represent a TR of 1E-05 or target HQ of 1, are used for the Resident Receptor.

Chromium Speciation

FWCUGs are available for hexavalent and trivalent chromium. Existing data at other AOCs, such as the Building 1200 and Anchor Test Area AOCs (USACE 2012c, USACE 2012d), indicate chromium exists predominantly in the trivalent state rather than the more toxic hexavalent state. Implementing the chromium speciation process per the PBA08 SAP is discussed below.

- **Hexavalent and total chromium sample collection and results** – To determine whether FWCUGs for trivalent or hexavalent chromium are most applicable to Load Line 8 and to support risk management decisions, four discrete surface soil samples were collected and analyzed for hexavalent and total chromium. Three samples were collected in March 2010 per the PBA08 SAP. Two of these 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. One additional sample was collected in October 2010 to correspond to the highest detected total chromium results from the March 2010 PBA08 ISM samples. Hexavalent chromium was detected in these speciation samples at concentrations ranging from 0.41–2 mg/kg. Total and hexavalent chromium results for these four samples are summarized in Table 7-9.
- **Percent hexavalent chromium in the chromium speciation samples** – As documented in the PBA08 SAP, “Chromium speciation evaluates the concentration ratio of hexavalent chromium to total chromium. This ratio will be calculated by collecting and analyzing three

samples per AOC for both hexavalent chromium and total chromium." The four chromium speciation samples at Load Line 8 contained 1.8%, 7.7%, 10.9%, and 23.8% hexavalent chromium, with the highest percentage of hexavalent chromium associated with the sample having the lowest concentration of total chromium (LL8ss-070). The total chromium concentration in sample LL8ss-070 (8.4 mg/kg) is well below the facility-wide background concentrations of 17.4 mg/kg in surface soil and 27.3 mg/kg in subsurface soil. The FWCUG for hexavalent chromium is based on a cancer unit risk factor (URF) calculated using a chromium mixture containing 14% hexavalent chromium and 86% trivalent chromium. With the exception of one sample with a low (below background) total chromium concentration, these sample results are below the 14% hexavalent chromium used as the basis for the cancer URF, which was used to calculate the hexavalent chromium FWCUGs.

- **Comparing the concentration of hexavalent chromium detected in the chromium speciation samples to the residential RSL for hexavalent chromium** – The FWCUG for hexavalent chromium is more appropriately applied to total chromium because it was calculated from a cancer URF based on a chromium mixture containing 1/7 (14%) hexavalent chromium (USEPA 2010). The residential RSL (3 mg/kg based on a TR of 1E-05) for hexavalent chromium is specific to hexavalent chromium (i.e., it has been adjusted for the chromium mixture used in the toxicity study). The detected concentrations of hexavalent chromium in the chromium speciation samples (0.41–2 mg/kg) are less than 3 mg/kg, indicating hexavalent chromium is not present above the residential RSL.
- **Comparing the concentration of total chromium to the FWCUG for trivalent chromium** – After implementing the chromium speciation process specified in the PBA08 SAP, hexavalent chromium was determined to be present at a very low concentration (i.e., below the residential RSL for hexavalent chromium), and the percent of hexavalent chromium is less than 14% in all but one sample with a low (well below facility-wide background concentrations) total chromium concentration. Therefore, hexavalent chromium is not of concern at Load Line 8, and the reported concentrations of total chromium were compared to the FWCUGs for trivalent chromium for identifying COCs at this AOC.

7.2.4.2 Exposure Point Concentrations for Comparison to FWCUGs

Surface Soil

Surface soil (0-1 ft bgs) at Load Line 8 was characterized using ISM sampling. The ISM analytical result can provide a more reliable estimate of the average concentration for a decision unit but cannot be combined with analytical results from discrete samples (USACE 2009c). As noted in the *Technical and Regulatory Guidance for Incremental Sampling Methodology* (ITRC 2012), different objectives require different spatial scales for ISM sample areas.

Some objectives call for characterizing contaminant concentrations over a relatively large area (e.g., multiple acres) if the primary objective is to conduct a risk assessment to represent an exposure concentration within a human health exposure area. Other objectives focus on distinguishing concentration differences on a much smaller scale (e.g., within a few feet) to delineate potential remediation areas. In accordance with the PBA08 SAP, two types of ISM grid sampling were used to characterize surface soil at Load Line 8.

1. Small targeted ISM samples were collected from areas biased toward locations anticipated to have the highest level of potential contamination (i.e., around former buildings or ditches) to delineate potential sources. These ISM samples ranged from 0.003–0.47 acres and averaged 0.08 acres in size.
2. Thirteen larger ISM samples were collected to characterize potential exposure areas within the AOC, but these samples do not provide the spatial resolution needed to identify potential source areas. Characterization of the AOC was achieved using ISM samples with a 1.7- to 4.3-acre grid size.

EPCs are intended to provide representative concentrations that a receptor might contact during the period of exposure. Exposure to surface soil was based on ISM samples. The ISM was used to determine an average concentration representative of the soil contained within a defined area (i.e., the “decision unit”). Therefore, individual ISM results were compared directly to the surface soil FWCUGs for the Load Line 8 receptors.

Subsurface Soil

EPCs were calculated for the 1–13 ft bgs subsurface soil exposure depth using analytical results from the discrete samples presented in Table 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

Three discrete sediment samples, collected from the ditches located in the southwest side of Load Line 8 where surface water exits the AOC, were used to characterize risks from exposure to sediment within Load Line 8. Because of the small number of discrete samples, each sample was evaluated separately (i.e., the detected concentration of the COPC in the sample was used as the EPC for comparison to the FWCUG).

Six ISM sediment samples were collected in 2004 from the ditches inside the production area at Load Line 8 and one ISM sediment sample was collected in 2010 from the ditch along the west side of the production area. These seven ISM samples were used to characterize risks from exposure to sediment within Load Line 8. The detected concentrations of the COPCs in each ISM sample were used as the EPCs for comparison to the FWCUGs.

Surface Water

Three discrete surface water samples were collected from the ditches located on the southwest side of Load Line 8 where surface water exits the AOC. Because of the small number of surface water samples, each sample was evaluated separately (i.e., the detected concentration of the COPC in each sample was used as the EPC for comparison to the FWCUG).

7.2.4.3 Identification of COCs for Unrestricted (Residential) Land Use

Load Line 8 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)

The COC screening for surface soil for the Resident Receptor (Adult and Child) is detailed in Appendix G, Tables G-5 through G-7. Two PAHs [benzo(a)pyrene and dibenz(a,h)anthracene] were identified as COCs for the Resident Receptor (Adult and Child), as explained below:

COPCs with EPCs lower than the Resident Receptor (Adult and Child) FWCUG: All chromium, cobalt, manganese, nickel, benz(a)anthracene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene concentrations were lower than the Resident Receptor (Adult and Child) FWCUG.

COPCs with EPCs exceeding the Resident Receptor (Adult and Child) FWCUG: Reported concentrations of two PAHs [benzo(a)pyrene and dibenz(a,h)anthracene] exceeded the FWCUG at one or more sample locations.

The reported concentrations of benzo(a)pyrene exceed the FWCUG for the Resident Receptor (Adult and Child) at five ISM locations (LL8ss-071M, LL8ss-072M, LL8ss-073M, LL8ss-076M, and LL8ss-085M) and the reported concentration of dibenz(a,h)anthracene exceeded the FWCUG at one ISM location (LL8ss-072M). Results for each of these locations are summarized in Table 7-10 and discussed below.

- **LL8ss-071M and LL8ss-072M,** collected in the area of the former tetryl pellet manufacture & storage building (2B-13) and the former booster assembly & shipping building (2B-21), are on or adjacent to the access road and in the footprint of former parking areas. The reported concentrations of benzo(a)pyrene in these samples were 0.24 and 1.3 mg/kg, respectively. The reported concentration of dibenz(a,h)anthracene in LL8ss-072M was 0.29 mg/kg. The combined area of these two samples is approximately 0.28 acres.
- **LL8ss-073M and LL8ss-076M,** collected in the area east of the former booster assembly & shipping building (2B-6) and near former change house buildings (2B-9 and 2B-10), are in the footprint of former access roads and parking areas. The reported concentrations of benzo(a)pyrene in these samples were 1.2 and 0.4 mg/kg, respectively. The combined area of these two samples is approximately 0.53 acres.
- **LL8ss-085M** is an approximately 2-acre grid ISM sample within the FPA. Sample location LL8ss-085M includes sample locations LL8ss-071M and LL8ss-072M and includes ISM sample aliquots taken from access roads and parking areas. These areas are currently composed of residual crushed gravel and slag paving ranging from areas of vegetation growing through gravel roads to areas of emergent vegetation growing in a combination of

soil and broken/pulverized gravel, slag, and building debris. The reported concentration of benzo(a)pyrene in this sample was 0.46 mg/kg.

The detected concentrations of benzo(a)pyrene in these five samples range from 0.24 to 1.3 mg/kg. The detected concentration of dibenz(a,h)anthracene in one of these samples is 0.29 mg/kg. These concentrations exceed the Resident (Adult and Child) FWCUG of 0.221 mg/kg, corresponding to a 1E-05 risk for benzo(a)pyrene and dibenz(a,h)anthracene. Benzo(a)pyrene and dibenz(a,h)anthracene were identified as COCs. The EPCs for all other soil COPCs were less than their respective FWCUGs.

<u>SOR analysis:</u> Three additional PAHs [benzo(b)fluoranthene, benz(a)anthracene, and indeno(1,2,3-cd)pyrene] were identified as COCs based on the SOR analysis summarized below:

- Four COPCs (chromium, cobalt, manganese, and nickel) identified in surface soil have FWCUGs for non-cancer endpoints. Cobalt, manganese, and nickel were detected below the facility-wide surface soil background concentration at many ISM sample locations. Inorganic chemicals were not included in the SOR for samples where the detected concentration is less than the facility-wide surface soil background concentrations. The total SORs (Table G-6), regardless of endpoint, were less than one; therefore, no additional COCs were identified using this analysis.
- Six COPCs [cobalt, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] identified in surface soil have FWCUGs for the cancer endpoint (chromium was evaluated for non-carcinogenic effects as trivalent chromium as previously discussed). An SOR was calculated for these six chemicals for each ISM sample (Table G-7). Cobalt was detected below the facility-wide background concentration for surface soil at all but a few ISM sample locations. Cobalt was not included in the SOR for samples where the detected concentration is less than the facility-wide background concentrations for surface soil. The SORs for sample locations LL8ss-071M, LL8ss-072M, LL8ss-073M, LL8ss-076M, and LL8-085M are greater than one due largely to benzo(a)pyrene, as noted below and in Appendix G, Table G-8.
    - The SORs for sample locations LL8ss-071M, LL8ss-072M, and LL8-085M range from two to nine. COPCs contributing at least 10% to these SORs are benzo(a)pyrene and dibenz(a,h)anthracene. Benzo(a)pyrene was detected above the FWCUG in three samples; dibenz(a,h)anthracene was detected above the FWCUG in one sample. Other COPCs contributing at least 5% to these SORs and identified as COCs are benz(a)anthracene and benzo(b)fluoranthene.
    - The SOR for sample location LL8ss-073M was seven due primarily to benzo(a)pyrene, which was detected above the FWCUG. COPCs contributing at least 10% to this SOR are benzo(a)pyrene and benzo(b)fluoranthene. Another COPC contributing at least 5% to this SOR and identified as a COC is benz(a)anthracene.
    - The SOR for sample location LL8ss-076M is two due primarily to benzo(a)pyrene, which was detected above the FWCUG. COPCs contributing at least 10% to this SOR are benzo(a)pyrene and benzo(b)fluoranthene. Other COPCs contributing at least 5% to this SOR and identified as COCs are benz(a)anthracene and indeno(1,2,3-cd)pyrene.

    - The calculated SORs for all other ISM sample locations are less than or equal to one.

COCs in Subsurface Soil (1–13 ft bgs)

The COC screening for the subsurface soil exposure depth (1–13 ft bgs) for the Resident Receptor (Adult and Child) is detailed in Appendix G, Table G-9.

<u>COPCs with EPCs lower than the Resident Receptor (Adult and Child) FWCUG:</u> The EPC for benzo(a)pyrene is lower than the FWCUG for the Resident Receptor (Adult and Child).

<u>COPCs with EPCs exceeding the Resident Receptor (Adult and Child) FWCUG:</u> The EPC for arsenic (13.8 mg/kg) exceeds the FWCUG of 4.25 mg/kg but is less than the subsurface soil facility-wide background concentration of 19.8 mg/kg. Arsenic is not a COC for subsurface soil.

<u>SOR Analysis:</u> No COCs were identified by the SOR analysis. The SOR analysis is summarized below:

- One COPC identified in subsurface soil has a FWCUG for non-cancer effects (arsenic). The EPC for this COPC is less than the background concentration; therefore, an SOR for a non-cancer endpoint was not calculated.
- Two COPCs [arsenic and benzo(a)pyrene] identified in subsurface soil have FWCUGs for the cancer endpoint. The FWCUG for arsenic is less than the background concentration for this inorganic chemical; therefore, the background concentration is used as the cleanup goal, and arsenic is not included in the SOR. As benzo(a)pyrene was the only remaining COPC, an SOR for the cancer endpoint was not calculated.

COCs for Sediment

COC screening for sediment for the Resident (Adult and Child) Receptor is detailed in Appendix G, Tables G-10 though G-12. No COCs were identified in discrete or ISM sediment samples because all detected concentrations were below FWCUGs.

<u>SOR Analysis:</u> No COCs were identified by the SOR analysis. The SOR analysis is summarized below:

- Three COPCs (aluminum, chromium, and cobalt) identified in sediment have FWCUGs for non-cancer endpoints. Sample-specific SORs were calculated (Appendix G, Table G-11). All three of these inorganic chemicals were detected below the facility-wide background concentrations for sediment at one or more of the discrete (aluminum) or ISM (chromium and cobalt) sample locations. These inorganic chemicals were not included in the SOR for samples where the detected concentration is less than the facility-wide background concentrations (i.e., the inorganic chemical is not an SRC in the sample). The calculated SORs, regardless of endpoint, are less than or equal to one; therefore, no COCs were identified.

- Two COPCs identified in sediment [cobalt and benzo(a)pyrene] have FWCUGs for the cancer endpoint. Hexavalent chromium is not included in the SOR because chromium speciation analysis for soil indicates the FWCUG for non-carcinogenic trivalent chromium is appropriate for evaluating total chromium results in soil at Load Line 8. The potential source of chromium contamination to the sediment and soil are the same; therefore, this conclusion applies to both media. An SOR was calculated for cobalt and benzo(a)pyrene for each ISM sample (Appendix G, Table G-12). Cobalt was detected below the facility-wide background concentrations for sediment in two of seven ISM sample locations. Cobalt was not included in the SOR for samples where the detected concentration is less than the facility-wide background concentration (i.e., the inorganic chemical is not an SRC in the sample). The calculated SORs are less than or equal to one; therefore, no COCs were identified.

COCs for Surface Water

COC screening for surface water for the Resident (Adult and Child) Receptor is detailed in Appendix G, Tables G-13 and G-14. Cobalt and lead were identified as COCs for the Resident Receptor (Adult and Child), as explained below:

<u>COPCs with EPCs lower than the Resident Receptor (Adult and Child) FWCUG:</u> All aluminum, arsenic, chromium, iron, and manganese concentrations were lower than the Resident Receptor (Adult and Child) FWCUG. Chromium speciation analysis for soil indicates the FWCUG for trivalent chromium is appropriate for evaluating total chromium results in soil at Load Line 8. The potential source of chromium contamination to the surface water may be Load Line 8 soil or a different upstream source; therefore, to be protective, detected concentrations of chromium in surface water were compared to (and are less than) the FWCUGs for both hexavalent and trivalent chromium.

<u>COPCs with EPCs exceeding the Resident Receptor (Adult and Child) FWCUG</u>: Reported concentrations of cobalt and lead exceeded the FWCUG at one or more sample locations. Cobalt and lead were identified as exceeding their FWCUGs in surface water in LL8sw-090. Concentrations of cobalt (0.0085 mg/L) exceeded the tap water RSL for cobalt corresponding to an HQ of 1 (0.006 mg/L) and lead (0.024 mg/L) exceeded MCL for lead for drinking water (0.015 mg/L). Thus, cobalt and lead are COCs for surface water at this location. Concentrations in LL8sw-091 and LL8sw-092 were below the RSL for cobalt and the MCL for lead.

<u>SOR Analysis:</u> The SOR analysis is summarized below:

- Six COPCs (aluminum, arsenic, chromium, cobalt, iron, and manganese) identified in surface water have FWCUGs for non-cancer endpoints. The calculated SOR, regardless of endpoint, is two for LL8sw-090. Two of these COPCs (chromium as hexavalent chromium and iron) have the stomach/gastrointestinal tract as the target organ. Aluminum, arsenic, and manganese each affect a different target organ. Cobalt was identified as a COPC having a FWCUG for an unspecified target organ. An SOR was calculated for chromium (as hexavalent chromium), cobalt, and iron for each sample (Appendix G, Table G-15). The SOR for sample location LL8sw-090M was two due primarily to cobalt. Another COPC contributing at least 10% to this SOR and identified as a COC is iron. SORs for the remaining samples were less than or equal to one.

- Only one COPC (arsenic) identified in surface water has a FWCUG based on the cancer endpoint; therefore, an SOR for carcinogens was not calculated.

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, comparing these limitations with background concentrations to identify SRCs, and estimating 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. In accordance with the PBA08 SAP, small targeted ISM samples (0.003 – 0.47 acres) were collected from areas biased toward areas anticipated to have the highest level of potential contamination (i.e., around former buildings and ditches) to delineate potential sources. In addition, 13 ISM grid samples were used to characterize surface soil across the AOC. The FPA was characterized using ISM samples with a 1.7- to 2.1-acre grid size and NPA areas were characterized using ISM samples with a 3.6- to 4.3-acre grid size. These large sample areas fully characterize potential exposure areas within the AOC but do not provide the spatial resolution needed to identify potential source areas.

In addition to the ISM samples, discrete samples are available from the 0–1 ft bgs interval of the soil borings used to evaluate subsurface soil. The results of these discrete samples were considered in the context of the ISM samples in which they were located. The results of the ISM and discrete sample evaluation are included in Table 7-11. The discrete sample results parallel the conclusions of the ISM samples. All chemicals detected in discrete surface samples were also detected in ISM samples. With the exception of antimony, arsenic, and cobalt, the MDCs of the chemicals in the discrete samples were less than the MDCs in ISM samples. The conclusions drawn from the ISM samples regarding antimony, arsenic, and cobalt, are not changed by the discrete samples as noted below:

- The MDCs for antimony (0.15 mg/kg) and arsenic (15.2 mg/kg) in the discrete surface soil were less than the surface soil facility-wide background concentrations of 0.96 (for antimony) and 15.4 mg/kg (for arsenic). Because the MDCs of the discrete sample were below the surface background concentration for antimony and arsenic, evaluation of the discrete data did not identify these chemicals as additional COPCs or COCs.
- Cobalt was detected in two of eight discrete surface soil samples at concentrations (11.8 mg/kg at LL8sb-063 and 12.8 mg/kg at LL8sb-067) above the facility-wide background

concentration for cobalt in surface soil (10.4 mg/kg) but below the facility-wide background concentration in subsurface soil (23.2 mg/kg). Cobalt was detected in 2 of 49 ISM samples at concentrations (10.6 mg/kg at LL8ss-075M and 11.2 mg/kg at LL8ss-088M) above facility-wide surface soil, but below facility-wide subsurface soil background concentrations. Because the MDC of the discrete sample was below the subsurface facility-wide background concentration for cobalt, evaluation of the discrete data did not identify cobalt as an additional COC.

The results of historical ISM surface soil samples were used to select locations for discrete subsurface soil sampling that focused on areas with the highest potential contamination. No subsurface samples were collected in the NPA because the ISM samples did not indicate any contamination in this area, and no source areas were identified in this area.

Uncertainties arise from temporal variabilities in samples used for analysis to characterize the AOC. Concentrations of chemicals, particularly in surface water, which is a transient medium, may vary significantly over time and space within an AOC. Elevated concentrations of aluminum, barium, and iron (23.9, 0.169, and 23.6 mg/L, respectively) were identified in the primary surface water sample collected from LL8sw-090 collected in March 2010 from the southeast drainage ditch. Concentrations of these metals (6.58, 0.0571, and 8.59 mg/L, respectively) were lower in the field duplicate. Variability in the primary and duplicate samples results may be present due to suspension of solids occurring during the collection process.

A water sample at location LL8sw-090 was collected from the same location in April 2011 from the southeast drainage ditch and analyzed for RVAAP full-suite analytes as there was no clear source for the elevated concentrations of aluminum, barium, and iron in surface water. The results of the surface water samples collected from LL8sw-090 in March 2010 and April 2011 are shown in Table 7-12. With the exception of calcium, which was detected below the background criteria in the March 2010 and April 2011 samples, the concentrations of aluminum, barium, and iron (as well as other analytes) in the April 2011 sample were significantly reduced compared to the March 2010 sample. The reduced concentrations in the April 2011 sample and lower concentrations in the field duplicate of the March 2010 sample indicate the previously detected concentrations of elevated metals may have been attributable to suspended solids being collected with sample.

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 maximum detection limit (MDL), when the actual concentration may be much smaller than the MDL. Risks may also 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.

Identifying SRCs – Part of determining SRCs is to identify chemicals detected above established RVAAP background concentrations. This screen does not account for potential sources of chemicals, and background concentrations are only available for inorganic chemicals.

Uncertainty associated with screening against background concentrations results from statistical limitations and natural variation in background concentrations. Because of these variations, inorganic chemical concentrations below the background concentration are likely representative of background conditions. Inorganic chemical concentrations above the background concentration may be above background conditions or may reflect natural variation. This is especially true for measured concentrations close to the background concentration.

At Load Line 8, three inorganic chemicals (cobalt, manganese, and selenium) had MDCs in surface soil that were above but close to (i.e., less than two times) the background concentration. Cadmium, silver, and thallium had no background concentrations for comparison. The consequences of carrying most of these inorganic chemicals forward as SRCs, even if they actually represent background concentrations, is negligible because they are not toxic at near background concentrations. By contrast, naturally occurring cobalt and manganese in soil exceed risk-based FWCUGs. Therefore, the consequence of identifying cobalt or manganese as SRCs if they are, in fact, representative of background can have a significant impact on the conclusions of the risk assessment.

The MDCs of arsenic in surface and subsurface soil at Load Line 8 were 13.9 and 26.9 mg/kg, respectively. The RVAAP background concentration for arsenic in surface soil is 15.4 mg/kg and in subsurface soil is 19.8 mg/kg. The MDCs of manganese in surface and subsurface soil at Load Line 8 were 2,400 and 618 mg/kg, respectively. The RVAAP background concentration for manganese in surface soil is 1,450 mg/kg and in subsurface soil is 3,030 mg/kg. Because building demolition activities disturbed the soil, including removing surface soil and exposing subsurface soil at the surface, it is appropriate to compare surface soil sample results to the subsurface background concentrations. Based on this information, manganese appears to be present at Load Line 8 at naturally occurring concentrations.

Other studies indicate arsenic may be naturally occurring in Ohio soil at greater than 20 mg/kg. For example, an environmental study of three locations in Cuyahoga County performed for Ohio EPA (Weston 2012) showed arsenic ranged from 4.6–25.2 mg/kg (22.9 mg/kg excluding statistical outliers) in surface soil (0–2 ft bgs) and 5.3–34.8 mg/kg (22.6 mg/kg excluding statistical outliers) in subsurface soil (2–4 ft bgs). Also, Vosnakis and Perry (2009) published the results of arsenic concentration studies that included 313 samples of Ohio soil. Naturally occurring arsenic in these samples ranged from 1.6–71.3 mg/kg with 95th percentiles of 21.7 mg/kg in surface soil, 25.5 mg/kg in subsurface soil, and upper tolerance limits of 22.8 mg/kg for surface soil and 29.6 mg/kg for subsurface soil. In other studies, native soil concentrations of arsenic in Ohio have been reported as ranging from 0.5–56 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 shale (USGS 2004). Based on this information, arsenic appears to be present at Load Line 8 at naturally occurring concentrations.

Organic chemicals were 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 8, PAHs were detected across the entire AOC; one or more PAHs were detected in 23 of 23 surface soil ISM samples and 8 of 8 discrete surface soil samples analyzed for SVOCs. PAH concentrations were less than the Resident Receptor (Adult and Child) FWCUGs in all but five sample locations (LL8ss-071M, LL8ss-072, LL8ss-073M, LL8ss-076M, and LL8ss-085M) where concentrations were up to 5.9 times the FWCUG of 0.221 mg/kg for benzo(a)pyrene and 1.3 times the FWCUG of 0.221 mg/kg for dibenz(a,h)anthracene.

Surface soil at locations LL8ss-071M, LL8ss-072M, LL8ss-073M, LL8ss-076M, and LL8-085M were sampled in 2010 in areas previously covered by and/or adjacent to crushed gravel and slag roads and parking areas. These areas are currently composed of residual crushed gravel and slag paving ranging from areas of vegetation growing through gravel roads to areas of emergent vegetation growing in a combination of soil and broken/pulverized gravel, slag, and building debris. These concentrations are indicative of road sources (i.e., diesel and automobile exhaust and slag). The results of these samples are not indicative of an operation-related point source of PAHs and may represent background concentrations for PAHs.

Although no background concentrations for PAHs were established for RVAAP, the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b), which established the background concentrations for inorganic chemicals, included characterizing naturally occurring background metal concentrations in surface and subsurface soil at Camp Ravenna using samples from outside the process areas. Surface soil samples were collected at 15 locations on the eastern half of Camp Ravenna. These background locations were chosen using aerial photographs and site visits with the concurrence of Ohio EPA and USACE to reflect areas not impacted by RVAAP activities and establish background values that are unaffected by any human activity. The background locations were situated upgradient and generally upwind of known or suspected contaminant sources.

Background sampling was conducted in April and May 1998. All background samples were analyzed for TAL metals, cyanide, and SVOCs. Two of the background samples were also analyzed for VOCs and pesticides/PCBs. The background soil sampling effort established concentrations for naturally occurring metals in soil at RVAAP.

In establishing the background concentrations for naturally occurring metals, data were screened to identify outliers in the inorganic chemical results. Ohio EPA guidance (Comment Resolution Meeting, December 2, 1998) called for using upper and lower cutoff limits based on quartiles to identify outliers. The upper cutoff limit is the third quartile (75th percentile) plus one and a half times the interquartile range. All results that exceeded the upper cutoff limit were examined to determine if the results should be used in establishing the background concentrations for naturally occurring metals. Outliers were removed so that background values would most nearly represent natural conditions and exclude human disturbance whether from RVAAP or pre-RVAAP activities.

Statistical outliers were identified in 5 surface soil and 15 subsurface soil samples. All analytical results for four of these samples [BKGss-011(b)-0794-SO, BKGss-012(b)-0795-SO, BKGss-015(b)-0798-SO, and BKGss-005(b)-0788-SO] were removed from the surface soil background data set.

The primary reason for eliminating these four samples from the surface soil background data set was that PAHs were elevated and these sampling locations were near pre-existing homes or farms and could have been influenced by activities associated with those structures (e.g., burning wood and fossil fuels, vehicle exhaust, or building materials such as slag used as fill or tar paper and shingles). The other 11 outlier samples were not excluded from the background calculations primarily because no SVOCs were detected in those samples and thus the outliers did not appear to be associated with human activities.

Concentrations of PAHs in surface soil at Camp Ravenna associated with pre-RVAAP anthropogenic sources calculated from the 15 RVAAP background surface soil samples are shown in Table 7-13. Since the purpose here is to identify PAH levels associated with anthropogenic activities unrelated to CERCLA releases from operations at RVAAP, it is appropriate to include all 15 background samples in these calculations. The following criteria were used per the method used in establishing the background concentrations for naturally occurring metals (USACE 2001b):

- For analytes with a frequency-of-detection greater than 50%, a distribution (determined using the Shapiro-Wilk test) that is neither normal nor log-normal, and a sample size of 59 or less, the maximum result represents the nonparametric 95% upper tolerance limit and was identified as the background concentration for naturally occurring metals. These conditions apply to four of the PAHs detected in background samples [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and chrysene].
- For analytes with a frequency-of-detection between 0 and 50% with a sample size of 15, the maximum result represents the 99th percentile value and was identified as the background concentration for naturally occurring metals. These conditions apply to the remainder of the PAHs detected in background samples.

These results demonstrate the large variability in environmental concentrations of PAHs. For example, benzo(a)pyrene was detected in 8 of 15 background surface soil samples at concentrations ranging from 0.058–3.7 mg/kg.

Other studies of environmental concentrations of PAHs in Ohio soil show similar variability. For example, in the environmental study of three locations in Cuyahoga County performed for Ohio EPA (Weston 2012), PAHs were detected in only 1 of 36 surface soil samples with a reported concentration of benzo(a)pyrene of 1.33 mg/kg. Aerial photographs indicate this sample was collected near an old road or trail, but no other sources of PAHs are apparent.

In addition to these RVAAP and Cuyahoga County studies, numerous other environmental studies have been conducted that examine environmental levels of PAHs in rural and urban surface soil (e.g., ATSDR 1995, Bradley et al. 1994, IEPA 2005, MADEP 2002, and Teaf et al. 2008). Reported minimum, maximum, and 95th percentile concentrations of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene from numerous studies are shown in Table 7-14. These studies further demonstrate the high variability in environmental levels of PAHs within a single study area and among multiple studies.

The lack of established RVAAP background concentrations for identifying SRCs for PAHs is a source of uncertainty. Evaluating potential RVAAP process-related sources and other common anthropogenic (non-CERCLA) sources using available PAH environmental data minimizes the impact of this uncertainty on the conclusions of the RI (see Section 7.2.6).

Exposure Point Concentrations - Surface soil was characterized using ISM. ISM is used to determine an average concentration representative of the soil contained within an ISM sample location (i.e., the “decision unit”). For ISM samples, 30–50 aliquots of surface soil are generally collected from random locations within a decision unit and combined into a single sample. Using ISM reduces the uncertainty associated with estimating a statistical average concentration within a decision unit.

Soil data at Load Line 8 were aggregated into surface and subsurface soil as described in Section 7.1.1. Based on AOC characteristics and the operational constraints during its use, the sample coverage to define nature and extent of operationally impacted areas of the AOC is adequate.

Targeted ISM samples (0.003–0.47 acres, with an average of 0.08 acres) were collected from areas biased toward locations anticipated to have the highest level of potential contamination (i.e., around former buildings and ditches) to delineate potential sources. Characterization of the FPA was achieved using ISM samples with a 1.7–2.1-acre grid size and the NPA was characterized using ISM samples with a 3.6–4.3-acre grid size. These sampling areas characterize potential exposure areas within the AOC, but do not provide the spatial resolution needed to identify potential source areas. Therefore, both types of samples were used in the analysis.

EPCs were calculated for the 1–13 ft bgs sample intervals using analytical results from the discrete samples listed in Table 7-2. Soil borings for discrete samples were located in areas of highest potential contamination based on previous sampling results, resulting in calculated EPCs that provide conservative estimates of exposure concentrations across the EU. At Load Line 8, subsurface soil samples were collected only in the FPA because no indication of activity or contamination was present at the NPA.

There is some evidence that using stainless steel grinding blades when processing ISM samples could contribute chromium and nickel to the ISM soil samples. However, neither of these metals were identified as COCs at Load Line 8; therefore, the impact of the potential contribution from grinding is minimal.

7.2.5.2 Uncertainty in Use of FWCUGs

Sources of uncertainty in the FWCUGs used to identify COCs include selecting appropriate receptors and exposure parameters, exposure models, and toxicity values used in calculating FWCUGs.

Selection of Representative Receptors – Load Line 8 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 a pathway, the resulting risk can be in excess of the 99th percentile and, therefore, outside of the range that may be reasonably expected. Thus, the consistent selection of upper-bound parameters generally leads to overestimation of the potential risk.

Toxicity Values - The toxicity of chemicals is under constant study and values change from time to time. The toxicity values used in calculating 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 hexavalent chromium and trivalent chromium.

Trivalent chromium has not been shown to be carcinogenic. It is an essential micronutrient but can also be toxic at high doses (i.e., above the RfD used to calculate the FWCUG). The FWCUGs for trivalent chromium are based on non-cancerous effects. Hexavalent chromium is much more toxic than trivalent chromium. It is classified as a "known human carcinogen" and may also cause non-cancerous effects. The cancer URF for hexavalent chromium published in USEPA's Integrated Risk Information System (IRIS) is based on epidemiological data on lung cancer in workers associated with chromate production. Workers in the chromate industry are exposed to trivalent and hexavalent compounds of chromium. The cancer mortality in the study used to establish the URF was assumed to be due to hexavalent chromium. It was further assumed that hexavalent chromium constituted no less than 1/7 of the total chromium in air that the workers were exposed to. As noted in IRIS, the assumption that the ratio of hexavalent to trivalent chromium was 1:6 in this study may lead to a sevenfold underestimation of risk when using this URF to evaluate exposure to hexavalent chromium alone.

To avoid the underestimation of risk, selecting the FWCUG for chromium includes a step that compares the maximum concentration of hexavalent chromium detected in chromium speciation samples to the residential RSL for hexavalent chromium. The detected concentrations of hexavalent chromium in the chromium speciation samples are less than the residential RSL for hexavalent chromium, and support use of the trivalent chromium FWCUGs for evaluating total chromium results. Using speciation samples to identify the appropriate FWCUG minimizes the associated uncertainty.

FWCUGs Below Background Concentrations. One purpose of the HHRA process is to identify COCs and cleanup goals for evaluating remedial alternatives for remediating residual contamination that has resulted from process operations at the AOC. The FWCUGs are risk-based values. In some cases, natural or anthropogenic background concentrations, unrelated to process operations, exceed the risk-based FWCUGs. For naturally occurring inorganic chemicals, this problem is addressed by using the background concentration as the cleanup goal. This introduces uncertainty in the chosen cleanup goal because there is uncertainty in assigning a specific value to background, which can be highly variable.

No background concentrations are available for organic chemicals, although PAHs are often present in the environment from natural and anthropogenic sources and regulatory standards are often much lower than baseline levels of PAHs in urban and rural surface soil, especially near areas of vehicle traffic (e.g., roads and parking areas). Given their frequent presence in environmental media, and especially in areas influenced by vehicle exhaust and tire particles, it is important to compare risk-based cleanup levels with typical environmental concentrations before utilizing unrealistically low cleanup targets. Numerous studies have been conducted that examine ambient levels of PAHs in rural and urban surface soil (e.g., ATSDR 1995, Bradley et al. 1994, MADEP 2002, and Teaf et al. 2008). These studies indicate that given the multitude of non-point mobile sources for PAHs, it is not uncommon for ambient concentrations to exceed health-based regulatory recommendations. Some states have begun to consider ambient anthropogenic levels by establishing minimum SLs based on environmental studies. For example, the New York State Department of Environmental Conservation has established a minimum soil cleanup objective of 1 mg/kg for benz(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene and 0.1 for dibenz(a,h)anthracene based on the 95th percentile concentrations of these PAHs in rural areas near roads (NYSDEC 2006).

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 and RSLs as well as the approach for identifying SRCs, COPCs, and ultimately COCs based on the FWCUGs and RSLs 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 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 a FWCUG for a given receptor or any COPC contributing significantly to an SOR greater than one. For inorganic chemicals with FWCUGs below background concentrations, the background concentration was used as the point of comparison. The TR for the FWCUGs 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.

COCs for Potential Remediation: Surface Soil (0–1 ft bgs)

Five PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] were identified as COCs for the Resident Receptor (Adult and Child) in surface soil. Benzo(a)pyrene and dibenz(a,h)anthracene are present above FWCUGs for the Resident Receptor (Adult and Child) and benz(a)anthracene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene contribute to an SOR greater than one at five ISM sample locations (LL8ss-071M, LL8ss-072M, LL8ss-073M, LL8ss-076M, and LL8ss-085M).

These ISM sample locations are described below:

- **LL8ss-071M and LL8ss-072M,** collected in the area of the former tetryl pellet manufacture & storage building (2B-13) and the former booster assembly & shipping building (2B-21), are on or adjacent to the access road and in the footprint of former parking areas. Gravel, slag, and crushed building debris were present in the ISM sample areas. Figure 7-1 shows the extent of gravel, slag, and crushed building debris in these ISM sample areas. The reported concentrations of benzo(a)pyrene in these samples were 0.24 and 1.3 mg/kg, respectively. The reported concentration of dibenz(a,h) anthracene in LL8ss-072M was 0.29 mg/kg. The combined area of these two samples is approximately 0.28 acres.

- **LL8ss-073M and LL8ss-076M,** collected in the area east of the former booster assembly & shipping building (2B-6) and near former change house buildings (2B-9 and 2B-10), are in the footprint of former access roads and parking areas. Gravel, slag, and crushed building debris were present in the ISM sample areas. Figures 7-2 and 7-3 show the extent of gravel, slag, and crushed building debris included in these ISM sample areas. The reported concentrations of benzo(a)pyrene in these samples were 1.2 and 0.4 mg/kg, respectively. The combined area of these two samples is approximately 0.53 acres.
- **LL8ss-085M** is an approximately 2-acre grid ISM sample within the FPA. Sample location LL8ss-085M includes sample locations LL8ss-071M and LL8ss-072M and includes ISM sample aliquots taken from access roads and parking areas. These areas are currently composed of residual crushed gravel and slag paving ranging from areas of vegetation growing through gravel roads to areas of emergent vegetation growing in a combination of soil and broken/pulverized gravel, slag, and building debris. Gravel, slag, and crushed building debris were present in the ISM sample area. Figure 7-1 shows the extent of gravel, slag, and crushed building debris included in this ISM sample area. Many of the ISM aliquots from these areas were collected to maximum depths of 0.1-0.5 ft bgs due to auger refusal when the auger hit buried gravel and slag from the former roads and parking areas. The reported concentration of benzo(a)pyrene in this sample was 0.46 mg/kg.

Benzo(a)pyrene concentrations in these five samples range from 0.24 to 1.3 mg/kg and are above the Resident Receptor (Adult and Child) FWCUG of 0.221 mg/kg. The dibenz(a,h)anthracene concentration in in LL8ss-072M (0.29 mg/kg) slightly exceeded the Resident Receptor (Adult and Child) FWCUG of 0.221 mg/kg. The SORs for these samples range from two to nine due primarily to benzo(a)pyrene. PAHs were detected across the entire AOC (i.e., one or more PAHs were detected in all 23 of 23 surface soil ISM samples analyzed for SVOCs). These areas are currently composed of residual crushed gravel and slag paving ranging from areas of vegetation growing through gravel roads to areas of emergent vegetation growing in a combination of soil and broken/pulverized gravel, slag, and building debris. The PAH concentrations in these ISM samples are indicative of road sources (i.e., diesel and automobile exhaust and slag used in road construction). The results of these samples are not indicative of an operation-related point source of PAHs and may represent background concentrations for PAHs. Due to the low concentrations of PAHs reported in these samples collected from areas with no identified source of PAHs other than roads, gravel, and building debris, PAHs were not identified as COCs for potential remediation in these five surface soil ISM sample areas.

COCs for Potential Remediation: Surface Water

Three inorganics [cobalt, iron, and lead] were identified as COCs for the Resident Receptor (Adult and Child) in surface water. Cobalt and lead were identified as exceeding their FWCUGs in surface water only because no FWCUGs are available for these inorganic chemicals. The detected concentration of cobalt (0.0085 mg/L) in the sample collected at LL8sw-090 in March 2010 slightly exceeds the tap water RSL (0.006 mg/L), corresponding to an HQ of 1. The MDC of lead (0.024 mg/L) is 1.6 times the MCL for drinking water (0.015 mg/L) in LL8sw-090 collected in March 2010. Iron was below the FWCUG in surface water, but contributed to an SOR greater than one in LL8sw-090.

Surface water sample (LL8sw-090) was re-collected in April 2011 from the southeast drainage ditch for RVAAP full-suite analyses because the previous surface water sample collected in March 2010 indicated elevated concentrations of aluminum, barium, and iron; however, the concentrations of these metals (and other analytes) were much lower in the March 2010 field duplicate, which may indicate the presence of some suspended solids in the primary sample. The April 2011 sample was collected after the original PBA08 RI and was only used qualitatively; however, the sample showed significant reductions in analyte concentrations compared to the primary March 2010 sample. The March 2010 concentrations may overestimate exposure due to the inclusion of suspended solids in the surface water sample. As a result, the April 2011 detected concentrations of COCs were compared to FWCUGs. The April 2011 detected concentrations of cobalt (0.00022 mg/L), iron (0.858 mg/L) and lead (0.0005 mg/L) in LL8sw-090 were well below the cobalt tap water RSL (0.006 mg/L), iron FWCUG (45.269 mg/L), and lead MCL (0.015 mg/L). Furthermore, incidental exposure to surface water will be much less than tap water ingestion. Thus, cobalt, iron, and lead are not COCs for potential remediation in surface water.

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 8. 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 CUGs (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 8 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 8 are surface and subsurface soil, sediment, and surface water.

Estimation of EPCs. For surface soil (0–1 ft bgs), the EPC is the detected concentration in each ISM sample collected at Load Line 8. For the subsurface soil (1–13 ft bgs) depth interval, EPCs were calculated using analytical results from discrete soil boring samples listed in Table 7-2. The EPC was either the 95% UCL of the mean or the MDC, whichever value is lowest. If the 95% UCL could not be determined, the EPC is the MDC.

Seven ISM sediment samples were collected from the ditches inside the production area and from the ditch along the west side of the production area. These seven ISM samples were used to characterize risks from exposure to sediment within Load Line 8. The detected concentrations of the COPCs in each ISM sample were used as the EPCs for comparison to the FWCUGs. In addition, three discrete sediment and three discrete surface water samples were collected from the ditches located in the southwest side of Load Line 8 where surface water exits the AOC to characterize risks from exposure to sediment and to surface water. The samples were evaluated individually (i.e., the number of samples was too small to calculate 95% UCLs and the EPC was the detected concentration in the samples).

Results of Human Health Risk Assessment. No COCs were identified for potential remediation for soil, sediment, or surface water at Load Line 8.

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 FWERWP (USACE 2003a), *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 8 contains habitat that supports ecological receptors. These habitats have known chemical contamination (MKM 2007). Habitat types and an assessment of the ecological resources found at Load Line 8 are presented in subsequent subsections. Additionally, the results of an historical ERA (an ERS performed as part of the Characterization of 14 AOCs) 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 the *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 8 is approximately 44 acres. The buildings and structures within the Load Line 8 fence line have been removed. The habitat is mostly field, shrubland, and forest 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 8 represents 0.20% of the 21,683 acres at RVAAP.

Future use at Load Line 8 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, composition B (a combination of TNT and RDX), sulfates, nitrates, lead styphnate, and lead azide. Additional site-specific contaminants at Load Line 8 include tetryl, Octol (a mixture of TNT and HMX), and heavy metals (lead, chromium, mercury, and arsenic) from munitions assembly activities; VOCs from former Building 2B-22 that was utilized for solvent storage; PCBs from on-site transformers; and PAHs from former Buildings 2B-23 and 2B-24 that were used as heater houses.

The goal of the historical ERA (MKM 2007) was to identify COPECs in soil, sediment, and surface water for Load Line 8. The historical ERA 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 (including SRVs) and the ESV, 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. Initial depths to groundwater encountered during the Characterization of 14 AOCs well installation varied from 11-19 ft bgs.

The historical ERA tables for soil, sediment, and surface water are provided in Appendix H, Tables H-1, H-2, and H-3 and include the following applicable components to the Level I assessment:

- Frequency-of-detection,
- Average concentration,
- MDC,
- Background concentration,
- SRVs (sediment only),
- SRC determination,
- ESVs used for COPEC determinations,
- PBT compound identification,
- COPEC determination, and
- COPEC rationale.

Historical COPECs for Soil. The historical ERA conducted as part of the Characterization of 14 AOCs reported 45 chemicals in surface soil (0-1 ft) at Load Line 8 (MKM 2007). Of the 45 chemicals detected, 4 chemicals (calcium, magnesium, potassium, and sodium) were essential nutrients and were excluded from the COPEC screen (Appendix H, Table H-1). Twelve 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. Of the 36 SRCs, 7 inorganic chemicals (chromium, copper, iron, lead, manganese, mercury, and zinc) and 1 organic chemical (PCB-1254) exceeded their ESVs and were identified as COPECs (Table 7-15). Three chemicals (dibenzofuran, tetryl, and nitrocellulose) were identified as COPECs due to a lack of ESVs. Two COPECs that exceeded their ESVs (mercury and PCB-1254) were also PBT compounds. Beta-BHC did not exceed its ESV but was retained as a COPEC because it is a PBT compound. Appendix H, Table H-1 presents the Characterization of 14 AOCs ecological screening for surface soil at Load Line 8.

Historical COPECs for Sediment. The historical ERA conducted as part of the Characterization of 14 AOCs reported 36 chemicals in sediment at Load Line 8 (MKM 2007). Of the 36 chemicals detected, 4 chemicals (calcium, magnesium, potassium, and sodium) were essential nutrients and were excluded from the COPEC screen (Appendix H, Table H-2). Twelve inorganic chemicals and 14 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 26 SRCs, 6 inorganic chemicals (arsenic, cadmium, copper, lead, mercury, and silver) and 2 organic chemicals (4,4'-DDE and 4,4'-DDT) exceeded their ESVs and were identified as COPECs (Table 7-15). In addition, five inorganic chemicals (barium, beryllium, iron, manganese, and selenium) and two organic chemicals (2-amino-4,6-DNT and nitrocellulose) were selected as COPECs because they did not have an ESV for comparison. Three COPECs that exceeded their ESVs (mercury; 4,4'-DDE; and 4,4'-DDT) were also PBT compounds. 4,4'-DDD did not exceed its ESV but was retained as a COPEC because it is a PBT compound.

Historical COPECs for Surface Water. The historical ERA conducted as part of the Characterization of 14 AOCs reported 33 chemicals in surface water at Load Line 8 (MKM 2007). Of the 33 chemicals detected, 4 chemicals (calcium, magnesium, potassium, and sodium) were essential nutrients and were excluded from the COPEC screen (Appendix H, Table H-3). Twelve inorganic chemicals, 1 anion, and 13 organic chemicals were determined to be SRCs because they exceeded background concentrations or did not have an associated background concentration for comparison. Of the 26 SRCs, 1 inorganic chemical (copper) exceeded its ESV and was identified as a COPEC (Table 7-15). In addition, three inorganic chemicals (iron, manganese, and selenium), one anion (nitrate), and eight organic chemicals [benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, benzoic acid, benzenemethanol, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] were selected as COPECs because they did not have an ESV for comparison. No PBT compounds were detected in surface water.

Summary of Historical ERA. An historical ERA was performed to determine COPECs at Load Line 8 in surface soil, sediment, and surface water. Table 7-15 summarizes the COPECs by medium. Based on the identified COPECs, ecological risk was predicted in the historical investigation, and an additional investigation was recommended for Load Line 8 (MKM 2007).

7.3.2.3 Ecological Significance

Sources of data and information about the ecological resources at Load Line 8 include the *Integrated Natural Resources Management Plan* (INRMP; OHARNG 2014), previous characterization work (e.g., Characterization of 14 AOCs), and visits to Load Line 8 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 8. 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 1996a) 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 8 with each of the important places and resources listed in Appendix H, Table H-4.

The 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 Appendix H, Table H-4 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 clear the ecological place or resource is present or absent in 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 8 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 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 8. For example, Goal 1 states 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, which incorporates invasive species management and by utilizing native species mixes for revegetation after ground disturbance activities. These management goals help detect degradation (whether from training activities or historical contamination). While the applicability of the remaining 10 management goals to Load Line 8 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 8, they do not affect the decisions concerning the presence or absence of important or significant ecological places or resources at Load Line 8.

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 the unnamed tributary to Hinkley Creek are important/significant ecological resources at Load Line 8 (Appendix H, Table H-4).

Terrestrial Resources. Load Line 8 is dominated by terrestrial resources, as described below.

Habitat Descriptions and Species. The INRMP and AOC visits by SAIC scientists indicated Load Line 8 consists of seven vegetation types (Figure 7-4 and Photographs 7-1 and 7-2). The habitat area is dominated by four vegetation types: dry, early-successional, herbaceous field in the north-central half of the AOC (Photograph 7-1); dogwood (*Cornus* spp.)/willow (*Salix* spp.) saturated shrubland alliance in the south-central part of the AOC; red maple (*Acer rubrum*) successional forest along the northern and western boundaries of the AOC; and green ash (*Fraxinus pennsylvanica)/*American elm (*Ulmus americana*)/sugarberry (*Celtis laevigata*) temporarily flooded forest alliance along the southern and eastern boundaries of the AOC. Small areas of two forest types are represented along the southeastern AOC boundary: mixed, cold-deciduous, successional forest and American beech (*Fagus grandifolia)*/oak (*Quercus* spp.)/maple (*Acer* spp.) forest alliance. Small areas of dry, mid-successional, cold-deciduous shrubland are located along the northwestern and southern boundaries of the AOC.

On May 20, 2010, SAIC scientists conducted a field survey at Load Line 8 and determined there have been changes in vegetation at the AOC since 1999 (USACE 1999), including (1) an increase in the dry, early-successional, herbaceous field habitat; (2) a decrease in the saturated shrubland alliance; and (3) an increase in the temporarily flooded forest alliance. The herbaceous habitat is largely located in the north-central half of the AOC. These areas remain open and have expanded slightly southward as a result of demolition activities and periodic mowing at the AOC. Common species include tall fescue (*Festuca arundinacea*), reed canary grass (*Phalaris arundinacea*), Canada goldenrod (*Solidago canadensis*), yarrow (*Achillea millefolium*), and bedstraw (*Galium* spp.).

The decrease in the saturated shrubland is attributable to demolition activities and plant succession. In general, the lost shrubland habitat has been replaced by modest increases in the forest and herbaceous field habitat types. The remaining saturated shrubland areas occur in the south-central part of the AOC. 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*).

Photograph 7-1. Habitat of Herbaceous Field in Foreground and Forest in Background (May 20, 2010)

Photograph 7-2. Habitat of Southwestern Ditch and Riparian Vegetation (May 20, 2010)

The increase in the temporarily flooded forest alliance is attributed primarily to plant succession, as saplings in the saturated shrubland habitat grow into more mature trees and other tree species colonize the habitat. Forested habitat has expanded across the knoll in the north-central portion of the AOC, almost to the perimeter road. The saturated forest alliance is associated with floodplains near streams and rivers and other temporarily flooded areas. Characteristic tree species include green ash (*Fraxinus pennsylvanica*), American elm (*Ulmus americana*), sugarberry (*Celtis laevigata*), and red maple (*Acer rubrum*). Swamp white oak (*Quercus bicolor*), cottonwood (*Populus deltoides*), and black willow (*Salix nigra*) also are present. The understory and shrub layers are dense and include species such as American elm (*Ulmus americana*), northern arrowwood (*Viburnum recognitum*), silky dogwood (*Cornus amomum*), elderberry (*Sambucus canadensis*), and willows (*Salix* spp.). Herbaceous species include wingstem (*Verbesina alternifolia*), jewel weed (*Impatiens biflora* and *I. pallida*), false nettle (*Boehmeria cylindrica*), jack-in-the-pulpit (*Arisaema triphyllum*), smartweeds (*Polygonum* spp.), and sedges (*Carex* spp.).

The red maple successional forest along the northern and western boundaries covers approximately the same amount of land, as described in 1999 and shown on Figure 7-4. This community is characterized by a high abundance of red maple (*Acer rubrum*), often in nearly pure stands. Green ash (*Fraxinus pennsylvanica*), white ash (*Fraxinus americana*), black cherry (*Prunus serotina*), and sugar maple (*Acer saccharum*) are present but never dominant. In some cases, the canopy is very dense, and little to no ground cover is present. In other cases, the canopy is somewhat open, and old field species such as blackberry (*Rubus allegheniensis*), goldenrod (*Solidago* spp.), dogbane (*Apocynum cannabinum*), and self-heal or heal-all (*Prunella vulgaris*) form a dense herbaceous layer.

The small areas of dry, mid-successional, cold-deciduous shrubland along the northwestern and southern boundaries of the AOC and mixed, cold-deciduous, successional forest and American beech (*Fagus grandifolia)*/oak (*Quercus* spp.)/maple (*Acer* spp.) forest alliance along the southeastern boundary of the AOC do not appear to have changed since 1999.

The habitats at Load Line 8 were assessed to be healthy and functioning based on May 2010 observations by a 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 8 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 8 (e.g., vegetation and 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). There are no other reported surveys of habitats and animals at Load Line 8 beyond those summarized in the INRMP (OHARNG 2014).

Aquatic Resources. Load Line 8 has three types of aquatic resources, as described below.

Habitat Descriptions and Species. There are three types of aquatic resources at Load Line 8: drainage ditches/natural conveyances, an unnamed tributary to Hinkley Creek, and five small wetlands.

The water features at Load Line 8 include a network of ditches that drain the western and central portions of the AOC. The western ditch extends from the southwestern corner of the AOC north along the west side of the main Load Line 8 access road (Figure 7-4). The central ditch network includes two drainage ditches that drain the interior portion of Load Line 8. The two sets of ditches converge in the southwestern corner of the AOC (Photograph 7-2) and form a tributary to Hinkley Creek. The unnamed tributary to Hinkley Creek exits the southwestern corner of Load Line 8 and eventually flows into the NACA Test Area before flowing into Hinkley Creek.

The western ditch includes a mix of aquatic, herbaceous, shrub, and forest habitat. There are two very small beaver dams in the ditch. There is enough water in the flooded portion of the ditch to support fish, frogs, and other aquatic life, and all of these were observed during the May 2010 field survey. This ditch is likely to be dry in the summer and fall, with the exception of the far southwestern end of the ditch.

The central ditch network includes a mix of aquatic, scrub-shrub, and forest habitat. Most of the network consists of flooded ditch habitat. There is enough water in the flooded portion of the ditch to support fish, frogs, and other aquatic life, and all of these were observed in the central ditch during the May 2010 field survey. This ditch is likely to be dry in the summer and fall, with the exception of the far southwestern end of the ditch.

Despite the presence of aquatic life, the western and central ditch habitats are considered poor due to the absence of riparian vegetation, stream substrate, and water during parts of the year (Photograph 7-2). There are two very small wetlands associated with the central ditch.

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 the wetlands at Load Line 8 perform these and other related functions.

The wetlands at Load Line 8 consist of one large jurisdictional wetland complex (located along the southwestern boundary of the AOC and extending along the western ditch) and four small wetlands (located completely within the boundary of the AOC). A planning level survey [i.e., based on desktop surveys conducted for the OHARNG of wetland data and resources (e.g., NWI maps, aerials)] identified the four small wetlands (Figure 7-4) (OHARNG 2014). No jurisdictional wetlands determination has been conducted for these four wetlands at this AOC. For any wetland at the AOC potentially affected by remedial activities, a jurisdictional determination by USACE would be required to determine the regulatory status of any wetlands at Load Line 8.

A SAIC Professional Wetland Scientist used the Ohio Rapid Assessment Method (ORAM) (Ohio EPA 2001) in May 2010 to assess the condition of the five wetlands within the habitat area for Load Line 8 (Appendix H, Figures H-1 through H-5). 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 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 8 are presented in Appendix H (Figures H-1 through H-5). Figure 7-4 shows the locations of the wetlands. Table 7-16 summarizes ORAM scores for each wetland at Load Line 8.

Wetland 1 is a large wetland complex located along the southeastern boundary of Load Line 8 and along the western ditch; this complex includes the southern half of the western ditch, the central ditch, and a large beaver pond on the unnamed tributary to Hinkley Creek southwest of Load Line 8. Wetland 1 is 18.4 acres, with 3.8 acres inside the AOC. The wetland consists of a mix of permanently flooded, scrub-shrub, and forested habitat. Based on the ORAM, Wetland 1 is classified as Category 3 (with a final score of 62), indicating a high quality, forested wetland (Appendix H, Figure H-1).

Wetland 2 is located entirely within Load Line 8 in the central portion of the AOC. The wetland covers 0.05 acres and consists of primarily forested habitat. Based on the ORAM, Wetland 2 is classified as Category 2 (with a final score of 30), indicating moderately good wetland quality with some moderate impairment of wetland functions and conditions (Appendix H, Figure H-2).

Wetland 3 is located entirely within Load Line 8, also in the central portion of the AOC. The wetland covers 0.03 acres and consists of primarily forested habitat. Based on the ORAM, Wetland 3 is classified as Category 2 (with a final score of 30), indicating moderately good wetland quality with some moderate impairment of wetland functions and conditions (Appendix H, Figure H-3).

Wetland 4 is located entirely within Load Line 8 in the western portion of the AOC. The wetland covers 0.87 acres and consists of primarily forested habitat. It appears to be an isolated wetland with no surface hydrologic connection to any streams or wetlands. Based on the ORAM, Wetland 4 is classified as Category 2 (with a final score of 44), indicating moderately good wetland quality with some moderate impairment of wetland functions and conditions (Appendix H, Figure H-4).

Wetland 5 is located entirely within Load Line 8 in the eastern portion of the AOC. The wetland covers 0.18 acres and consists of primarily forested habitat. It appears to be an isolated wetland with no surface hydrologic connection to any streams or wetlands. Based on the ORAM, Wetland 5 is classified as Category 2 (with a final score of 40), indicating moderately good wetland quality with some moderate impairment of wetland functions and conditions (Appendix H, Figure H-5).

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 8 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. There are no other known aquatic resources (Appendix H, Table H-4) at or near Load Line 8 (e.g., vegetation, animals). Aside from the vegetation map in the INRMP, as shown in Figure 7-4, there are no other reported surveys of habitats and wildlife at Load Line 8.

Ecosystem and Landscape Roles and Relationships. There are four spatial areas evaluated to assess the ecosystem and landscape roles and relationships at Load Line 8: 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 forest communities, two shrubland communities, and one herbaceous field habitat border Load Line 8 (Figure 7-4). There are no apparent differences in habitat quality of these forest communities inside or outside of the AOC. The types and qualities of habitat are not unique and can be found at many other areas at Camp Ravenna.

Wetlands are located outside of Load Line 8, to the west along the AOC boundary, north of Fuze and Booster Road, and east of the AOC boundary. In addition, the large wetland complex that is located in the southern/southwestern portion of the AOC extends beyond the AOC boundary. Two ditches converge in the southwestern corner of the AOC (Photograph 7-2) and form the upper reaches of the tributary to Hinkley Creek.

The closest recorded rare species [bryophyte lurking leskea (*Plagiothecium latebricola*)] is located approximately 600 ft east of the AOC (Table 7-17); it is a state-threatened species. The next closest rare species [Northern harrier (*Circus cyaneus*)] is located approximately 2,000 ft west of the AOC; it is a state-endangered species.

A beaver dam is located southwest of the AOC and is associated with the southern wetland complex. No 100-year floodplains or biological/water quality sampling locations (stream and pond samples) are in or near the AOC. The nearest resources of these types are more than 1,600 ft away.

The Entire Camp Ravenna. Load Line 8 is approximately 44 acres in size, representing 0.2% of the total area of Camp Ravenna (21,683 acres). There are approximately 2,310 acres of forest type FL1 [temporarily flooded forest alliance (e.g., green ash and American elm)] at Camp Ravenna

(OHARNG 2014), representing 10.7% of the habitat at RVAAP. There are approximately 2,290 acres of forest type FU2 (American beech/oak/maple) at RVAAP (OHARNG 2014), representing 10.6% of the habitat at Camp Ravenna. There are approximately 3,510 acres of forest type FU4 (red maple and green/red ash) (OHARNG 2014), representing 16.2% of the habitat at Camp Ravenna. There are approximately 1,650 acres of forest type FU5 (white ash/black cherry/red maple) (OHARNG 2014), representing 7.6% of the habitat at Camp Ravenna. There are approximately 2,050 acres of vegetation type HU1 (goldenrod and clasping-leaf dogbane) (OHARNG 2014), representing 9.5% of the habitat at Camp Ravenna. There are approximately 300 acres of vegetation type SL4 (silky dogwood and pussy willow) (OHARNG 2014), representing 1.4% of the habitat at Camp Ravenna. There are approximately 2,900 acres of vegetation type SU1 (gray dogwood and northern arrowwood) (OHARNG 2014), representing 13.4% of the habitat at Camp Ravenna. There are approximately 1,970 acres of wetlands (jurisdictional and planning level survey) as defined in the INRMP (OHARNG 2014), representing 9.1% of the habitat at Camp Ravenna. These types of resources are abundant and are not unique to Load Line 8 at Camp Ravenna.

Ecoregion. In the area surrounding Camp Ravenna, forests occupy a high percentage of the terrain. Ohio’s forests cover approximately 8,000,000 acres or 30% of the state (USDA 2009). The Erie/Ontario Drift and Lake Plain ecoregion (USEPA 2011) is located in the northeastern part of Ohio and both contain communities of temporarily flooded forest alliance (e.g., green ash and American elm); American beech/oak/maple forest alliance; red maple and ash successional forest; and mixed, cold-deciduous, successional forest (e.g., white ash/black cherry/red maple). The Erie/Ontario Drift and Lake Plain ecoregion exhibits rolling to level terrain formed by lacustrine and low lime drift deposits. Lakes, wetlands, and swampy streams occur where stream networks converge or where the land is flat and clayey (USEPA 2011). 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 Camp Ravenna (USFS 2011). In 2009, approximately 93,900 acres of forest type FL1; approximately 621,100 acres of forest type FU2; approximately 265,290 acres of forest type FU4; and approximately 355,800 acres of forest type FU5 were found throughout northwestern Ohio in Cuyahoga, Geauga, Mahoning, Portage, Stark, Summit, and Trumbull counties that surround RVAAP (USFS 2011). The herbaceous field and shrubland was not individually found in this query because it is not classified as a main group of trees in the forest inventory data tool. However, herbaceous field (HU1) and shrubland (SL4 and SU1) are common across the ecoregion (USDA 2011). Wetlands across the ecoregion make up 207,800 acres (USEPA 1999b). The vegetation and wetland communities at Load Line 8 are also found in the surrounding counties in the ecoregion of northeastern Ohio.

In summary, the current vegetation types of: (1) temporarily flooded forest alliance (e.g., green ash/American elm); (2) American beech/oak/maple forest alliance; (3) red maple, green/red ash successional forest; (4) mixed, cold-deciduous, successional forest; (5) dry, early-successional, herbaceous field; (6) saturated shrubland alliance; (7) dry, mid-successional, cold-deciduous shrubland; and (8) wetlands are found in the vicinity of Load Line 8. The forest types, herbaceous field, shrubland, and wetlands are in abundance at Camp Ravenna and the larger surrounding local ecoregion. There is no known unique resource at Load Line 8 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, 12 soil COPECs, 16 sediment COPECs, and 13 surface water COPECs were identified at Load Line 8. These COPECs are listed in Table 7-15.

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. The resources on this list present at Load Line 8 are the wetlands and the unnamed tributary to Hinkley Creek. Environmental management goals and objectives of OHARNG are applicable to Load Line 8, 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 8 is made up of approximately 44 acres of herbaceous field, shrubland, and forest communities. Five wetlands are found at the AOC. The vegetation types and wetlands at Load Line 8 are found nearby, at RVAAP, and in the ecoregion.

Because there is contamination at Load Line 8 and important or ecologically significant resources (i.e., tributary, wetlands) are present, this ERA continues to a Level II Screening 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 8 are the contaminant source. The operations contributed chemicals to the surrounding soil, sediment, and surface water.
- **Transport Mechanisms.** Material in soil can migrate via erosion and leaching. Migration to sediment and surface water via erosion and leaching 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 the land is relatively flat and has extensive vegetative ground cover that will further help to increase infiltration and decrease erosion. This extensive vegetative cover includes herbaceous fields, shrublands, and forests. While much of the precipitation landing on this area is expected to infiltrate the soil, some rainfall will leave the AOC as runoff. For example, there are shallow ditches that provide a likely flow pathway from the location of the former buildings to the unnamed tributary to Hinkley Creek and to the wetlands. The ditches also provide a possible pathway to transport leachate from soil to the wetlands.

- **Exposure Media.** These are media where contaminants are available for exposure to ecological receptors. Potential exposure media at Load Line 8 are soil, sediment, surface water, vegetation, and animals.
- **Exposure Pathways.** A main exposure pathway is ingestion of contaminated food. Other exposure 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 at Load Line 8 are defined in the Level I ERA (Section 7.3.2). Eight types of habitats are described. Habitats, species, and other resources were analyzed, and it was determined that important or significant ecological resources are present at Load Line 8. One large jurisdictional wetland, four small planning level survey wetlands, and an unnamed tributary to Hinkley Creek are located at Load Line 8. 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 SL 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 collection of discrete soil boring samples and ISM surface soil (0-1 ft bgs) samples at locations surrounding historical ISM sample locations. Sample locations are provided in Figure 4-7. Discrete samples and ISM samples are not combined in the PBA08 RI COPEC screening for soil, and only ISM soil samples collected during the PBA08 RI and the historical ERA were used in the analysis. For sediment, discrete samples were collected in 2010 from the ditches in the southwestern side of Load Line 8 where surface water exits the AOC. ISM samples collected in 2004 and 2010 were taken from the ditches in the production area. Discrete samples and ISM samples are evaluated separately; they are not combined in the PBA08 RI COPEC screening for sediment. For surface water, only discrete samples collected within the Load Line 8 boundary during the PBA08 RI were used to evaluate the 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 (and/or SRV for sediment). 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. Chemicals are retained as COPECs if they exceed background concentrations (and SRVs for sediment) and the ESV, if the chemical exceeds background concentrations (and SRVs 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 negative 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 Ohio EPA Outside Mixing Zone Maximum (OMZM) ESV, when available, Ohio EPA requested the MDC concentration also be compared to the Ohio EPA Outside Mixing Zone Average (OMZA) ESV (Appendix H, Tables H-9 and H-14).

Maximum and Average Detected Concentrations. The MDCs were compared to the background concentrations and ESVs (Appendix H, Tables H-10 through H-14) for detected chemicals. These comparisons are provided for soil (Appendix H, Table H-10), sediment in the ditches (Appendix H, Tables H-11 and H-12), and surface water in the ditches (Appendix H, Tables H-13 and H-14). For potential use in Step 3a, average concentrations were compared to the background concentrations and ESVs (Appendix H, Tables H-15 through H-17) for detected chemicals. These comparisons are provided for soil (Appendix H, Table H-15), sediment in the drainage ditches (Appendix H, Table H-16), and surface water in the drainage ditches (Appendix H, Table H-17).

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 the guidance document (Ohio EPA 2008). 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 (SQGs), followed by ESLs. The hierarchy for surface water is the Ohio EPA Water Quality Criteria OMZM and OMZA ESVs, 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 Surface Soil (0-1 ft bgs)

During the PBA08 RI, 55 chemicals were detected in surface soil at Load Line 8. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. A total of 13 inorganic chemicals and 32 organic chemicals were determined to be SRCs because they exceeded background concentrations or did not have an associated background concentration for comparison. Of the 45 SRCs, 8 inorganic chemicals (cadmium, chromium, copper, lead, manganese, mercury, nickel, and zinc) and 2 organic chemicals (naphthalene and 4,4’-DDE) exceeded their ESVs and are identified as integrated COPECs (Table 7-18). In addition, four organic chemicals (HMX, nitrocellulose, tetryl, and dibenzofuran) were selected as integrated COPECs because they do not have an ESV for comparison. Two of the integrated COPECs (mercury and 4,4’-DDE) were also PBT compounds. Four PBT compounds (4,4’-DDD; 4,4’-DDT; PCB-1254; and beta-BHC) were identified as integrated COPECs in the PBA08 RI, even though they did not exceed their ESVs. Table 7-18 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 surface soil.

Most of the inorganic COPECs reported in the historical ERA (Table 7-15) for soil are also identified in this ERA. The historical ERA (MKM 2007) identified one inorganic COPEC (iron) that is not an integrated COPEC because it is considered an essential nutrient in the PBA08 RI data set. Seven new integrated COPECs (cadmium; nickel; HMX; naphthalene; 4,4’-DDD; 4,4’-DDE; and 4,4’-DDT) were identified in this ERA. Cadmium was identified as an integrated COPEC due to detections above a new, more conservative ESV (Ohio EPA 2008). Six new integrated COPECs (nickel; HMX; naphthalene; 4,4’-DDD; 4,4’-DDE; and 4,4’-DDT) were identified due to detections of these 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.

7.3.3.5 Integrated COPECs for Sediment

As discussed in Section 7.3.3.3, the sediment data collected within the geographic area of Load Line 8 were subdivided into two data sets: discrete data and ISM data. A summary of the integrated COPECs identified in sediment at Load Line 8 for each data set is presented below.

Integrated COPECs for Sediment – Discrete Samples. During the PBA08 RI, 25 chemicals were detected in sediment from the discrete ditch samples. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. Five organic chemicals were determined to be SRCs because they exceeded their background concentrations or did not have associated background concentrations for comparison. None of the five SRCs were identified as integrated COPECs because none exceeded their ESV (Appendix H, Table H-11). In addition, no PBT compounds were identified in the ditch sediment. None of the COPECs reported in the historical ERA (Table 7-15) for sediment are identified as integrated COPECs in the discrete samples collected during the PBA08 RI. Based on the absence of integrated COPECs from discrete samples collected from the ditches, this ERA predicts the potential for ecological risk in sediment at these ditches is unlikely.

Integrated COPECs for Sediment – ISM Samples. During the PBA08 RI, 37 chemicals were detected in sediment from the ISM ditch samples. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. A total of 6 inorganic chemicals and 16 organic chemicals were identified as SRCs because they exceeded background concentrations or did not have an associated background concentration for comparison. Of the 22 SRCs, 2 inorganic chemicals (cadmium and mercury) and 2 organic chemicals (4,4'-DDE and 4,4'-DDT) exceeded their ESVs and are identified as integrated COPECs (Table 7-19). In addition, two inorganic chemicals (beryllium and selenium) and two organic chemicals (nitrocellulose and tetryl) were integrated COPECs because they do not have an ESV for comparison. Three of the integrated COPECs (mercury; 4,4'-DDE; and 4,4'-DDT) were also PBT compounds. Although it did not exceed its ESV, 4,4'-DDD was identified as an integrated COPEC in the PBA08 RI because it is a PBT compound. Table 7-19 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.

In the historical ERA (MKM 2007), ditch samples and sewer samples were combined and evaluated as sediment. An analysis of sewer samples will be conducted as part of the investigation for RVAAP-67 Facility-wide Sewers; consequently, the sewer samples were excluded from the analysis in this RI Report. Six inorganic chemicals (arsenic, barium, copper, iron, lead, and manganese) identified as COPECs in the historical ERA are excluded from this evaluation, as the elevated detections of these chemicals were from the sewer samples. In ditch sediment, the remaining historical COPECs (Table 7-15) were also identified as integrated COPECs (Table 7-19). One new integrated COPEC (tetryl) was identified because it was detected in the ISM sample collected in 2010. Based on the presence of integrated COPECs, this ERA predicts the potential for ecological risk in sediment where the ISM samples were collected.

7.3.3.6 Integrated COPECs for Surface Water

During the PBA08 RI, 20 chemicals were detected in ditch surface water. Four chemicals (calcium, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. Iron is typically an essential nutrient; however, the MDC exceeded the RDA/RDI-based SL for iron and it was retained as an SRC for surface water. Fifteen inorganic chemicals and one anion were identified as SRCs because they exceeded their background concentrations or did not have an associated background concentration for comparison. Of the 16 SRCs, 5 inorganic chemicals (aluminum, copper, iron, manganese, and zinc) exceeded their ESVs and are identified as integrated COPECs (Table 7-20). An additional inorganic chemical (lead) did not exceed the OMZM, but did exceed the OMZA, and was selected as an integrated COPEC (Table 7-20). In addition, one anion (nitrate) was selected as an integrated COPEC because it did not have an ESV for comparison. No PBT compounds were identified in surface water. Table 7-20 shows the calculated ratio of MDC to ESV (including OMZM and OMZA ESVs) for each integrated COPEC. Appendix H, Table H-13 presents the details of the MDC to OMZM ESV comparisons, and Table H-14 presents the details of the MDC to OMZA ESV comparisons for surface water in the ditch. These comparisons used the OMZM and OMZA from the Ohio EPA Water Quality Criteria, when available, as the ESV; when the OMZM or OMZA were not available, the hierarchy of preferred sources was followed.

Most of the inorganic COPECs reported in the historical ERA (Table 7-15) for surface water are also identified in this ERA. The historical ERA (MKM 2007) identified one inorganic COPEC (selenium) because it did not have an ESV for comparison; however, an ESV is now available, and selenium is not identified as an integrated COPEC. The historical ERA (MKM 2007) also identified eight SVOCs as integrated COPECs; however, these chemicals were not detected in PBA08 RI samples and were not identified as integrated COPECs. One new integrated COPEC (aluminum) was identified because of detections greater than the background concentration in the PBA08 RI data set.

Based on the presence of integrated COPECs (aluminum, copper, iron, lead, manganese, zinc, and nitrate), this ERA predicts the potential for ecological risk in surface water in 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 evaluates and applies 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 the *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 ERA should be initiated.”

The evaluation and refinement factors used in Step 3A are as follows:

- Comparison of average (i.e., 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.

There are 18 integrated COPECs in surface soil at Load Line 8. Cadmium; chromium; copper; lead; manganese; mercury; nickel; zinc; naphthalene; and 4,4’-DDE are the 10 integrated COPECs that exceeded their ESVs. Mercury and 4,4’-DDE are also PBT compounds. Though they did not exceed their ESVs, 4,4’-DDD; 4,4’-DDT; PCB-1254; and beta-BHC were identified as integrated COPECs in the PBA08 RI because they are PBT compounds. Four additional chemicals (HMX, nitrocellulose, tetryl, and dibenzofuran) are integrated COPECs because the chemicals do not have an ESV.

There are no integrated COPECs in sediment based on the discrete data. However, there are nine integrated COPECs in sediment (beryllium; cadmium; mercury; selenium; nitrocellulose; tetryl; 4,4’-DDD; 4,4’-DDE; and 4,4’-DDT) based on the ISM data. Cadmium; mercury; 4,4’-DDE; and 4,4’-DDT are the four integrated COPECs that exceeded their ESVs. Mercury; 4,4’-DDE; and 4,4’-DDT are also PBT compounds. Though it did not exceed its ESV, 4,4’-DDD was identified as an integrated COPEC in the PBA08 RI because it is a PBT compound. Four additional chemicals (beryllium, selenium, nitrocellulose, and tetryl) are integrated COPECs because the chemicals do not have an ESV.

There are seven integrated COPECs in surface water at Load Line 8. Aluminum, copper, iron, lead, manganese, and zinc are integrated COPECs that exceeded their background concentrations and ESVs. One additional chemical (nitrate) is an integrated COPEC because it does not have an ESV. No PBT compounds were identified in surface water.

PBT compounds are discussed later in Step 3A. Chemicals with no ESVs are discussed later in Step 3A and in the uncertainty section (Section 7.3.3.9). 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 (i.e., 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 7-21).

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 (Table 7-21) on a COPEC-by-COPEC basis. These evaluations are followed by the application of additional evaluation and refinement factors, when necessary.

Comparison of Mean Concentration to ESV. Nine integrated COPECs (chromium; copper; nickel; naphthalene; 4,4’-DDD; 4,4’-DDE; 4,4’-DDT; beta-BHC; and PCB-1254) in soil are eliminated in this step because the mean concentration is smaller than the ESV (Appendix H, Table H-15). Each eliminated integrated COPEC is discussed below relative to the mean concentration being smaller than the ESV and the related evaluation and refinement factors. Table 7-22 shows the relevant data and various comparisons. Additional information about PBT compounds (4,4’-DDD; 4,4’-DDE; 4,4’-DDT; beta-BHC; and PCB-1254) is provided later in Step 3A.

Chromium. Chromium was detected in all 49 ISM samples analyzed for inorganic chemicals in Load Line 8 surface soil. Forty-five samples exceeded the background concentration, and only 13 samples had chromium concentrations exceeding the ESV (Table 7-22). Although the MDC for chromium in surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV. Therefore, chromium is eliminated from further consideration and will not be a final COPEC.

Copper. Copper was detected in all 49 ISM samples analyzed for inorganic chemicals in Load Line 8 surface soil. Twenty-one samples were above the background concentration, and only four samples had copper concentrations exceeding the ESV (Table 7-22). Although the MDC for copper in surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and close to the background concentration. Therefore, copper is eliminated from further consideration and will not be a final COPEC.

Nickel. Nickel was detected in all 49 ISM samples analyzed for inorganic chemicals in Load Line 8 surface soil. Twenty-one samples were above the background concentration, and only one sample had a nickel concentration exceeding the ESV (Table 7-22). Although the MDC for nickel in surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and close to the background concentration. Therefore, nickel is eliminated from further consideration and will not be a final COPEC.

Naphthalene. Naphthalene was detected in 16 of 23 ISM samples analyzed for organic chemicals in Load Line 8 surface soil. There is no background concentration for comparison, but only two samples had concentrations exceeding the ESV (Table 7-22). Although the MDC for naphthalene in surface soil exceeds the ESV, the mean concentration is less than the ESV. Therefore, naphthalene is eliminated from further consideration and will not be a final COPEC.

4,4’-DDD. 4,4’-DDD was detected in one of eight ISM samples analyzed for pesticides in Load Line 8 surface soil. The detected 4,4’-DDD concentration did not exceed its ESV in surface soil but was retained as a COPEC because it is a PBT compound (Appendix H, Table H-10 and Table 7-22). The mean MDC for 4,4’-DDD; 4,4’-DDE; and 4,4’-DDT is 0.0121 mg/kg, which is below the ESV of 0.021 mg/kg; therefore, the cumulative toxicity is low. While 4,4’-DDD is a PBT compound, the ESV accounted for bioaccumulation (USEPA 2007a); therefore, 4,4’-DDD is eliminated from further consideration and will not be a final COPEC.

4,4’-DDE. 4,4’-DDE was detected in one of eight ISM samples analyzed for pesticides in Load Line 8 surface soil. There is no background concentration for comparison, but only the single detection had a concentration exceeding the ESV (Table 7-22). The mean MDC for 4’-DDD; 4,4’-DDE; and 4,4’-DDT is 0.0121 mg/kg, which is below the ESV of 0.021 mg/kg; therefore, the cumulative toxicity is low. Although the MDC for 4,4’-DDE in surface soil exceeds the ESV, the mean concentration is less than the ESV. While 4,4’-DDE is a PBT compound, the ESV accounted for bioaccumulation (USEPA 2007a); therefore, 4,4’-DDE is eliminated from further consideration and will not be a final COPEC.

4,4’-DDT. 4,4’-DDT was detected in one of eight ISM samples analyzed for pesticides in Load Line 8 surface soil. The detected 4,4’-DDT concentration did not exceed its ESV in surface soil but was retained as a COPEC because it is a PBT compound (Appendix H, Table H-10 and Table 7-22). The mean MDC for 4,4’-DDD; 4,4’-DDE; and 4,4’-DDT is 0.0121 mg/kg, which is below the ESV of 0.021 mg/kg; therefore, the cumulative toxicity is low. While 4,4’-DDT is a PBT compound, the ESV accounted for bioaccumulation (USEPA 2007a); therefore, 4,4’-DDT is eliminated from further consideration and will not be a final COPEC.

Beta-BHC. Beta-BHC was detected in one of eight ISM samples analyzed for pesticides in Load Line 8 surface soil. The detected beta-BHC concentration did not exceed its ESV in surface soil but was retained as a COPEC because it is a PBT compound (Appendix H, Table H-10 and Table 7-22). While beta-BHC is a PBT compound, the ESV accounted for bioaccumulation (USEPA 2003); therefore, beta-BHC is eliminated from further consideration and will not be a final COPEC.

PCB-1254. PCB-1254 was detected in three of eight ISM samples analyzed for PCBs in Load Line 8 surface soil. PCB-1254 did not exceed its ESV in surface soil but was retained as a COPEC because it is a PBT compound (Appendix H, Table H-10 and Table 7-22). While PCB-1254 is a PBT compound, the ESV accounted for bioaccumulation (DOE 1997); therefore, PCB-1254 is eliminated from further consideration and will not be a final COPEC.

Of the 14 integrated surface soil COPECs with MDCs exceeding the ESV, 9 COPECs (chromium; copper; nickel; naphthalene; 4,4’-DDD; 4,4’-DDE; 4,4’-DDT; beta-BHC; and PCB-1254) were eliminated from further consideration. Five remaining integrated COPECs with MDCs greater than the ESV (cadmium, lead, manganese, mercury, and zinc) in surface soil have mean concentrations greater than the ESV.

Comparison of Mean Concentration Above ESV to Background Concentration. One integrated COPEC (manganese) in surface soil has a mean concentration larger than the ESV but is eliminated in this step because the mean concentration is smaller than the background concentration. Manganese is discussed relative to the various evaluation and refinement factors.

Manganese. Manganese in surface soil has a mean concentration less than the background concentration, and the background concentration is more than six times greater than the ESV (Table 7-22). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Manganese was detected in all 49 ISM samples at concentrations above the ESV; however, only 3 samples had detections that exceeded the background concentration. Although the MDC for manganese in surface soil exceeds the background concentration and the ESV, the mean concentration is below background concentration, and the ESV is conservative. Therefore, manganese is eliminated from further consideration and will not be a final COPEC.

Continued Evaluations. The remaining four integrated COPECs (cadmium, lead, mercury, and zinc) in surface soil have mean concentrations greater than the ESV and the background concentration (Table 7-22). Each remaining integrated COPEC is discussed below relative to the first four and related evaluation and refinement factors.

Cadmium. Cadmium in surface soil has a mean concentration greater than the ESV. There is no background concentration for comparison. It was detected above the ESV in 11 of 49 ISM samples (Table 7-22). Because the mean concentration in surface soil exceeds the ESV and there is not a background concentration for comparison, cadmium requires further evaluation as a COPEC.

Lead. Lead in surface soil has a mean concentration greater than the background concentration and ESV. It was detected above the background concentration in 30 of 49 ISM samples and above the ESV in all 49 samples (Table 7-22). This is because 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 surface soil exceeds both the background concentration and ESV. Lead requires further evaluation as a COPEC.

Mercury. Mercury in surface soil has a mean concentration greater than the background concentration and ESV. Mercury was detected above the background concentration in 25 of 49 ISM samples and above the ESV in 44 of 49 samples (Table 7-22). This is because the background concentration is 70 times greater than the ESV, suggesting the ESV may be very conservative. Although mercury has a very conservative ESV, it is a PBT compound, and the mean concentration exceeds both the background concentration and ESV. Mercury requires further evaluation as a COPEC.

Zinc. Zinc in surface soil has a mean concentration greater than the background concentration and ESV. It was detected above the background concentration in 36 of 49 ISM samples and at concentrations above the ESV in all 49 samples (Table 7-22). This is because the ESV is lower than the background concentration, which indicates the ESV for zinc may be conservative. Because the mean concentration in 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 the background concentration, evaluates how much higher the mean soil concentration is than the background concentration. Four COPECs (cadmium, lead, mercury, and zinc) 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 will not be considered a final COPEC. Table 7-23 shows that while the mean concentration exceeds the background concentration, the exceedance is relatively small for lead, mercury, and zinc. For example, the mean concentration for zinc is 89.6 mg/kg, while the background concentration is 61.8 mg/kg. Cadmium was not detected during the investigation of background concentrations at RVAAP; therefore, a comparison of mean concentration to background concentration is not available. The remaining four COPECs are evaluated further.

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.

Magnitude of ESV Exceedance. Although the mean concentration to ESV ratios for cadmium (1.4), lead (4.4), mercury (120), and zinc (2) indicate a possibility of risk, the ratios for cadmium and zinc are relatively small (Table 7-24). The small ratio for cadmium and zinc indicates the potential for toxicity is relatively low, and this likely supports elimination of cadmium and zinc as integrated 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."

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 2003). 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). Because Ohio EPA does not provide guidance on which value to select of these four, the most conservative (lowest) value was chosen for this ERA. It is possible that the chosen ESV is too conservative. Alternative ESVs are presented below for the remaining four integrated COPECs in surface soil.

The Ohio EPA approved and preferred cadmium ESV used in this ERA is 0.36 mg/kg. This ESV is from the USEPA EcoSSLs (Appendix H, Table H-7). The cadmium ESV used in this ERA is the most conservative ESV of the USEPA EcoSSLs. Other EcoSSLs for cadmium include 0.77 mg/kg, 32 mg/kg, and 140 mg/kg (USEPA 2005a). The ESV of 0.36 mg/kg is about 10 times lower than the ESV (4 mg/kg) from the next source (DOE 1997) of ESVs preferred by Ohio EPA (Appendix H, Table H-7). This information indicates the Ohio EPA approved and preferred ESV for cadmium is conservative; thus, including cadmium as a COPEC is conservative.

The Ohio EPA approved and preferred lead ESV used in this ERA is 11 mg/kg. This ESV is 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 mg/kg, 120 mg/kg, and 1,700 mg/kg (USEPA 2005b). The ESV of 11 mg/kg is about four times lower than the ESV (40.5 mg/kg) from the next source (DOE 1997) of ESVs preferred by Ohio EPA (Appendix H, Table H-7). 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 the selection of lead as a COPEC, is very conservative.

The Ohio EPA approved and preferred mercury ESV used in this ERA is 0.00051 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, USEPA 2001, USEPA 2003) (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 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; therefore, 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). The zinc ESV used in this ERA is the most conservative ESV of the USEPA EcoSSLs. Other EcoSSLs for zinc include 79 mg/kg, 120 mg/kg, 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 (DOE 1997) of ESVs preferred by Ohio EPA (Appendix H, Table H-7). 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 for the Level II work. Table 7-24 shows the ratio of mean concentration-to-ESV 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 cadmium and mercury in surface soil, use of the alternative ESV would decrease ratios to less than 1. If the alternative ESVs were used, cadmium and mercury would be eliminated from further consideration and would not be final COPECs. The ratio of mean concentration to the alternative ESV for lead and zinc is slightly greater than 1, indicating that selection of these two chemicals as COPECs is somewhat conservative.

Qualitative Relationship of Exposure Area to General Home Range. A majority of the highest cadmium, lead, mercury, and zinc concentrations in surface soil (0-1 ft bgs) are scattered near the former buildings and roads at Load Line 8 (Figure 5-2). The two highest concentrations are as follows:

- Cadmium: 2.8 mg/kg at LL8ss-004M and 1.9 mg/kg at LL8ss-012M.
- Lead: 210 mg/kg at LL8ss-004M and 150 mg/kg at LL8ss-016M.
- Mercury: 0.87 mg/kg at LL8ss-011M and 0.26 mg/kg at LL8ss-012M.
- Zinc: 220 mg/kg at LL8ss-004M and 160 mg/kg at LL8ss-005M and LL8ss-016M.

Wildlife receptors, especially those with 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 cadmium, lead, mercury, and zinc at Load Line 8. The highest concentrations of integrated COPECs are interspersed with large areas of lower concentrations over many acres. For example, the two highest cadmium concentrations are about 400 ft apart, with lower concentrations between the peaks. This suggests the exposure area with highly elevated concentrations would be small compared to the home ranges of small receptors (robins and field mice) and even smaller for large receptors (turkey and deer) that roam over hundreds of acres. Likewise, the amount of area with highest concentrations to which immobile receptors (plants) would be exposed is small.

An examination of the number of concentrations detected above the alternative ESVs (discussed in the previous section) indicates that the magnitude of receptor exposures to these elevated concentrations would be limited. Specifically, only 3 of the 49 mercury results and 7 of the 49 cadmium results are above their alternative ESVs. The ratios of mean concentrations to alternative ESVs are less than 1 for cadmium (0.61) and mercury (0.63). Lead (22 of 49 detections) and zinc (23 of 49 detections) are detected above the alternative ESVs at a higher frequency; however, the ratios of mean concentration to alternative ESV are relatively small for lead (1.2) and zinc (1.1). In addition, the PBA08 RI ISM samples have measurements lower than the historical ISM samples. For example, the PBA08 MDCs for cadmium (0.36 mg/kg), lead (42.1 mg/kg), mercury (0.076 mg/kg), and zinc (88.7 mg/kg) are near or below their alternative ESVs (Figure 5-2). Thus, COPEC exposure to receptors would be limited to the small areas of elevated concentrations around the former buildings, suggesting that cadmium, lead, mercury, and zinc can be eliminated from further consideration and would not be final COPECs. However, mercury is a PBT compound and will be assessed further.

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 surface soil. Some factors, such as those concerning wetlands and off-site migration, apply to the whole AOC and will be discussed later. 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.

Sediment. No COPECs were identified in the discrete sediment samples. The nine integrated COPECs in ISM sediment samples are beryllium; cadmium; mercury; selenium; nitrocellulose; tetryl; 4,4’-DDD; 4,4’-DDE; and 4,4’-DDT (Table 7-19). Beryllium, selenium, nitrocellulose, and tetryl were identified as integrated COPECs because the chemicals did not have an ESV and are discussed later in Step 3A and in the uncertainty section (Section 7.3.3.9). 4,4’-DDD did not exceed its ESV but was retained as a COPEC because it is a PBT compound. Four COPECs (cadmium; mercury; 4,4’-DDE; and 4,4’-DDT) had an MDC that exceeded the ESV and are discussed below.

Cadmium. Cadmium was detected in five of seven ISM sediment samples collected in the ditches (Table 7-25). Cadmium does not have a background concentration for comparison; however, three of five detections exceeded both the ESV and SRV. The magnitude of the mean to SRV ratio (1.4) was low, and the mean to ESV ratio (1.08) was also low (Appendix H, Table H-16). The small exceedances indicate risk to ecological receptors is small, and this supports elimination of cadmium as an integrated COPEC for sediment in the ditches. However, because the mean cadmium concentration in sediment is above the SRV and ESV, it is evaluated further with additional refinement factors.

Mercury. Mercury was detected in all seven ISM sediment samples collected in the ditches. Five of seven samples had detections above its background concentration, and one detection (0.26 mg/kg) exceeded its ESV and SRV (Table 7-25; Appendix H, Table H-12). The magnitude of ESV exceedance was low, and the mean to ESV ratio (0.52) was below 1 (Appendix H, Table H-16). The single, small exceedance and mean to ESV ratio below 1 indicates risk to ecological receptors is small; therefore, mercury in sediment is eliminated from further consideration and will not be a final COPEC (Table 7-25).

4,4'-DDD. 4,4'-DDD was detected in one of two ISM sediment samples analyzed for pesticides at Load Line 8. 4,4'-DDD does not have a background concentration or SRV for comparison. The single detection did not exceed the ESV in sediment (Table 7-19; Appendix H, Table H-12); however, it was retained as an integrated COPEC because it is a PBT compound. The single detection below the ESV indicates a small amount of risk to ecological receptors; this support elimination of 4,4'-DDD as an integrated COPEC for sediment. Additional information about PBT compounds is provided later in Step 3A.

4,4'-DDE. 4,4'-DDE was detected in one of two ISM sediment samples analyzed for pesticides at Load Line 8, and the single detection exceeded the ESV (Table 7-19; Appendix H, Table H-12). 4,4'-DDE does not have a background concentration or SRV for comparison. The mean to ESV ratio (4.05) requires that 4,4'-DDE be evaluated further.

4,4'-DDT. 4,4'-DDT was detected in one of two ISM sediment samples analyzed for pesticides at Load Line 8, and the single detection (0.0065 mg/kg) slightly exceeded the ESV (0.00416 mg/kg) (Table 7-19; Appendix H, Table H-12). 4,4'-DDT does not have a background concentration or SRV for comparison. The magnitude of ESV exceedance and the mean to ESV ratio (1.03) were low (Appendix H, Table H-16). The small ratio indicates risk to ecological receptors is small; this supports elimination of 4,4'-DDT as an integrated COPEC for sediment. However, because the mean 4,4'-DDT concentration in sediment is above the ESV, it is evaluated further with additional refinement factors.

Surface Water. The seven integrated COPECs in surface water are aluminum, copper, iron, lead, manganese, zinc, and nitrate (Table 7-20). Nitrate was identified as an integrated COPEC because the chemical did not have an ESV and is discussed later in Step 3A and in the uncertainty section (Section 7.3.3.9). The remaining six surface water COPECs had MDCs that exceeded their ESVs and are discussed below.

Aluminum. Aluminum was detected in all three samples taken in surface water, but only one sample had a detection above its background concentration. This maximum detection elevated the mean concentration (9.03 mg/L) to greater than the background concentration (3.4 mg/L) (Table 7-26 and Appendix H, Table H-17). Although the MDC to ESV ratio (275) (Table 7-20) and mean concentration to ESV ratio (104) (Appendix H, Table H-17) indicate a possibility of risk, aluminum was detected below the SRV in discrete and ISM sediment samples (Appendix H, Tables H-11 and H-12), and the MDC in soil was below the background concentration. The relatively low concentrations of aluminum in surface soil and sediment suggest these media are not sources of aluminum in surface water. However, because the aluminum concentration in surface water is above the ESV, it is evaluated further with additional refinement factors.

Copper. Copper was detected in all three samples taken in surface water, but only one sample was above its ESVs (both OMZM and OMZA) and background concentration. The mean concentration (0.0116 mg/L) was slightly above the OMZA ESV (0.0093 mg/L) (Table 7-26 and Appendix H, Table H-17). Copper is evaluated further with additional refinement factors.

Iron. Iron is typically an essential nutrient; however, the MDC (23.6 mg/L) exceeded the RDA/RDI-based SL (18 mg/L) for iron, and it was retained as a COPEC for surface water. Iron was detected in all three surface water samples; one sample exceeded the RDA/RDI-based SL (Section 7.1.2), two samples exceeded the background concentration, and all three samples exceeded the ESV. The mean concentration (9.7 mg/L) was less than the RDA/RDI-based SL (18 mg/L) (Table 7-26 and Appendix H, Table H-17). As a result, iron is eliminated from further consideration and will not be a final COPEC.

Lead. Lead was detected in all three surface water samples. As lead was not detected in the background data set for surface water, all three detections of lead in the Load Line 8 ditches were above background. Only one Load Line 8 ditch surface water sample was above the OMZA ESV (0.0064 mg/L). None of the samples were detected above the OMZM ESV (0.12 mg/L). The mean concentration of lead (0.00907 mg/L) slightly exceeded the OMZA ESV (0.0064 mg/L) (Appendix H, Table H-17). Although the MDC to OMZA ESV ratio (3.8) (Table 7-20) and mean concentration to OMZA ESV ratio (1.4) (Appendix H, Table H-17) indicate a possibility of risk, the MDC of lead was below the OMZM ESV, lead was detected below its background concentration in discrete sediment samples (Appendix H, Table H-11), and the mean concentrations in ISM sediment (Appendix H, Table H-12) and soil (Appendix H, Table H-10) are similar to the background concentrations. The relatively low concentrations of lead in surface soil and sediment suggest these media are not sources of lead in surface water. However, because the MDC of lead and mean lead concentration in surface water are above the OMZA ESV, it is evaluated further with additional refinement factors.

Manganese. Manganese was detected in all three samples taken in surface water, but only one sample had a detection above the background concentration. However, because the maximum detect was high, manganese had a mean concentration (0.532 mg/L) greater than the background concentration (0.391 mg/L) (Table 7-26 and Appendix H, Table H-17). Although the MDC to ESV ratio (10.3) (Table 7-20) and mean concentration to ESV ratio (4.4) (Appendix H, Table H-17) indicate a possibility of risk, manganese was detected below its background concentration in discrete and ISM sediment samples (Appendix H, Tables H-11 and H-12), and the mean concentration in soil was below the background concentration (Appendix H, Table H-10). The relatively low concentrations of manganese in surface soil and sediment suggest these media are not sources of manganese in surface water. However, because the manganese concentration in surface water is above the ESV, it is evaluated further with additional refinement factors.

Zinc. Zinc was detected in all three samples taken in surface water; two samples exceeded the background concentration, and one sample exceeded the OMZM and OMZA ESV of 0.12 mg/L. Zinc had a mean concentration (0.133 mg/L) greater than the background concentration (0.042 mg/L) (Appendix H, Table H-17). Although the MDC to ESV ratio (2.3) (Table 7-20) and mean concentration to ESV ratio (1.1) for both the OMZM and OMZA comparisons (Appendix H, Table H-17) indicate a possibility of risk, zinc was detected below its background concentration in discrete and ISM sediment samples (Appendix H, Tables H-11 and H-12), and the mean concentration in soil (Appendix H, Table H-10) is similar to the background concentration. The relatively low concentrations of zinc in surface soil and sediment suggest these media are not sources of zinc in surface water. However, because the zinc concentration in surface water is above the ESV, it is evaluated further with additional refinement factors.

Summary for Sediment and Surface Water. In summary, cadmium; 4,4’-DDE; and 4,4’-DDT are retained for further evaluation in sediment. Aluminum, copper, lead, manganese, and zinc are retained for further evaluation in surface water.

Comparison of Ohio EPA Approved and Preferred ESVs. Consideration of the Ohio EPA approved and preferred ESVs gives perspective to the remaining sediment and surface water COPECs. There are no alternative ESVs available for cadmium or 4,4’-DDE in sediment. For 4,4’-DDT, the preferred ESV source (MacDonald et al. 2000) contains a value for Total DDTs (0.00528 mg/L). The mean sediment concentration for 4,4’-DDT (0.0043 mg/L) is very close to the preferred ESV (0.00416 mg/L) and is below the alternative ESV, which supports the elimination of 4,4’-DDT as a sediment COPEC.

For surface water, there are several considerations related to the ESVs. The Ohio EPA approved and preferred aluminum ESV used in this ERA is 0.087 mg/L. There is an alternative ESV for aluminum (0.1 mg/L), but it is still below the background concentration (3.37 mg/L). The *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota* (Suter and Tsao 1996), from which the preferred ESV originates, has several other chronic values for aluminum, but they are also below the background concentration. It also notes “the toxicity of aluminum has been shown to vary widely with water hardness and pH.” The National Ambient Water Quality Criteria lists aluminum as a non-priority pollutant and notes that aluminum in nature may be less toxic than the ESV indicates: “In surface waters, however, the total recoverable procedure might measure aluminum associated with clay particles, which might be less toxic than aluminum associated with aluminum hydroxide” (USEPA 2009). This information indicates the Ohio EPA approved and preferred ESV for aluminum, and the selection of aluminum as a COPEC, is conservative.

The Ohio EPA approved and preferred copper OMZM and OMZA ESVs used in this ERA are 0.014 and 0.0093 mg/L. These values are from the Ohio Administrative Code Outside Mixing Zone Average and Ohio Administrative Code Outside Mixing Zone Maximum, which are hardness-dependent. The most conservative values (with the lowest water hardness) were used as the default values, but the water hardness for the sample that exceeds the ESV is 260 mg/L. Using the site-specific hardness, the appropriate copper ESVs for this AOC would then be 0.033 and 0.0201 mg/L.

The copper MDC and average concentrations (0.0266 and 0.0166 mg/L, respectively) are both below the OMZM (0.033 mg/L). The copper MDC (0.0266 mg/L) is slightly above the OMZA, but the average copper concentration (0.0166 mg/L) was below the OMZA (0.0201 mg/L). This supports elimination of copper as a final surface water COPEC.

The Ohio EPA approved and preferred lead OMZA ESV used in this ERA is 0.0064 mg/L. This value is from the Ohio Administrative Code Outside Mixing Zone Average, which is hardness-dependent. The most conservative value (with the lowest water hardness) was used as the default value, but the water hardness for the sample that exceeds the ESV is 260 mg/L. Using the site-specific hardness, the appropriate lead OMZA ESV for this AOC would then be 0.020 mg/L. The lead MDC (0.024 mg/L) is slightly above the OMZA, but the average lead concentration (0.00907 mg/L) was below the OMZA (0.020 mg/L). This supports elimination of lead as a final surface water COPEC.

Manganese in surface water does not have an ESV from another Ohio EPA approved source. However, the *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota*, from which the preferred ESV originates, has several other chronic values for manganese, including 1.78 mg/L for fish and 1.1 mg/L for daphnids and all other aquatic organisms (Suter and Tsao 1996). Both values are greater than the mean concentration (0.532 mg/L) for manganese in surface water, which supports the elimination of manganese as a surface water COPEC.

The Ohio EPA approved and preferred zinc ESV used in this ERA is 0.12 mg/L. This value is from the Ohio Administrative Code Outside Mixing Zone Maximum and Average, which is hardness-dependent. The most conservative value (with the lowest water hardness) was used as the default value, but the water hardness for the sample that exceeds the ESV is 260 mg/L. Using the site-specific hardness, the appropriate zinc OMZM and OMZA ESV for this AOC would then be 0.27 mg/L. The zinc MDC (0.278 mg/L) is slightly above the ESV, but the average zinc concentration (0.133 mg/L) was below the ESV (0.27 mg/L). This supports elimination of zinc as a final surface water COPEC.

Qualitative Relationship of Exposure Area to General Home Range. The central ditch drains the central portion of the AOC and flows southwest to Wetland 1 and to the headwaters of an unnamed tributary to Hinkley Creek. The central ditch receives surface water from a network of small ditches. Surface water flows intermittently in drainage ditches at Load Line 8. SAIC scientists have observed no water in the central ditch during repeated visits to the area during sampling and other activities. The intermittent surface water in the central ditch is not sufficient to create and maintain aquatic habitat. Therefore, aquatic receptors would have relatively low exposure to COPECs in sediment and surface water in the central ditch. Any ecological receptor that uses Load Line 8 as part of its home range would have only incidental contact with water and aquatic biota in the central ditch. Surface water in the western ditch and in the headwaters to the unnamed tributary to Hinkley Creek is more permanent; however, no COPECs were identified in discrete sample LL8sd/sw-092, as described in the following section.

Wetland Quality, Geographical Information, and On-site Migration of Chemicals. The next three evaluation and refinement factors are concerned with risk to 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 AOC exceedance area (i.e., high concentration area), or on-site migration is unlikely, it increases the likelihood that the remaining integrated COPECs in soil, sediment, and surface water at the AOC will not be of ecological concern to wetlands and do not need to be evaluated as final COPECs.

There are five wetlands partially or completely inside Load Line 8. They range in total size from 0.03 to 18.4 acres, with 0.03 to 3.8 acres inside the AOC boundary. Four of the five wetlands are Category 2, while Wetland 1 is a Category 3 wetland (Table 7-16). Category 2 indicates moderate wetland quality, with some degradation of wetland functions. Category 3 indicates high wetland quality that is often forested. RVAAP contains about 1,970 acres of wetlands (OHARNG 2014), and the 4.93 acres of wetlands inside the habitat boundary at Load Line 8 represent 0.25% of the total wetlands of RVAAP. The availability of many more wetland acres at RVAAP lowers the importance of the wetlands at Load Line 8.

Wetlands 1 through 4 at Load Line 8 are part of large interconnected complexes that are possible pathways for contaminant migration (Figure 7-4). Wetland 1 is located in the southern portion of Load Line 8, along the western ditch and lower portion of the central ditch. Wetlands 2 and 3 are located along the upper portion of the central ditch, about 150 ft east of the western ditch and the associated Wetland 1. The western and central ditches converge in the southwestern corner of the AOC and form the unnamed tributary to Hinkley Creek. Wetland 4, although not directly connected to the wetland complexes at Load Line 8, is only about 100 ft northwest and upgradient of Wetland 1; contaminants could migrate downgradient to Wetland 1 and eventually to the unnamed tributary to Hinkley Creek. Of the five wetlands, Wetland 5 is somewhat isolated in the east-central portion of the AOC.

Several soil samples with elevated COPEC concentrations occur in the vicinity of the former buildings near the western and central ditches associated with Wetlands 1 through 4. This suggests COPECs from the AOC could migrate to the wetlands. Although COPECs could migrate along the ditches and the associated wetlands, three of the four soil COPECs (lead, mercury, and zinc) were not detected above their background concentrations in discrete sediment samples (LL8sd-090, LL8sd-091, and LL8sd-092) collected downstream from the areas of elevated soil contamination (Figure 5-6). None of the four soil COPECs (cadmium, lead, mercury, and zinc) exceeded sediment ESVs in downstream sediment samples. In addition, sediment COPECs (cadmium; 4,4’-DDE; and 4,4’-DDT) were not detected above ESVs in discrete sediment samples (LL8sd-090, LL8sd-091, and LL8sd-092) collected downstream from the areas of elevated sediment contamination.

The former building locations are upstream of the ditches and wetlands. Given the elevated COPEC concentrations in the vicinity of the former buildings, the possibility of downgradient migration was examined. All discrete sediment/surface water samples at Load Line 8 were taken along Wetland 1 (Figures 5-5, 5-6, 5-7, 5-8, and 7-4). LL8sd/sw-090 was taken along the central ditch, about 100 ft upstream of where the central and western ditches converge; LL8sd/sw-091 was taken along the western ditch, about 200 ft upstream from where the central and western ditches converge; and LL8sd/sw-092 was taken about 300 ft downstream of where the central and western ditches converge along the unnamed tributary to Hinkley Creek. Aluminum, copper, iron, and manganese show clear decreases in concentrations moving downstream, and were not detected above their background concentrations in downstream sample LL8sd/sw-092. Likewise, lead and zinc show clear decreases in concentrations moving downstream, and were not detected above their ESVs in downstream sample LL8sd/sw-092. Thus, aluminum, copper, iron, lead, manganese, and zinc are eliminated as surface water COPECs, and there are no final integrated COPECs for surface water at Load Line 8.

Evaluation of Biological and Water Quality Sampling Stations. The last evaluation and refinement factor is:

- Evaluation of off-site migration of chemicals at biological/water quality stations.

The nearest biological/water quality station is approximately 7,500 ft southwest of Load Line 8. Due to the distance to the nearest biological/water quality station, this evaluation and refinement factor does not apply.

Evaluation of PBT Compounds and COPECs Without ESVs. As discussed in Level II, there are six chemicals that are PBT compounds in surface soil (mercury; 4,4’-DDD; 4,4’-DDE; 4,4’-DDT; PCB-1254; and beta-BHC) and four chemicals that are PBT compounds in sediment (mercury; 4,4’-DDD; 4,4’-DDE; and 4,4’-DDT). No PBT compounds were detected in surface water. Four chemicals (HMX, nitrocellulose, tetryl, and dibenzofuran) in surface soil, four chemicals (beryllium, selenium, nitrocellulose, and tetryl) in sediment, and one chemical (nitrate) in surface water are integrated COPECs because they did not have ESVs. 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 (e.g., 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 (i.e., EcoSSLs and PRGs), bioaccumulation in higher trophic levels is considered in development of the ESV. According to 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 2007a). Derivation of EcoSSL values includes uptake equations that account for both direct ingestion and food chain bioaccumulation (USEPA 2007a). 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 one can be dismissed as final COPECs. For this ERA, this includes 4,4’-DDD; 4,4’-DDT; and PCB-1254 in surface soil. 4,4’-DDE in surface soil was previously evaluated in Step 3A, and it will not be a final COPEC because the MDC (0.024 mg/kg) is only slightly greater than the ESV (0.021 mg/kg), and the mean concentration (0.00701 mg/kg) is less than the ESV.

The USEPA Region 5 ESLs (USEPA 2003) are an Ohio EPA-approved source of soil, sediment, and surface water ESVs (see Appendix H, Tables H-7 to H-9 for hierarchies) for some PBT compounds not covered by the EcoSSLs or PRGs. The development of ESLs included bioaccumulation in higher trophic levels as a standard component in the equations, as “development of ESLs focused on mammalian or avian species and identified those chemicals that have the potential for significant bioaccumulation or biomagnification” (USEPA 1999a). Thus, ESLs also account for bioaccumulation in the food chain, and PBT compounds with ESVs in soil, sediment, and surface water from this source that have ratios less than 1 can be dismissed as final COPECs. For this ERA, this includes beta-BHC in surface soil.

Mercury was detected in surface soil above the ESV, which accounts for bioaccumulation (DOE 1997). These exceedances can be expected, considering the background concentration is 70 times greater than the ESV. While the mean concentration of mercury (0.061 mg/kg) is above the background concentration (0.036 mg/kg) (Table 7-22), the similarity between the concentrations suggests exposures to mercury at Load Line 8 are similar to background concentrations. In addition, the mean concentration of mercury is less than the alternative ESV of 0.1 mg/kg (which accounts for bioaccumulation). Thus, mercury is eliminated from further consideration and will not be a final COPEC.

The *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald et al. 2000) is the source for mercury; 4,4’-DDD; 4,4’-DDE; and 4,4’-DDT sediment ESVs, and bioaccumulation is not accounted for. The mean-to-ESV ratios for the four COPECs are 0.52 for mercury; 0.37 for 4,4’-DDD; 4.05 for 4,4’-DDE; and 1.03 for 4,4’-DDT. While the mean concentration of mercury (0.0927 mg/kg) is slightly above the background concentration (0.06 mg/kg), the mean concentration is below the SRV (0.12 mg/kg). Thus, the similarity between the concentrations suggests exposure to mercury at Load Line 8 is similar to background concentrations. The low mean-to-ESV-ratio, similarity to background concentration, and the SRV suggest mercury can be eliminated as a final COPEC. The pesticides in sediment lack background concentrations for comparison and are discussed later in the assessment.

PBT compounds at Load Line 8 are mercury; 4,4’-DDD; 4,4’-DDE; 4,4’-DDT; PCB-1254; and beta-BHC in surface soil and mercury; 4,4’-DDD; 4,4’-DDE; and 4,4’-DDT in sediment. As discussed above, all but three PBT compounds will not be final COPECs. 4,4’-DDD; 4,4’-DDE; and 4,4’-DDT in sediment continue to be of potential concern.

COPECs without ESVs. The *Guidance for Conducting Ecological Risk Assessments* specifies 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. For Load Line 8, 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, the four integrated COPECs without ESVs are HMX, nitrocellulose, tetryl, and dibenzofuran. HMX was detected in 2 of 49 ISM samples, tetryl was detected in 7 of 49 samples, and dibenzofuran was detected in 1 of 8 samples. Thus, exposure to these chemicals would be limited. While nitrocellulose was detected in seven of seven samples, it is essentially non-toxic (USEPA 1987) and not expected to be an ecological concern.

For sediment, the four integrated COPECs without ESVs are beryllium, selenium, nitrocellulose, and tetryl. Beryllium was detected in seven of seven sediment samples; however, the mean concentration (0.92 mg/kg) is essentially the same as the SRV (0.8 mg/kg). Selenium was detected in four of seven sediment samples; however, the mean concentration (1.59 mg/kg) is less than the SRV (1.7 mg/kg). Beryllium and selenium are not considered ecological concerns in sediment. Tetryl was detected in one of seven samples; thus, exposure to tetryl would be limited. While nitrocellulose was detected in one of two samples, it is essentially non-toxic (USEPA 1987) and not expected to be an ecological concern.

For surface water, one anion (nitrate) was the only identified integrated COPEC without an ESV for comparison. Although it is possible nitrate is related to the AOC, nitrates are not typically considered to be toxic and are often added to soil as fertilizer. While high amounts of nitrates added to water can cause a contamination, aquatic biota in Ohio reference streams and rivers were not negatively affected at a concentration of 3-4 mg nitrate/L (Ohio EPA 1999). The MDC at Load Line 8 is 0.2 mg nitrate/L which is considerably lower than this concentration. Thus, the nitrate concentration at Load Line 8 would not likely be a concern for surface water.

Further Evaluation of the Remaining Sediment COPECs – 4,4’-DDT; 4,4’-DDD; and 4,4’-DDE. The various evaluation and refinement factors have been applied to all integrated COPECs for sediment, and three pesticides (4,4’-DDT; 4,4’-DDD; and 4,4’-DDE) remain for further consideration because they are PBT compounds and their sediment ESVs do not consider bioaccumulation. The ratios of mean concentration to ESV are 0.37 for 4,4’-DDD; 4.05 for 4,4’-DDE; and 1.03 for 4,4’-DDT. Despite being PBT compounds, there are a number of factors that together support the elimination of 4,4’-DDD; 4,4’-DDE; and 4,4’-DDT from being final COPECs in sediment at Load Line 8.

These factors are: (1) use of the pesticides; (2) observations across RVAAP and Load Line 8; and (3) location of 4,4'-DDD; 4,4'-DDE; and 4,4'-DDT at Load Line 8.

1. 4,4'-DDD; 4,4'-DDE; and 4,4'-DDT were not known to be stored and used in the production process at Load Line 8; rather, they are assumed to have been applied correctly in the production area. Further, 4,4'-DDD; 4,4'-DDE; and 4,4'-DDT are relatively immobile (USEPA 2007a).
2. The pesticides are not often found in RVAAP soil. Of 20 ISM samples analyzed for pesticides during the PBA08 RI, 4,4'-DDD and 4,4'-DDT were detected 1 time, and 4,4'-DDE was detected 2 times. Of the 28 discrete samples, none of the pesticides were detected. In Load Line 8 soil, the pesticides were found in one of eight ISM samples and were located in the northern production area. In the two Load Line 8 ISM sediment samples, the pesticides were found in one ditch sample in the northern production area. The pesticides were not detected in the single discrete sediment sample analyzed for pesticides at Load Line 8. Thus, 4,4'-DDD; 4,4'-DDE; and 4,4'-DDT are not found very often at RVAAP or Load Line 8, and the single sediment detection at Load Line 8 is not representative.
3. 4,4'-DDD; 4,4'-DDE; and 4,4'-DDT are not found in the sediment near the exit point in the southwestern corner of the AOC. This means these pesticides are not migrating from the upgradient production area. It is likely the former ditch no longer contains aquatic habitat and the pesticides in dry sediment could be treated as soil COPECs. The MDC for 4,4'-DDD (0.0015 mg/kg); 4,4'-DDE (0.023 mg/kg); and 4,4'-DDT (0.0065) in sediment is below the soil ESV (0.021 mg/kg) for these three pesticides and accounts for bioaccumulation. Based on the low MDC to soil ESV ratios for 4,4'-DDD (0.07); 4,4'-DDE (1.1); and 4,4'-DDT (0.31), the three pesticides are not ecological concerns.

These factors are interpreted to mean that it is not justified to retain 4,4'-DDD; 4,4'-DDE; and 4,4'-DDT as final COPECs at Load Line 8.

Summary of Findings in Step 3A. Of the 18 integrated COPECs in surface soil at Load Line 8, the 4 COPECs that did not have ESVs (HMX, nitrocellulose, tetryl, and dibenzofuran) were eliminated as COPECs because they had low frequency-of-detection or little to no toxicity. Additional integrated COPECs were eliminated from further consideration because the mean concentration is smaller than the ESV (chromium; copper; nickel; naphthalene; 4,4'-DDD; 4,4'-DDE; 4,4'-DDT; beta-BHC; and PCB-1254) or the mean concentration is smaller than the background concentration (manganese). Three PBT compounds (4,4'-DDD; 4,4'-DDT; and PCB-1254) were eliminated because they had a ratio less than 1, using an ESV that accounted for bioaccumulation. One PBT compound (4,4'-DDE) was eliminated because it had a MDC just slightly greater than the ESV and the mean concentration is less than the ESV that accounted for bioaccumulation. The remaining four integrated COPECs in soil (cadmium, lead, mercury, and zinc) were eliminated from further consideration based on a combination of two or more of the following factors:

1. Mean concentrations are only slightly higher than background concentrations.
2. Mean-to-ESV concentration ratios of exceedance are near 1.

3. Alternative ESVs are less conservative than the ESVs used in this ERA, resulting in ratios below or just slightly greater than 1.
4. Limited exposure of ecological receptors exposed to detected soil concentrations above the alternative ESVs.
5. The wetlands in the vicinity of the elevated surface soil concentrations are relatively small and of medium quality.
6. The downgradient sediment sampling station in the southwestern corner of Load line 8 indicates that the surface soil COPECs are not migrating to nearby sediment and surface water.

No final COPECs were identified for Load Line 8 surface soil.

Of the nine integrated COPECs in ISM sediment samples, beryllium, selenium, nitrocellulose, and tetryl have no ESVs. Beryllium and selenium were eliminated as COPECs because the mean concentration is essentially the same as the SRV. Nitrocellulose and tetryl were eliminated as COPECs because they had little to no toxicity or low frequency-of-detection. The ISM sediment COPECs that were PBTs or had MDCs greater than their ESVs were cadmium; mercury; 4,4’-DDD; 4,4’-DDE; and 4,4’-DDT. Cadmium was eliminated from further consideration because the mean concentration to ESV ratio was low, and it was not detected in discrete sediment samples collected downstream from the areas of elevated sediment contamination. Mercury was eliminated from further consideration because the mean concentration is smaller than the ESV, similar to the background concentration, and below the SRV. 4,4’-DDD; 4,4’-DDE; and 4,4’-DDT were eliminated from further consideration because the mean concentrations are smaller than or similar to the ESVs, the area of contamination is small, they were not detected in discrete sediment samples collected downstream from the area of sediment contamination, and they are not an issue when evaluated as soil. Thus, no final COPECs were identified for Load Line 8 sediment.

Of the seven integrated COPECs in surface water, nitrate had no ESV, is not typically considered to be toxic, and is often added to soil as fertilizer. Copper was eliminated from further consideration because the mean concentration is smaller than the ESV and it is not a PBT compound. Iron was eliminated from further consideration because the mean concentration was less than the RDA/RDI-based SL. Aluminum, copper, lead, manganese, and zinc were eliminated from further consideration because mean concentrations are low in soil and sediment media that contribute to surface water, and none of these chemicals were identified as COPECs in the downstream sediment/surface water sample collected from the ditch in the southwestern corner of Load Line 8 where the surface water exits the AOC. No final COPECs were identified for Load Line 8 surface water.

7.3.3.8 Consideration of Human Health Driven Remediation

The HHRA does not identify any COCs for remediation and recommends no further action for surface soil, sediment, and surface water at Load Line 8. Thus, there would be no remediation implemented to further protect human health that would also protect ecological resources at Load Line 8.

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 concerning exposure data for receptors in the AOC. The chemical concentration data were from surface soil and the top portions of sediment where most organisms live. Chemical concentrations from deep soil and other sources were not evaluated for ecological risk. To mitigate uncertainty in effects information, a site visit for habitat condition was conducted, and the latest INRMP of state-listed or federally listed species sightings and jurisdictional wetlands was used (OHARNG 2008). In addition, the ORAM was applied to the 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 concerning effects on receptors in the AOC. Some COPECs do not have ESVs. These 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 concerning 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), but a mitigation for uncertainty associated with ESVs was assessed in the use of alternative ESVs from sources approved by Ohio EPA. To mitigate uncertainty concerning effects due to additivity of some PBT compounds, the combined toxicity of 4,4’-DDD; 4,4’-DDE; and 4,4’-DDT in soil was considered. The sum of mean concentrations (0.018 mg/kg) is less than the ESV (0.021 mg/kg), so the potential synergy of the pesticides’ toxicity is not a concern.

Uncertainties arise from temporal variabilities in samples used for analysis to characterize the AOC. Concentrations of chemicals, particularly in surface water, which is a transient medium, may vary significantly over time and space within an AOC. Elevated concentrations of aluminum, barium, and iron (23.9 mg/L, 0.169 mg/L, and 23.6 mg/L, respectively) were identified in the primary surface water sample collected from LL8sw-090 collected in March 2010 from the south-east drainage ditch. A water sample was recollected from the same location in April 2011 from the south-east drainage ditch and analyzed for the RVAAP full-suite analyses as there was no clear source for the elevated concentrations of aluminum, barium, and iron in surface water. The results of the surface water samples collected from LL8sw-090 in March 2010 and April 2011 are shown in Table 7-12. The concentrations of chemicals in the April 2011 sample were significantly reduced compared to the March 2011 sample. Although aluminum, copper, iron, lead, manganese, zinc, and nitrate were identified as integrated COPECs, the concentrations of these metals were all significantly lower in the April 2011 collected sample from the same location. The consequences of carrying these metals forward as integrated COPECs is negligible because they were eliminated from consideration as final COPECs based on other considerations.

7.3.3.10 Summary and Recommendations of Screening Level Ecological Risk Assessment

Integrated COPECs were identified in surface soil, sediment, and surface water at Load Line 8. Most of the soil COPECs identified in the historical ERA were also identified during screening of PBA08 RI data. One historical COPEC was not identified during the PBA08 RI, and new COPECs were identified due to additional sampling. Historical sediment data were considered. Those chemicals retained after screening historical and PBA08 RI data were termed integrated COPECs.

Eighteen integrated soil COPECs, nine integrated sediment COPECs, and seven 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 8 can conclude with a Level II ERA that no further action is necessary to be protective of important ecological resources.

7.3.4 Conclusions

There is chemical contamination present in surface soil, sediment, and surface water at Load Line 8. This contamination was identified using historical and PBA08 RI data. Dry, early-successional, herbaceous field; dogwood/willow saturated shrubland alliance; red maple successional forest; and green ash/American elm/sugarberry temporarily flooded forest alliance were the four dominant vegetation types observed on the 44 acres of the AOC; however, there are small areas of one other shrubland and two other forest types at Load Line 8. Some wetlands and the ditches in the southwestern corner of Load Line 8 are important and significant ecological resources near contamination in the AOC. These findings invoked a Level II assessment.

The Level II assessment evaluated soil, sediment, and surface water using historical and PBA08 RI data, identified integrated COPECs, and evaluated the integrated COPECs using technical and refinement factors in Step 3A. The assessment of 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 a Level II ERA that no further action is necessary to be protective of important ecological resources.

Table 7-1. Risk Assessment Data Set for Surface Soil (0-1 ft bgs): ISM Samples

Location	Sample ID	Date	Depth (ft bgs)
LL8ss-001M	LL8ss-001M-SO	10/27/2004	0 - 1
LL8ss-002M	LL8ss-002M-SO	10/27/2004	0 - 0.5
LL8ss-003M	LL8ss-003M-SO	10/27/2004	0 - 0.5
LL8ss-004M	LL8ss-004M-SO	10/29/2004	0 - 1
LL8ss-005D	LL8ss-005D-SO	11/1/2004	0 - 0.5
LL8ss-005M	LL8ss-005M-SO	11/1/2004	0 - 0.5
LL8ss-006M	LL8ss-006M-SO	10/27/2004	0 - 1
LL8ss-007M	LL8ss-007M-SO	11/1/2004	0 - 1
LL8ss-008M	LL8ss-008M-SO	11/1/2004	0 - 1
LL8ss-009M	LL8ss-009M-SO	11/1/2004	0 - 0.5
LL8ss-010M	LL8ss-010M-SO	11/1/2004	0 - 1
LL8ss-011M	LL8ss-011M-SS	11/2/2004	0 - 1
LL8ss-012M	LL8ss-012M-SS	11/2/2004	0 - 0.5
LL8ss-013M	LL8ss-013M-SS	11/2/2004	0 - 1
LL8ss-014M	LL8ss-014M-SO	11/1/2004	0 - 1
LL8ss-015D	LL8ss-015D-SO	11/2/2004	0 - 1
LL8ss-015M	LL8ss-015M-SO	11/2/2004	0 - 1
LL8ss-016M	LL8ss-016M-SO	11/1/2004	0 - 1
LL8ss-017M	LL8ss-017M-SO	10/29/2004	0 - 1
LL8ss-018M	LL8ss-018M-SO	11/1/2004	0 - 1
LL8ss-042M	LL8ss-042M-SO	8/8/2007	0 - 1
LL8ss-043M	LL8ss-043M-SO	8/8/2007	0 - 1
LL8ss-044M	LL8ss-044M-SO	8/8/2007	0 - 1
LL8ss-045D	LL8ss-045D-SO	8/14/2007	0 - 1
LL8ss-045M	LL8ss-045M-SO	8/14/2007	0 - 1
LL8ss-046M	LL8ss-046M-SO	8/7/2007	0 - 1
LL8ss-047D	LL8ss-047D-SO	8/14/2007	0 - 1
LL8ss-047M	LL8ss-047M-SO	8/14/2007	0 - 1
LL8ss-048M	LL8ss-048M-SO	8/7/2007	0 - 1
LL8ss-049M	LL8ss-049M-SO	8/7/2007	0 - 1
LL8ss-050M	LL8ss-050M-SO	8/8/2007	0 - 1
LL8ss-051M	LL8ss-051M-SO	8/7/2007	0 - 1
LL8ss-052M	LL8ss-052M-SO	8/7/2007	0 - 1
LL8ss-053M	LL8ss-053M-SO	8/7/2007	0 - 1
LL8ss-054M	LL8ss-054M-SO	8/14/2007	0 - 1
LL8ss-071M	LL8ss-071M-5386-SO	3/18/2010	0 - 1
LL8ss-072M	LL8ss-072M-5387-SO	3/18/2010	0 - 1
LL8ss-073M	LL8ss-073M-5388-SO	3/18/2010	0 - 1
LL8ss-074M	LL8ss-074M-5389-SO	3/17/2010	0 - 1
LL8ss-075M	LL8ss-075M-5390-SO	3/18/2010	0 - 1
LL8ss-076M	LL8ss-076M-5392-SO	3/18/2010	0 - 1
LL8ss-077M	LL8ss-077M-5393-SO	3/17/2010	0 - 1
LL8ss-078M	LL8ss-078M-5394-SO	3/17/2010	0 - 1
LL8ss-079M	LL8ss-079M-5395-SO	3/17/2010	0 - 1
LL8ss-080M	LL8ss-080M-5396-SO	3/17/2010	0 - 1
LL8ss-081M	LL8ss-081M-5397-SO	3/17/2010	0 - 1
LL8ss-082M	LL8ss-082M-5398-SO	3/17/2010	0 - 1
LL8ss-083M	LL8ss-083M-5399-SO	3/17/2010	0 - 1
LL8ss-084M	LL8ss-084M-5400-SO	3/18/2010	0 - 1
LL8ss-085M	LL8ss-085M-5782-SO	3/18/2010	0 - 1
LL8ss-086M	LL8ss-086M-5401-SO	3/18/2010	0 - 1

1

Table 7-1. Risk Assessment Data Set for Surface Soil (0-1 ft bgs): ISM Samples (continued)

Location	Sample ID	Date	Depth (ft bgs)
LL8ss-087M	LL8ss-087M-5402-SO	3/18/2010	0 - 1
LL8ss-088M	LL8ss-088M-5403-SO	3/18/2010	0 - 1
LL8ss-068[a]	LL8ss-068-5380-SO	3/18/2010	0 - 1
LL8ss-069[a]	LL8ss-069-5381-SO	3/18/2010	0 - 1
LL8ss-070[a]	LL8ss-070-5382-SO	3/18/2010	0 - 1
LL8ss-072[a]	LL8ss-072-5808-SO	10/18/2010	0 - 1

[a] Chromium speciation samples used to evaluate the presence of hexavalent chromium. LL8ss-068 collected at ISM area LL8ss-003M; LL8ss-069 collected at ISM area LL8ss-017M; LL8ss-070 collected at ISM area LL8ss-008M; LL8ss-072 collected at ISM area LL8ss-072M.

bgs = Below ground surface.
Ft = Feet.
ID = Identification.
ISM = Incremental sampling methodology.

2

Table 7-2. Risk Assessment Data Set for Subsurface Soil Discrete Samples

Location	Sample ID	Date	Depth (ft bgs)
LL8sb-060	LL8sb-060-5347-SO	3/15/2010	1 - 4
LL8sb-061	LL8sb-061-5351-SO	3/15/2010	1 - 4
LL8sb-062	LL8sb-062-5355-SO	3/15/2010	1 - 4
LL8sb-063	LL8sb-063-5359-SO	3/15/2010	1 - 4
LL8sb-064	LL8sb-064-5363-SO	3/15/2010	1 - 4
LL8sb-065	LL8sb-065-5367-SO	3/15/2010	1 - 4
LL8sb-066	LL8sb-066-5370-SO	3/11/2010	1 - 4
LL8sb-067	LL8sb-067-5374-SO	3/11/2010	1 - 4
LL8sb-060	LL8sb-060-5348-SO	3/15/2010	4 - 7
LL8sb-061	LL8sb-061-5352-SO	3/15/2010	4 - 7
LL8sb-062	LL8sb-062-5356-SO	3/15/2010	4 - 7
LL8sb-063	LL8sb-063-5360-SO	3/15/2010	4 - 7
LL8sb-064	LL8sb-064-5364-SO	3/15/2010	4 - 7
LL8sb-065	LL8sb-065-5368-SO	3/15/2010	4 - 7
LL8sb-066	LL8sb-066-5371-SO	3/11/2010	4 - 7
LL8sb-067	LL8sb-067-5375-SO	3/11/2010	4 - 7
LL8sb-060	LL8sb-060-5349-SO	3/15/2010	7 - 13
LL8sb-067	LL8sb-067-5376-SO	3/11/2010	7 - 13

bgs = Below ground surface.
Ft = Feet.
ID = Identification.

3

Table 7-3. Risk Assessment Data Set for Surface Water

Location	Sample ID	Date
LL8sw-090	LL8sw-090-5384-SW	3/1/2010
LL8sw-091	LL8sw-091-5385-SW	3/1/2010
LL8sw-092	LL8sw-092-5383-SW	3/1/2010

ID = Identification.

Table 7-4. Risk Assessment Data Set for Sediment

Location	Sample ID	Date	Depth (ft bgs)
Discrete Samples Co-located with Surface Water Samples			
LL8sd-090	LL8sd-090-5378-SD	3/1/2010	0 - 0.5
LL8sd-091	LL8sd-091-5379-SD	3/1/2010	0 - 0.5
LL8sd-092	LL8sd-092-5377-SD	3/1/2010	0 - 0.5
ISM Samples			
LL8sd-001M	LL8sd-001M-SD	11/8/2004	0 - 1
LL8sd-002M	LL8sd-002M-SD	11/8/2004	0 - 1
LL8sd-003M	LL8sd-003M-SD	11/8/2004	0 - 1
LL8sd-004M	LL8sd-004M-SD	11/2/2004	0 - 0.1
LL8sd-005M	LL8sd-005M-SD	11/2/2004	0 - 0.5
LL8sd-006M	LL8sd-006M-SD	11/8/2004	0 - 1
LL8ss-089M	LL8ss-089M-5404-SO	3/18/2010	0 - 1

bgs = Below ground surface.
ft = Feet.
ID = Identification.
ISM = Incremental sampling methodology.

Table 7-5. Summary of SRCs

SRC	Surface Soil[a] (0-1 ft bgs)	Subsurface Soil[b] (1-13 ft bgs)	Sediment Discrete Samples	Sediment ISM Samples	Surface Water
Inorganic Chemicals					
Aluminum	--	--	X	--	X
Arsenic	--	X	--	--	X
Barium	X	--	--	X	X
Beryllium	X	--	X	X	X
Cadmium	X	X	X	X	X
Chromium	X	--	--	X	X
Cobalt	X	--	--	X	X
Copper	X	--	--	--	X
Iron	--	--	--	--	X
Lead	X	X	--	X	X
Manganese	X	--	--	--	X
Mercury	X	--	--	X	--
Nickel	X	--	--	X	X
Nitrate	--	--	--	--	X
Selenium	--	X	--	X	X
Silver	X	X	X	--	--
Thallium	X	--	--	--	--
Vanadium	--	--	--	--	X
Zinc	X	--	--	--	X
Explosives					
HMX	X	--	--	--	--
Nitrocellulose	X	--	--	X	--
Tetryl	X	--	--	X	--
Semi-volatile Organic Compounds					
2-Methylnaphthalene	X	--	--	--	--
Acenaphthene	X	--	--	--	--
Acenaphthylene	X	--	--	--	--
Anthracene	X	--	--	--	--

Table 7-5. Summary of SRCs (continued)

SRC	Surface Soil^a (0-1 ft bgs)	Subsurface Soil^b (1-13 ft bgs)	Sediment Discrete Samples	Sediment ISM Samples	Surface Water
Benz(a)anthracene	X	X	X	X	--
Benzenemethanol	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	--	--	--	--
Chrysene	X	--	--	X	--
Di-n-butyl phthalate	X	--	--	--	--
Dibenz(a,h)anthracene	X	X	--	--	--
Dibenzofuran	X	--	--	--	--
Diethyl phthalate	X	--	--	--	--
Fluoranthene	X	X	X	X	--
Fluorene	X	--	--	--	--
Indeno(1,2,3-cd)pyrene	X	X	--	X	--
Naphthalene	X	--	--	X	--
Phenanthrene	X	--	X	X	--
Phenol	X	--	--	--	--
Pyrene	X	X	X	X	--
Pesticides/PCBs					
4,4'-DDD	X	--	--	X	--
4,4'-DDE	X	--	--	X	--
4,4'-DDT	X	--	--	X	--
PCB-1254	X	--	--	--	--
beta-BHC	X	--	--	--	--
Volatile Organic Compounds					
Acetone	--	X	--	--	--
2-Butanone	X	--	--	--	--
Toluene	--	--	X	--	--

[a] Surface soil characterized using ISM sampling.
[b] Subsurface soil characterized using discrete sampling.
bgs = Below ground surface.
BHC = Hexachlorocyclohexane.
DDD = Dichlorodiphenyldichloroethane.
DDE = Dichlorodiphenyldichloroethylene.
DDT = Dichlorodiphenyltrichloroethane.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane.
ISM = Incremental sampling methodology.
PCB = Polychlorinated biphenyl.
SRC = Site-related contaminant.
X = Chemical is an SRC in this medium.
-- = Compound not identified as an SRC in this medium.

Table 7-6. Summary of COPCs

COPC	Surface Soil[a] (0-1 ft bgs)	Subsurface Soil[b] (1-13 ft bgs)	Sediment Discrete Samples	Sediment ISM Samples	Surface Water
Aluminum	--	--	X	--	X
Arsenic	--	X	--	--	X
Chromium	X	--	--	X	X
Cobalt	X	--	--	X	X
Iron	--	--	--	--	X
Lead	--	--	--	--	X
Manganese	X	--	--	--	X
Nickel	X	--	--	--	--
Benz(a)anthracene	X	--	--	--	--
Benzo(a)pyrene	X	X	--	X	--
Benzo(b)fluoranthene	X	--	--	--	--
Dibenz(a,h)anthracene	X	--	--	--	--
Indeno(1,2,3-cd)pyrene	X	--	--	--	--

[a] Surface soil characterized using ISM sampling.

[b] Subsurface soil characterized using discrete sampling.

bgs = Below ground surface.
COPC = Chemical of potential concern.
ft = Feet.
ISM = Incremental sampling methodology.
X = Chemical is a COPC in this medium.
-- = Chemical is not identified as a COPC in this medium.

Table 7-7. FWCUGs Corresponding to an HQ of 1 and TR of 1E-05 in Soil and/or Sediment

COPC	Critical Effect orTarget Organ	FWCUG (mg/kg)	
		Resident (Adult and Child)[a]	
		HQ = 1	TR = 1E-05
Aluminum	Neurotoxicity in offspring	73,798	--
Arsenic	Skin	20.2	4.25[b]
Chromium, trivalent	NOAEL	81,473	--
Cobalt[c]	NS	1,313	8,030
Manganese	CNS	2,927[b]	--
Nickel	Decreased body and major organ weights	1,552	--
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
Indeno(1,2,3-cd)pyrene	NA	--	2.21

[a] Resident Receptor FWCUGs are the smaller of the Resident Receptor (Adult or Child) values for each COPC and endpoint (non-cancer and cancer).

[b] FWCUG value is less than the background screening values for arsenic in surface soil (15.4 mg/kg) and subsurface soil (19.8 mg/kg) and for manganese in surface soil (1,450 mg/kg) and subsurface soil (3,030 mg/kg).

[c] No FWCUGs are available for cobalt in sediment. FWCUGs are available for cobalt in surface soil. The sediment and surface soil FWCUGs are the same for this receptor; therefore, cobalt concentrations were compared to the FWCUG for soil for the identification of chemicals of concern in sediment.

CNS = Central nervous system.
-- = No value available.
COPC = Chemical of potential concern.
FWCUG = Facility-wide cleanup goal.
HQ = Hazard quotient.
NA = Not applicable.
NOAEL = No observable adverse effect level.
mg/kg = Milligrams per kilogram.
NS = Not specified.
TR = Target risk.

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Table 7-8. FWCUGs Corresponding to an HQ of 1 and TR of 1E-05 in Surface Water

COPC	**Critical Effect or Target Organ**	**FWCUG (mg/L)**	
		Resident (Adult and Child)[a]	
		HQ = 1	**TR = 1E-05**
Aluminum	Neurotoxicity in offspring	148.274	NA
Arsenic	Skin	0.0463	0.011
Cobalt	NS	0.006[b]	--
Chromium (hexavalent)	Stomach, liver/kidney	0.303	NA
Chromium (trivalent)	None	111.735	NA
Iron	Gastrointestinal	6.144	NA
Lead	--	--	--
Manganese	CNS	6.326	--

[a] Resident Receptor FWCUGs are the smaller of the Resident Receptor (Adult or Child) values for each COPC.
[b] No FWCUG is available for cobalt. Value is the U.S. Environmental Protection Agency tap water RSL.
CNS = Central nervous system.
COPC = Chemical of potential concern.
FWCUG = Facility-wide cleanup goal.
HQ = Hazard quotient.
mg/L = Milligrams per liter.
NA = Not applicable.
NS = Not specified.
TR = Target risk.
-- = No value available.

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Table 7-9. Total and Hexavalent Chromium Soil Sample Results

ISM Sample Results		**Discrete Chromium Speciation Sample Results**		
ISM Sample Location	**Total Chromium (mg/kg)**	**Discrete Sample Location[a]**	**Total Chromium (mg/kg)**	**Hexavalent Chromium (mg/kg)**
LL8ss-003M	39	LL8ss-068	11.2	0.86J
LL8ss-017M	22	LL8ss-069	18.3	2
LL8ss-008M	19	LL8ss-070	8.4	2
LL8ss-072M	30.7	LL8ss-072	23.3	0.41J

[a] Discrete sample location is located within the corresponding ISM sample location.
ISM = Incremental sampling methodology.
J = Estimated concentration.

Table 7-10. Surface Soil (0-1 ft bgs) with Detected Concentrations of PAHs Greater than Resident (Adult and Child) FWCUG

Sample Location	Rationale	ISM Sample Size (acres)	Year Sample Collected	Detected Concentration (mg/kg)	
				Benzo(a) pyrene	**Dibenz(a,h) anthracene**
LL8ss-071M	Collected to define the extent of Mn at LL8ss-009M on the west side of Bldg 2B-13	0.11	2010	**0.24**	0.13
LL8ss-072M	Collected to define the extent of Mn and PAHs at LL8ss-005M on the east side of Bldg 2B-21	0.17	2010	**1.3**	**0.29**
LL8ss-073M	Collected to define the extent of Mn at LL8ss-003M on the east Side of Bldg 2B-6	0.23	2010	**1.2**	ND
LL8ss-076M	Collected at former Bldgs 2B-9 and 2B-10	0.3	2010	**0.4**	ND
LL8ss-085M	Production area grid sample	2	2010	**0.46**	0.096

Bldg 2B-6 = Building 2B-6 (booster assembly & shipping).
Bldgs 2B-9 and 2B-10 = Building 2B-9 and Building 2B-10 (change houses).
Bldg 2B-13= Building 2B-13 (tetryl pellet manufacture & storage).
Bldg 2B-21 = Building 2B-21 (booster assembly & shipping).
Bgs = Below ground surface.
ft = Feet.
FWCUG = Facility-wide cleanup goal at a target risk level of 1E-05.
ISM = Incremental sampling methodology.
mg/kg = Milligrams per kilogram.
Mn = Manganese.
ND =Not detected.
PAH = Polycyclic aromatic hydrocarbon.
Bold = Detected concentration exceeds FWCUG at a target risk of 1E-05.

Table 7–11. Comparison of Surface Soil (0-1 ft bgs) Results for ISM and Discrete Samples at Load Line 8

Analyte (mg/kg)	CAS Number	ISM Sample Results		Discrete Sample Results		Maximum Detected Concentration in ISM or Discrete Sample
		Freq of Detect	Maximum Detect	Freq of Detect	Maximum Detect	
Metals and Anions						
Aluminum	7429-90-5	49/49	17000	8/8	10200	ISM
Antimony	7440-36-0	16/47	0.13	6/8	0.15	Discrete
Arsenic	7440-38-2	49/49	13.9	8/8	15.2	Discrete
Barium	7440-39-3	49/49	260	8/8	70	ISM
Beryllium	7440-41-7	36/49	4.3	8/8	0.67	ISM
Cadmium	7440-43-9	33/49	2.8	8/8	0.39	ISM
Calcium	7440-70-2	49/49	180000	8/8	154000	ISM
Chromium	**7440-47-3**	**49/49**	**39**	**12/12**	**23.3**	**ISM**
Cobalt	**7440-48-4**	**49/49**	**11.2**	**8/8**	**12.8**	**Discrete**
Copper	7440-50-8	49/49	67	8/8	28.4	ISM
Iron	7439-89-6	49/49	29800	8/8	29200	ISM
Lead	7439-92-1	49/49	210	8/8	58.1	ISM
Magnesium	7439-95-4	49/49	13000	8/8	6040	ISM
Manganese	**7439-96-5**	**49/49**	**2400**	**8/8**	**725**	**ISM**
Mercury	7439-97-6	44/49	0.87	--	ND	ISM
Nickel	**7440-02-0**	**49/49**	**162**	**8/8**	**25.4**	**ISM**
Potassium	7440-09-7	46/49	1700	8/8	1480	ISM
Selenium	7782-49-2	24/49	1.4	8/8	0.83	ISM
Silver	7440-22-4	1/49	0.036	6/8	0.03	ISM
Sodium	7440-23-5	29/49	1700	8/8	94.3	ISM
Thallium	7440-28-0	19/49	0.2	7/8	0.17	ISM
Vanadium	7440-62-2	49/49	26	8/8	21.7	ISM
Zinc	7440-66-6	49/49	220	8/8	122	ISM
Explosives						
HMX	2691-41-0	2/49	0.015	--	ND	ISM
Nitrocellulose	9004-70-0	7/7	4	--	ND	ISM
Tetryl	479-45-8	7/49	0.63	--	ND	ISM
Pesticides/PCBs						
4,4'-DDD	72-54-8	1/8	0.014	--	ND	ISM
4,4'-DDE	72-55-9	1/8	0.024	--	ND	ISM
4,4'-DDT	50-29-3	1/8	0.0083	--	ND	ISM
beta-BHC	319-85-7	1/8	0.0027	--	ND	ISM
PCB-1254	11097-69-1	3/8	0.1	--	ND	ISM
Semi-volatile Organic Compounds						
2-Methylnaphthalene	91-57-6	5/8	0.086	2/2	0.039	ISM
Acenaphthene	83-32-9	7/23	0.43	2/8	0.013	ISM
Acenaphthylene	208-96-8	1/23	0.01	--	ND	ISM
Anthracene	120-12-7	10/23	0.79	4/8	0.03	ISM
Benz(a)anthracene	**56-55-3**	**14/23**	**1.7**	**7/8**	**0.14**	**ISM**
Benzenemethanol	100-51-6	2/5	0.45	--	ND	ISM
Benzo(a)pyrene	**50-32-8**	**17/23**	**1.3**	**6/8**	**0.11**	**ISM**
Benzo(b)fluoranthene	**205-99-2**	**19/23**	**1.8**	**8/8**	**0.16**	**ISM**
Benzo(ghi)perylene	191-24-2	13/23	0.72	4/8	0.073	ISM
Benzo(k)fluoranthene	207-08-9	15/23	0.75	3/8	0.07	ISM
Bis(2-ethylhexyl)phthalate	117-81-7	4/8	0.18	--	ND	ISM
Chrysene	218-01-9	20/23	1.5	6/8	0.14	ISM
Dibenz(a,h)anthracene	**53-70-3**	**4/23**	**0.29**	**2/8**	**0.035**	**ISM**

Table 7–11. Comparison of Surface Soil (0-1 ft bgs) Results for ISM and Discrete Samples at Load Line 8 (continued)

Analyte (mg/kg)	CAS Number	ISM Sample Results		Discrete Sample Results		Maximum Detected Concentration in ISM or Discrete Sample
		Freq of Detect	Maximum Detect	Freq of Detect	Maximum Detect	
Metals and Anions						
Dibenzofuran	132-64-9	1/8	0.025	--	ND	ISM
Diethyl phthalate	84-66-2	1/8	0.027	--	ND	ISM
Di-n-butyl phthalate	84-74-2	1/8	0.033	--	ND	ISM
Fluoranthene	206-44-0	22/23	4	7/8	0.24	ISM
Fluorene	86-73-7	7/23	0.35	2/8	0.0094	ISM
Indeno(1,2,3-cd)pyrene	**193-39-5**	**13/23**	**0.75**	**5/8**	**0.065**	**ISM**
Naphthalene	91-20-3	16/23	0.26	3/8	0.027	ISM
Phenanthrene	85-01-8	22/23	2.5	4/8	0.11	ISM
Phenol	108-95-2	1/8	0.037	--	ND	ISM
Pyrene	129-00-0	22/23	3.3	7/8	0.22	ISM
Volatile Organic Compounds						
2-Butanone	78-93-3	2/7	0.0024	--	ND	ISM

bgs = Below ground surface.
BHC = Hexachlorocyclohexane.
CAS = Chemical Abstract Service.
DDD = Dichlorodiphenyldichloroethane.
DDE = Dichlorodiphenyldichloroethylene.
DDT = Dichlorodiphenyltrichloroethane.
ft = Feet.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane.
ISM = Incremental sampling methodology.
mg/kg = Milligrams per kilogram.
ND = Not detected.
PCB = Polychlorinated biphenyl.
-- = No value available.
Bold = Chemical is a chemical of potential concern.

Table 7–12. Comparison of March 2010 and April 2011 Surface Water Results for Discrete Samples Collected at LL8sw-090

Analyte (mg/L)	CAS Number	Background Criteria	Sample Date		Sample Date with MDC
			03/01/2010	04/11/2011	
Aluminum	**7429-90-5**	**3.37**	**23.9**	**0.682**	**March 2010**
Arsenic	**7440-38-2**	**0.0032**	**0.0048**	**ND**	**March 2010**
Barium	7440-39-3	0.0475	0.169	0.0208	March 2010
Beryllium	7440-41-7	0	0.00083	ND	March 2010
Cadmium	7440-43-9	0	0.0011	ND	March 2010
Calcium	7440-70-2	41.4	21.9	23.4	April 2011
Chromium	**7440-47-3**	**0**	**0.0264**	**0.0013**	**March 2010**
Cobalt	**7440-48-4**	**0**	**0.0085**	**0.00022**	**March 2010**
Copper	7440-50-8	0.0079	0.0266	0.0027	March 2010
Iron	**7439-89-6**	**2.56**	**23.6**	**0.858**	**March 2010**
Lead	**7439-92-1**	**0**	**0.024**	**0.0005**	**March 2010**
Magnesium	7439-95-4	10.8	6.7	3.88	March 2010
Manganese	**7439-96-5**	**0.391**	**1.23**	**0.0525**	**March 2010**
Nickel	7440-02-0	0	0.0191	0.0013	March 2010
Potassium	7440-09-7	3.17	5.05	1.47	March 2010
Selenium	7782-49-2	0	0.0017	ND	March 2010
Sodium	7440-23-5	21.3	1.95	1.45	March 2010
Vanadium	7440-62-2	0	0.0416	0.00078	March 2010
Zinc	7440-66-6	0.042	0.278	0.0178	March 2010
Anions					
Nitrate	14797-55-8	None	0.2	--	March 2010

CAS = Chemical Abstract Service.
MDC = Maximum detected concentration.
mg/L = Milligrams per liter.
ND = Not detected.
-- = No value available.
Bold = Chemical is a chemical of potential concern.

Table 7–13. Environmental Concentrations of PAHs Measured in Background Surface Soil Samples at RVAAP

Analyte	% Detects		Reported Concentration (mg/kg)	
			Minimum	Maximum
Acenaphthene	1/15	7%	0.88	0.88
Acenaphthylene	1/15	7%	0.07	0.07
Anthracene	2/15	13%	0.12	1
Benz(a)anthracene	10/15	67%	0.044	4.1
Benzo(a)pyrene	8/15	53%	0.058	3.7
Benzo(b)fluoranthene	10/15	67%	0.062	4.8
Benzo(ghi)perylene	6/15	40%	0.046	1.3
Benzo(k)fluoranthene	6/15	40%	0.053	2.6
Chrysene	10/15	67%	0.057	4
Dibenz(a,h)anthracene	2/15	13%	0.11	0.37
Indeno(1,2,3-cd)pyrene	5/15	33%	0.054	1.5

mg/kg = Milligrams per kilogram.
PAH = Polycyclic aromatic hydrocarbon.
RVAAP = Ravenna Army Ammunition Plant.

Table 7–14. Concentrations of Benz(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, and Dibenz(a,h)anthracene in Soil from Various Environmental Studies

Study	Number of Samples	Geometric Mean or Median (mg/kg)	Minimum (mg/kg)	95th Percentile[a] (mg/kg)	Maximum (mg/kg)
Benz(a)anthracene					
CA/T Project[b]	872	0.33	0.045	19	250
LSPA Project[b]	490	0.563	ND	--	796
Watertown[b]	17	0.411	0.021	6.04	6.05
Worcester[b]	68	--	ND	3.8	15
New England[c]	62	0.672	ND	1.86	15
Illinois[d] Urban	--	--	--	1.8	--
Illinois[d] Rural	--	--	--	0.72	--
ATSDR[e] Urban	--	--	0.169	--	59
ATSDR[e] Rural	--	--	0.005	--	0.02
ATSDR[e] Agricultural	--	--	0.056	--	0.11
NYSDEC Rural Near Roads[f]	28	--	ND	1.2	2.9
NYSDEC Rural Distant Roads[f]	118	--	ND	0.16	2.6
Benzo(a)pyrene					
CA/T Project[b]	873	0.3	0.031	17	230
LSPA Project[b]	489	0.44	ND	--	222
Watertown[b]	17	0.95	0.6	4.77	6.08
Worcester[b]	67	--	ND	3.3	9.7
New England[c]	62	0.686	ND	1.82	13
Illinois[d] Urban	--	--	--	2.1	--
Illinois[d] Rural	--	--	--	0.98	--
ATSDR[e] Urban	--	--	0.165	--	0.22
ATSDR[e] Rural	--	--	0.002	--	1.3
ATSDR[e] Agricultural	--	--	0.0046	--	0.9
NYSDEC Rural Near Roads[f]	28	--	ND	1.1	2.4
NYSDEC Rural Distant Roads[f]	118	--	ND	0.12	3.4
Benzo(b)fluoranthene					
CA/T Project[b]	873	0.68	0.045	18	270
NYSDEC Rural Distant Roads[f]	118	--	ND	--	0.23
LSPA Project[b]	486	--	ND	--	250
Watertown[b]	17	1.4	0.6	6.79	7.08
Worcester[b]	--	--	--	--	--
New England[c]	62	0.722	ND	1.97	12
Illinois[d] Urban	--	--	--	2	--
Illinois[d] Rural	--	--	--	0.7	--
ATSDR[e] Urban	--	--	15	--	62
ATSDR[e] Rural	--	--	0.02	--	0.03
ATSDR[e] Agricultural	--	--	0.058	--	0.22
NYSDEC Rural Near Roads[f]	28	--	ND	1.2	3.3
NYSDEC Rural Distant Roads[f]	118	--	ND	0.36	4.6
Dibenz(a,h)anthracene					
CA/T Project[b]	866	0.17	0.045	2.1	39
LSPA Project[b]	--	--	--	--	--
Watertown[b]	17	0.195	0.155	0.604	0.64
Worcester[b]	68	--	ND	--	1.6
New England[c]	62	0.245	ND	--	2.9
Illinois[d] Urban	--	--	--	0.42	--
Illinois[d] Rural	--	--	--	0.15	--

Table 7–14. Concentrations of Benz(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, and Dibenz(a,h)anthracene in Soil from Various Environmental Studies (continued)

Study	Number of Samples	Geometric Mean or Median (mg/kg)	Minimum (mg/kg)	95th Percentile[a] (mg/kg)	Maximum (mg/kg)
ATSDR[e]	--	--	--	--	--
NYSDEC Rural Near Roads[f]	28	--	--	--	--
NYSDEC Rural Distant Roads[f]	118	--	ND	--	0.23

[a] Lognormal 95th percentile value for all studies except: (1) New England value is 95% upper confidence limit and (2) New York State Department of Environmental Conservation (NYSDEC) values are distribution-free 95th percentile.

[b] Data reported by Massachusetts Department of Environmental Protection (MADEP 2002) are from the following data sets:

CA/T = Data collected by Mass Highway Department as part of the Central Artery/Tunnel (CA/T) project.

LSPA = Preliminary data compiled by the Massachusetts Licensed Site professional Association (LSPA) from data submitted by its members in 2001.

Water Town and Worcester Site-specific samples.

[c] Data from three New England locations from Bradley et al. 1994.

[d] Concentrations of polycyclic aromatic hydrocarbons (PAHs) in Illinois metropolitan statistical areas (urban) and non-metropolitan statistical areas (rural) as reported by Illinois Environmental Protection Agency (IEPA 2005).

[e] Data published by the Agency for Toxic Substances and Disease Registry (ATSDR) in PAHs August 1995.

[f] Distribution-free 95th percentile values for near roads (less than 10 ft from roads and pavement) and not near roads (more than 15 ft from roads and pavement) from New York State Brownfield Cleanup program Development of Soil Cleanup Objectives Technical Support Document (September 2006), Appendix D.

ND = Not detected.

-- = No value reported for this source.

Table 7-15. Summary of Historical COPECs per the Characterization of 14 AOCs

Group	COPEC	Shallow Soil	Sediment	Surface Water
Inorganic Chemicals	Arsenic	--	X	--
	Barium	--	X	--
	Beryllium	--	X	--
	Cadmium	--	X	--
	Chromium	X	--	--
	Copper	X	X	X
	Iron	X	X	X
	Lead	X	X	--
	Manganese	X	X	X
	Mercury	X	X	--
	Selenium	--	X	X
	Silver	--	X	--
	Zinc	X	--	--
Anions	Nitrate	--	--	X
Pesticides/PCBs	Aroclor-1254 (PCB-1254)	X	--	--
	beta-BHC	X	--	--
	4,4’-DDD	--	X	--
	4,4’-DDE	--	X	--
	4,4’-DDT	--	X	--
SVOCs	Benzo(a)pyrene	--	--	X
	Benzo(b)fluoranthene	--	--	X
	Benzo(ghi)perylene	--	--	X
	Benzo(k)fluoranthene	--	--	X
	Benzoic acid	--	--	X
	Benzenemethanol	--	--	X
	Dibenz(a,h)anthracene	--	--	X
	Dibenzofuran	X	--	--
	Indeno(1,2,3-cd)pyrene	--	--	X
Explosives	2-Amino-4,6-Dintirotoluene	--	X	--
	Tetryl	X	--	--
Propellants	Nitrocellulose	X	X	--

Adapted from Tables LL8-14 through LL8-16 from the Characterization of 14 AOCs (MKM 2007).
AOC = Area of concern.
Beta-BHC = Beta-hexachlorocyclohexane.
COPEC = Chemical of potential ecological concern.
DDD = Dichlorodiphenyldichloroethane.
DDE = Dichlorodiphenyldichloroethylene.
DDT = Dichlorodiphenyltrichloroethane.
PCB = Polychlorinated biphenyl.
SVOC = Semi-volatile organic compound.
-- = Chemical not identified as a COPEC in this data set.
X = Quantitative COPEC, exceeds ESV.

1 **Table 7-16. Wetlands Associated with Load Line 8**

Wetland ID	Wetland Type[a]	Total Wetland Size	ORAM Score	ORAM Category
Wetland 1	PUBH/PSS1E/PFO1E	3.8 acres[b]	62	3
Wetland 2	PFO1E	0.05 acres	30	2
Wetland 3	PFO1E	0.03 acres	30	2
Wetland 4	PFO1E	0.87 acres	44	2
Wetland 5	PFO1E	0.18 acres	40	2

[a] Cowardin Classification: PUBH = palustrine, unconsolidated bottom, permanently flooded; PSS1E = palustrine, broad-leaved deciduous, scrub-shrub, seasonally flooded/saturated; PFO1E = palustrine, broad-leaved deciduous, forested, seasonally flooded/saturated.

[b] Size within the AOC only; entire wetland is 18.4 acres.

AOC = Area of concern.

ID = Identifier.

ORAM = Ohio Rapid Assessment Method.

2 **Table 7-17. 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 (Jurisdictional and Planning Level Survey)	One Category 3 wetland complex along the southern boundary and along the western ditch and four small Category 2 wetlands	Wetland 1 extends beyond the southern boundary of Load Line 8	Other wetlands are in the vicinity of the AOC (Figure 7-4)
Rare Species	No known sightings	Identified 600 ft east of AOC (see text for species names)	2,000 ft west (see text for species names)
Beaver Dams	Two small beaver dams (see text for dam locations)	One beaver dam located southwest of the AOC	Approximately 1,100 ft west
100-year Floodplain	None	None	Approximately 2,900 ft west
Stream Sampling[b]	None	None	Approximately 7,500 ft southwest (Hinkley Creek)
Pond Sampling[b]	None	None	Approximately 1,600 ft north (Fuze and Booster Pond)

[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.

ft = Feet.

Table 7-18. Summary of Integrated COPECs for Surface Soil

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Cadmium	2.8	0.36	7.8	None
Chromium	39	26	1.5	None
Copper	67	28	2.4	None
Lead	210	11	19.1	Second highest ratio at 19x
Manganese	2400	220	10.9	None
Mercury	0.87	0.00051	1,706	Highest ratio at 1,706x, PBT compound
Nickel	162	38	4.3	None
Zinc	220	46	4.8	None
HMX	0.015	No ESV	--	None
Nitrocellulose	4	No ESV	--	None
Tetryl	0.63	No ESV	--	None
Dibenzofuran	0.025	No ESV	--	None
Naphthalene	0.26	0.0994	2.6	None
4,4’-DDD	0.014	0.021	0.67	PBT compound
4,4'-DDE	0.024	0.021	1.1	PBT compound
4,4’-DDT	0.0083	0.021	0.40	PBT compound
PCB-1254	0.1	0.371	0.27	PBT compound
beta-BHC	0.0027	0.00398	0.68	PBT compound

Table excludes nutrients.
BHC = Beta-hexachlorocyclohexane.
COPEC = Chemical of potential ecological concern.
DDD = Dichlorodiphenyldichloroethane.
DDE = Dichlorodiphenyldichloroethylene.
DDT = Dichlorodiphenyltrichloroethane.
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.
-- = Not applicable, no ESV is available for comparison.

Table 7-19. Summary of Integrated COPECs for Sediment

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Beryllium	1.3	No ESV	--	None
Cadmium	2.6	0.99	2.63	Second highest ratio at 2.6x
Mercury	0.26	0.18	1.44	PBT compound
Selenium	2.3	No ESV	--	None
Nitrocellulose	1.1	No ESV	--	None
Tetryl	0.014	No ESV	--	None
4,4’-DDD	0.0015	0.00488	0.31	PBT compound
4,4'-DDE	0.023	0.00316	7.28	Highest ratio at 7x, PBT compound
4,4’-DDT	0.0065	0.00416	1.56	PBT compound

Table excludes nutrients.
COPEC = Chemical of potential ecological concern.
DDD = Dichlorodiphenyldichloroethane.
DDE = Dichlorodiphenyldichloroethylene.
DDT = Dichlorodiphenyltrichloroethane.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
mg/kg = Milligrams per kilogram.
PBT = Persistent, bioaccumulative, and toxic.
x = Multiplier.
-- = Not applicable, no ESV is available for comparison.

Table 7-20. Summary of Integrated COPECs Based on MDCs in Surface Water

COPEC	MDC (mg/L)	ESV (mg/L)	Ratio of Maximum to ESV	Comments
Aluminum	23.9	0.087[a]	274.7	ESV is NAWQC
Copper	0.0266	0.014/0.0093[b]	1.9/2.9	Ratios are MDC/OMZM and MDC/OMZA
Iron	23.6	1[a]	23.6	ESV is NAWQC
Lead	0.024	0.0064[c]	3.8	Ratio is MDC/OMZA (MDC/OMZM<1)
Manganese	1.23	0.12[a]	10.3	ESV is Tier II Chronic
Zinc	0.278	0.12/0.12[b]	2.3/2.3	Ratios are MDC/OMZM and MDC/OMZA
Nitrate	0.2	No ESV	--	None

[a] No Ohio EPA Administrative Code ESV (OMZM or OMZA) is available; ESV is next available in hierarchy of sources.
[b] ESVs shown are OMZM/OMZA.
[c] ESV shown is OMZA. The analyte is not a COPEC when screened against OMZM (MDC<OMZM). See Appendix H, Table H-13 for OMZM screening of this analyte.
Table excludes nutrients.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
mg/L = Milligrams per liter.
MDC = Maximum detected concentration.
NAWQC = National ambient water quality criteria.
OMZA = Outside mixing zone average.
OMZM = Outside mixing zone maximum.
-- = Not applicable, no ESV is available for comparison.

Table 7-21. Application and Decisions of Selected Evaluation Factors to Integrated COPECs for 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 (Ratio ≤ 1)	COPEC is not a candidate to be a final COPEC. Evaluation ceased.
	(B) Mean concentration larger than the ESV (Ratio ≥ 1)	Continue evaluation of chemical.
Compare mean concentration above ESV to background concentration	(A) Mean concentration smaller than the background concentration (Ratio ≤ 1)	COPEC is not a candidate to be a final COPEC. Evaluation ceased.
	(B) Mean concentration larger than background concentration (Ratio ≥ 1)	Continue evaluation of chemical.

COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.

Table 7-22. Summary of Data for Step 3A Refinement of Integrated COPECs in Surface Soil at Load Line 8

COPEC	Mean Concentration (mg/kg)	ESV (mg/kg)	Mean Concentration > ESV? (Yes/No)	Background Concentration (mg/kg)	Mean Concentration > Background Concentration? (Yes/No)	ESV > Background Concentration? (Yes/No)	Frequency of Detections	Frequency of Detections[a] > ESV	Frequency of Detections[a] > Background Concentration	Further Evaluation in Level II Required? (Yes/No)
COPEC with Mean Concentration < ESV										
Chromium	23.5	26	No	17.4	Yes	Yes	49 /49	13 /49	45 /49	No
Copper	18.9	28	No	17.7	Yes	Yes	49 /49	4 /49	21 /49	No
Nickel	24.3	38	No	21.1	Yes	Yes	49 /49	1 /49	21 /49	No
Naphthalene	0.0946	0.0994	No	NA	NA	NA	16 /23	2 /16	NA	No
4,4'-DDD	0.00588	0.021	No	NA	NA	NA	1 /8	0 /1	NA	No
4,4'-DDE	0.00701	0.021	No	NA	NA	NA	1 /8	1 /1	NA	No
4,4'-DDT	0.00517	0.021	No	NA	NA	NA	1 /8	0 /1	NA	No
beta-BHC[b]	0.0027	0.00398	No	NA	NA	NA	1 /8	0 /1	NA	No
PCB-1254	0.0303	0.371	No	NA	NA	NA	3 /8	0 /3	NA	No
COPEC with Mean Concentration > ESV and Mean Concentration < Background Concentration										
Manganese	673	220	Yes	1450	No	No	49 /49	49 /49	3 /49	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration										
Cadmium	0.488	0.36	Yes	0	Yes	Yes	33 /49	11 /33	33 /33	Yes
Lead	48.6	11	Yes	26.1	Yes	No	49 /49	49 /49	30 /49	Yes
Mercury	0.061	0.00051	Yes	0.036	Yes	No	44 /49	44 /44	25 /44	Yes
Zinc	89.6	46	Yes	61.8	Yes	No	49 /49	49 /49	36 /49	Yes

[a] 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.

[b] Concentration for beta-BHC is for the single detection. Average result is calculated with half the reporting limit for non-detects and is greater than the single detection.

COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
mg/kg = Milligrams per kilogram.
NA = Not applicable (no value available).
> = Greater than.

Table 7-23. Summary of Mean Concentrations and Background Concentrations of Remaining Integrated Soil 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
Cadmium	0.488	ND	NA	NA
Lead	48.6	26.1	1.9	Concentrations are somewhat similar
Mercury	0.061	0.036	1.7	Concentrations are somewhat similar
Zinc	89.6	61.8	1.4	Concentrations are similar

COPEC = Chemical of potential ecological concern.
mg/kg = Milligrams per kilogram.
NA = Not available, ratio could not be calculated.
ND = Not detected.

Table 7-24. Comparison of Mean Concentration to Alternative ESV for Remaining Integrated Soil COPECs

COPEC	Mean Concentration (mg/kg)	Preferred ESV (mg/kg)	Alternative ESV[a] (mg/kg)	Ratio of Mean Concentration to Preferred ESV	Ratio of Mean Concentration to Alternative ESV
Cadmium	0.488	0.36	0.77	1.4	0.63
Lead	48.6	11	40.5	4.4	1.2
Mercury	0.061	0.00051	0.1	120	0.61
Zinc	89.6	46	79	2	1.1

[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.

Table 7-25. Summary of Data for Step 3A Refinement of Integrated COPECs in ISM Sediment at Load Line 8

COPEC	Mean Concentration (mg/kg)	ESV (mg/kg)	Mean Concentration > ESV? (Yes/No)	Background Concentration (mg/kg)	Mean Concentration > Background Concentration? (Yes/No)	ESV > Background Concentration? (Yes/No)	Frequency of Detections	Frequency of Detections[a] > ESV	Frequency of Detections[a] > Background Concentration	Further Evaluation in Level II Required? (Yes/No)
COPEC with Mean Concentration < ESV										
Mercury	0.0927	0.18	No	0.059	Yes	Yes	7 /7	1 /7	5 /7	No
4,4'-DDD	0.0018	0.00488	No	NA	NA	NA	1 /2	0 /1	NA	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration										
Cadmium	1.07	0.99	Yes	NA	NA	NA	5 /7	3 /5	5 /5	Yes
4,4'-DDE	0.0128	0.00316	Yes	NA	NA	NA	1 /2	1 /1	NA	Yes
4,4'-DDT	0.0043	0.00416	Yes	NA	NA	NA	1 /2	1 /1	NA	Yes

[a] 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.
DDD = Dichlorodiphenyldichloroethane.
DDT = Dichlorodiphenyltrichloroethane.
ESV = Ecological screening value.
ISM = Incremental sampling methodology.
mg/kg = Milligrams per kilogram.
NA = Not applicable (no value available).

Table 7-26. Summary of Data for Step 3A Refinement of Integrated COPECs in Surface Water at Load Line 8

COPEC	Mean Concentration (mg/L)	ESV (mg/L)	Mean Concentration > ESV? (Yes/No)	Background Concentration (mg/L)	Mean Concentration > Background Concentration? (Yes/No)	ESV > Background Concentration? (Yes/No)	Frequency of Detections	Frequency of Detections[a] > ESV	Frequency of Detections[a] > Background Concentration	Further Evaluation in Level II Required? (Yes/No)
COPEC with Mean Concentration < ESV										
None										
Essential Nutrient – COPEC with Mean Concentration > ESV and Mean Concentration < RDA/RDI-based Screening Level										
Iron	9.7	1	Yes	2.56	Yes	No	3 /3	3 /3	2 /3	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration										
Aluminum	9.03	0.087	Yes	3.37	Yes	No	3 /3	3 /3	1 /3	Yes
Copper	0.0116	0.0093[c]	Yes	0.0079	Yes	Yes	3 /3	1 /3	1 /3	Yes
Lead	0.00907	0.0064[d]	Yes	0	Yes	Yes	3 /3	1 /3	3 /3	Yes
Manganese	0.532	0.12	Yes	0.391	Yes	No	3 /3	3 /3	1 /3	Yes
Zinc	0.133	0.12[e]	Yes	0.042	Yes	Yes	3 /3	1 /3	2 /3	Yes

[a] 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.

[b] Iron was included as a COPEC because the maximum concentration exceeded the human health RDA of 18 mg/L. It is eliminated here because the mean is below the RDA/RDI.

[c] ESV shown is OMZA. The average copper rface water concentration is less than the OMZM ESV (0.014 mg/L).

[d] ESV shown is OMZA. The average lead surface water concentration is less than the OMZM ESV (0.12 mg/L).

[e] The OMZM and OMZA ESVs for zinc are both 0.12 mg/L.

COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
mg/L = Milligrams per liter.
RDA/RDI = Recommended daily allowance/recommended daily intake.

Figure 7-1. Sample Areas LL8ss-071M, LL8ss-072M, LL8-085M, and Nearby Samples

Figure 7-2. Sample Area LL8ss-073M and Nearby Samples

Figure 7-3. Sample Area LL8ss-076M and Nearby Samples

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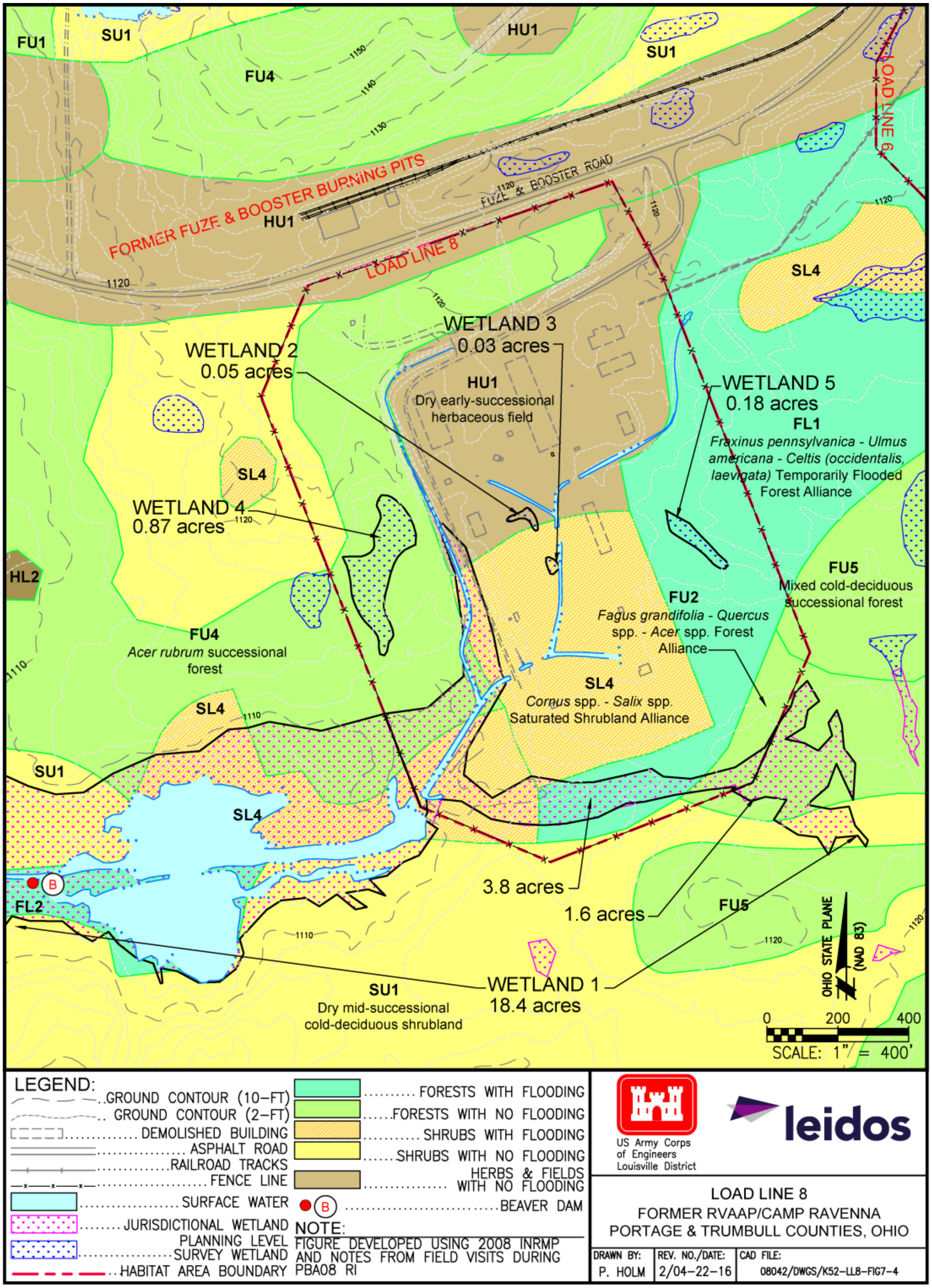

Figure 7-4. Natural Resources Inside and Near Habitat Area at Load Line 8

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8.0 REMEDIAL INVESTIGATION CONCLUSIONS AND RECOMMENDATIONS

8.1 INTRODUCTION

The RI Report for Load Line 8 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 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 if COCs occur that may require further evaluation in an FS. This section concludes with recommendations for any further characterization under the RI phase of work and, for each of the media evaluated in the RI, whether to proceed to the FS phase of the RI/FS process.

8.2 SUMMARY OF DATA USED IN THE REMEDIAL INVESTIGATION

Quality-assured sample data from the 2004 Characterization of 14 AOCs, 2007 Investigation of Under Slab Surface Soils, and 2010 PBA08 RI were used to evaluate nature and extent of contamination at Load Line 8. These investigations used discrete and ISM 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 2004 (Characterization of 14 AOCs) and 2007 (Investigation of Under Slab Surface Soil) data sets were evaluated to determine if conditions had changed substantively between earlier characterization efforts and the 2010 PBA08 RI, as building demolition activities occurred in 2006, after the 2004 sampling. The samples collected in 2004 were collected within ditch lines adjacent to former buildings and in large areas encompassing, but also extending beyond the footprint of the former buildings. The 2007 sampling was conducted within the footprints of the demolished buildings after slab removal. Therefore, both data sets were considered representative of current conditions within and surrounding the footprints of the former buildings at Load Line 8.

Data collected as part of the PBA08 RI focused on delineating the extent of contaminants identified in surface soil (0–1 ft bgs) during prior investigations, subsurface soil (1–13 ft bgs) (not previously sampled), sediment, and surface water. Since ISM was used for surface soil (0–1 ft bgs) as part of the 2004 Characterization of 14 AOCs, ISM was also used for surface soil sampling during the PBA08 RI. Discrete samples were collected to assess subsurface soil, 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 were analyzed for chemicals identified in historical investigations.

8.3 SUMMARY OF NATURE AND EXTENT

Nature and extent of contamination in surface soil (0-1 ft bgs), subsurface soil (greater than 1 ft bgs), sediment, and surface water was evaluated in the RI. Data from the 2004 Characterization of 14 AOCs, 2007 Investigation of Under Slab Surface Soil, and 2010 PBA08 RI effectively characterized 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 (USACE 2010a). It can be concluded that the vertical and horizontal extent of contamination is defined, and no further sampling is needed to evaluate Load Line 8.

Sites where explosives were identified as potential contaminants from previous use (TNT, RDX, HMX, and tetryl) were thoroughly evaluated, including around former process buildings and across the AOC as a whole. TNT and RDX were not detected in any of the environmental media sampled at Load Line 8 and HMX and tetryl were not detected in subsurface soil or surface water. The maximum concentrations of HMX and tetryl detected in the ISM surface soil samples were below their respective SLs and were not considered COPCs. In addition, tetryl was detected in one ISM sediment sample below the SL and was not considered a COPC.

Arsenic, chromium, lead, and mercury were identified as potential inorganic SRCs and as potentially related to previous site use. Arsenic was detected below its background concentration in surface soil at Load Line 8. An arsenic concentration (26.9 mg/kg) detected in the subsurface soil interval from 4-7 ft bgs at LL8sb-060 exceeded the subsurface soil background concentration (19.8 mg/kg). The concentration decreased below the background concentration in the 7-13 ft bgs interval at LL8sb-060. Chromium, lead, and mercury had concentrations above their background concentrations, but all concentrations were below their respective SLs in soil and sediment samples. Lastly, all detections of these four inorganic chemicals in surface water were below their respective SLs in the most recent samples of surface water at Load Line 8.

Three other inorganic chemicals (cobalt, manganese, and nickel) exceeded their respective SLs in surface soil. The exceeding concentrations of these inorganic chemicals were below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1 except manganese at three ISM surface soil locations (LL8ss-003M, LL8ss-005M, and LL8ss-009M). No other inorganic chemicals exceeded their respective SLs in the subsurface soil at Load Line 8.

Aluminum exceeded its SL at discrete sediment sample location LL8sd-090; however, the concentration was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Cobalt was detected at concentrations exceeding the SL at LL8sw-091 and LL8sw-092; however, the concentrations were below the RSL at a TR of 1E-05, HQ of 1.

PAHs were identified as potential contaminants from previous site use at former Buildings 2B-23 and 2B-24 that were used for heater houses; however, concentrations detected in surface soil and the other environmental media adjacent to or surrounding these former buildings were less than the SLs. PAHs were widely distributed in surface soil throughout the AOC; however, the maximum detections of the five PAHs identified as COPCs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene] were observed at sample location LL8ss-072M, which is in the vicinity of former Building 2B-21. At sample location LL8ss-072M, the detections of benzo(a)pyrene and dibenzo(a,h)anthracene exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Five surface soil locations (LL8ss-071M, LL8ss-072M, LL8ss-073M, LL8ss-076M, and LL8ss-085M) slightly exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1 for benzo(a)pyrene. In addition, benzo(a)pyrene was detected at ISM sediment sample location LL8sd-001M above the SL and is therefore considered a COPC.

Former Building 2B-22 was the only building at Load Line 8 whose purpose was solvent storage. The sample (LL8ss-019) associated with Building 2B-22 had no detectable VOC concentrations in surface soil. One VOC (2-butanone) was identified as an SRC in surface soil, as estimated concentrations were reported from PBA08 RI multi-acre ISM samples LL8ss-074M (0.002J mg/kg) and LL8ss-088M (0.0024J mg/kg). In addition, the VOC acetone was detected in one discrete subsurface sample at a low, estimated concentration. One VOC (toluene) was detected at a low concentration in one discrete sediment sample. All detected VOC concentrations were below their respective SLs.

One PCB (PCB-1254) and four pesticides (4,4’-DDD; 4,4’-DDE; 4,4’-DDT; and beta-BHC) were identified as SRCs in surface soil. Three of the four pesticides (4,4’-DDD; 4,4’-DDE; and 4,4’-DDT) were identified as SRCs in surface soil and in sediment. None of the detections exceeded their respective SLs. No pesticides or PCBs were detected in subsurface soil or surface water, and no PCBs were detected in sediment.

8.4 SUMMARY OF CONTAMINANT FATE AND TRANSPORT

All SRCs identified in surface soil, subsurface soil, and sediment at Load Line 8 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 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 the SESOIL model 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 the AT123D model to predict groundwater concentrations beneath source areas and at the nearest downgradient groundwater receptor to the AOC (e.g., stream).

The evaluation of modeling results with respect to current AOC groundwater data and model limitations identified the following CMCOPCs for soil and sediment:

- Arsenic, selenium, and naphthalene in soil were predicted to exceed the screening criteria in groundwater beneath the source area; however, none of these constituents were predicted to exceed screening criteria at the downgradient receptor location.
- Barium; cadmium; chromium; cobalt; lead; mercury; nickel; selenium; benz(a)anthracene; benzo(b)fluoranthene; naphthalene; and 4,4'-DDE in sediment were predicted to exceed the screening criteria in groundwater beneath the source area; however, none of these constituents were predicted to exceed screening criteria 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 and sediment at Load Line 8 that may impact the groundwater at Load Line 8 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 8 for the protection of groundwater.

8.5 SUMMARY AND CONCLUSIONS OF THE HUMAN HEALTH RISK ASSESSMENT

The HHRA identified COCs and conducted risk management analysis to determine if COCs pose unacceptable risk to the Resident Receptor. Since the risk management analysis determined there was 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 8 are surface soil, subsurface soil, sediment, and surface water. Soil data associated with Load Line 8 were aggregated into surface and subsurface soil. Sediment was evaluated from ditches within and west of the production area. In addition, sediment and surface water were evaluated from ditches located in the southwest side of Load Line 8 where surface water exits the AOC.

No COCs were identified for the Resident Receptor in subsurface soil or sediment. Five PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] were identified as COCs for the Resident Receptor (Adult and Child) in surface soil. Five ISM sample locations have benzo(a)pyrene concentrations above the Resident Receptor (Adult and Child) FWCUG of 0.221 mg/kg (i.e., ranging from 0.24 to 1.3 mg/kg). The dibenz(a,h)anthracene concentration in LL8ss-072M (0.29 mg/kg) slightly exceeded the Resident Receptor (Adult and Child) FWCUG of 0.221 mg/kg. The SORs for these samples are greater than one, due primarily to benzo(a)pyrene. Gravel, slag, and crushed building debris were present in the ISM sample areas. The PAH concentrations at Load Line 8 are not indicative of an operation-related point source of PAHs and are indicative of road sources. Due to the low concentrations of PAHs reported in these samples collected from areas with no identified source of PAHs other than roads, gravel, and building debris, PAHs were not identified as COCs for potential remediation.

Three COCs (cobalt, iron, and lead) were identified for the Resident Receptor in surface water. Cobalt and lead were identified as exceeding their FWCUGs in surface water only because no FWCUGs are available for these inorganic chemicals. The detected concentration of cobalt (0.0085 mg/L) in the sample collected at LL8sw-090 in March 2010 slightly exceeds the tap water RSL (0.0060 mg/L), corresponding to an HQ of 1. The MDC of lead (0.024 mg/L) is 1.6 times the MCL for drinking water (0.015 mg/L) in LL8sw-090 collected in March 2010. Iron was below the FWCUG in surface water, but contributed to an SOR greater than one in LL8sw-090. These metals were not identified as COCs for remediation as (1) concentrations of these metals were significantly lower in a subsequent surface water sample collected from the same location in April 2011, and (2) incidental exposure to surface water in a ditch would be much less than exposure from ingestion of tap water or drinking water, which the conservative comparisons for cobalt and lead were based on.

Based on the risk management analysis, no COCs were identified to be carried forth in an FS for the Resident Receptor 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 Level I ERA 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 surface soil, sediment, and surface water at Load Line 8. This contamination was identified using historical and PBA08 RI data. Various field, forest, shrubland, and other ecological resources were observed on the 44 acres in the AOC. There are important and significant ecological resources in the AOC. Specifically, wetlands and surface water (i.e., ditches and a stream) 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. Eighteen integrated COPECs were identified for soil. Nine integrated COPECs were identified for sediment. Seven 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 for Load Line 8 concludes with a recommendation that no further action is required to be protective of important ecological resources.

8.7 UPDATED CONCEPTUAL SITE MODEL

The updated CSM is presented in this section to incorporate results of this RI. Elements of the CSM include:

- Primary and secondary contaminant sources and release mechanisms,
- Contaminant migration pathways and discharge or exit points,
- Potential receptors of risk, and
- Data gaps and uncertainties.

The following sections describe each of the above elements of the CSM for Load Line 8 and 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 nature and extent of SRCs are cited to assist in visualizing key summary points of the CSM.

8.7.1 Primary and Secondary Contaminant Sources and Release Mechanisms

No primary contaminant sources (e.g., operational facilities) were located at the AOC. All buildings were demolished in 2006. Remnant contamination in soil and sediment within the AOC is considered as a secondary source of contamination.

Sites where explosives were identified as potential contaminants from previous use (RDX and TNT) were thoroughly evaluated, including around former process buildings and across the AOC as a whole. RDX and TNT were not detected in any of the environmental media sampled (i.e., surface soil, subsurface soil, sediment, and surface water).

The occurrence and distribution of inorganic SRCs above background concentrations in surface soil is generally widespread and notable spatial patterns are not evident for most SRCs. Detections of PAH SRCs were widespread throughout the AOC; however, the maximum detections of the five PAHs identified as COPCs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene] were observed in the vicinity of former Building 2B-21. Lower numbers and generally lower concentrations of inorganic SRCs occur in subsurface soil than in associated surface soil.

Building 2B-22 was the only building at Load Line 8 whose purpose was solvent storage. The sample (LL8ss-019) associated with Building 2B-22 had no detectable VOC concentrations in surface soil. Furthermore, all other samples with detected VOC concentrations were below their respective SLs.

Surface water drainage generally follows the topography at the AOC, flowing into ditch conveyances and along the north, west, and central portions of the production area. Surface water flowing in ditches or other drainage features is the primary migration pathway for contamination to leave the AOC. Surface water exits from the southwest portion of the AOC. The surface drainage flows toward an unnamed perennial stream located at the southwest corner of the AOC and flows west to Hinkley Creek. Three sediment and surface water samples were collected in ditches at Load Line 8. Although SRCs were identified in sediment and surface water, none were detected above SLs. explosives were detected about the SLs.

The primary mechanisms for release of chemicals from secondary sources at the AOC are the following:

- Eroding soil matrices with sorbed chemicals and mobilization in overland surface water storm runoff during heavy rainfall conditions,
- Dissolving soluble chemicals and transport in perennial surface water conveyances and intermittent surface water runoff,

- Re-suspending contaminated sediment during periods of high flow with downstream transport within the surface water system, and
- Leaching contaminants to groundwater.

8.7.2 Contaminant Migration Pathways and Exit Points

8.7.2.1 Surface Water Pathways

Chemical migration from soil sources via surface water occurs primarily by (1) particle-bound chemicals moving through surface water runoff, and (2) dissolved chemicals being transported in surface water. In the case of particle-bound contaminant migration, chemicals will be mobilized during periods of high flow (e.g., rain events). Upon reaching portions of surface water conveyances where flow velocities decrease, chemicals will settle out as sediment accumulation. Sediment-bound chemicals may become re-suspended and migrate during storm events or may partition to dissolved phase in surface water. Sediment data on Load Line 8 consists of three samples collected from the conveyance ditches. Surface water exits from the southwest portion of the AOC. The surface drainage flows toward an unnamed perennial stream located at the southwest corner of the AOC and flows west to Hinkley Creek. The ditches are predominantly dry but may transport water during periods of heavy rain, although ditches to the south have been known to hold water during periods of time without rain.

In the case of dissolved phase contaminant transport, migration patterns typically reflect a combination of continuous baseflow inputs with superimposed episodic cycles in association with rain events, snow melt, or seasonal precipitation patterns. Such episodic events may temporarily increase dissolved phase contaminant concentrations depending on the source and solubility of SRCs. The events may also dilute and decrease contaminant concentrations if a large influx of comparatively non-contaminated water occurs. As noted in Section 3.0, intermittent surface water from a majority of the AOC flows along various small drainage ditches and exits the AOC at the southwestern boundary through the main drainage conveyance.

8.7.2.2 Groundwater Pathways

The estimated direction of groundwater flow at the AOC is to the southwest. 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 1104.46–1109.47 ft amsl, with the highest elevation at LL8mw-001. Potentiometric data indicate the groundwater table occurs within 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 Hinkley Creek located along the southwest AOC boundary.

The FWGWMP was initiated in 2005 and involves quarterly sampling of selected wells within the former RVAAP. Between 2009–2010, five different sampling events under the FWGWMP collected groundwater data at Load Line 8.

Contaminant leaching pathways from soil and sediment to the water table are through silty loam unconsolidated soil with an overall average hydraulic conductivity of 2.40E-04 cm/s. Conservative transport modeling indicated 3 chemicals may leach from soil (arsenic, selenium, and naphthalene) and 12 chemicals may leach from sediment (barium; cadmium; chromium; cobalt; lead; mercury; nickel; selenium; benz(a)anthracene; benzo(b)fluoranthene; naphthalene; and 4,4-DDE) and migrate to the groundwater table at concentrations exceeding MCLs/RSLs beneath their respective sources; however, none of these constituents is predicted to migrate laterally and reach the nearest surface water receptor (unnamed tributary to Hinkley Creek located along the southwest boundary of Load Line 8) at a concentration exceeding MCL/RSLs. These chemicals were not detected in AOC groundwater samples collected from 2009-2010 above their respective groundwater criteria; 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 or sediment at Load Line 8 that may potentially impact groundwater at Load Line 8. 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 or sediment to be protective of groundwater.

8.7.2.3 Sewer System

The sewers within the perimeter of Load Line 8 are being investigated and assessed as part of the Facility-wide Sewers AOC (RVAAP-67). Storm sewers are not present at Load Line 8. 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 effectively characterized the nature and extent of the contamination at the Load Line 8 FA, and no further sampling was recommended. All SRCs found in the subsurface sewer media samples within the Load Line 8 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 8 FA for the National Guard Trainee or Resident Receptor (Adult and Child). Since the Load Line 8 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 did not identify Resident Receptor COCs to be carried forward for potential remediation; therefore, Load Line 8 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 8, 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

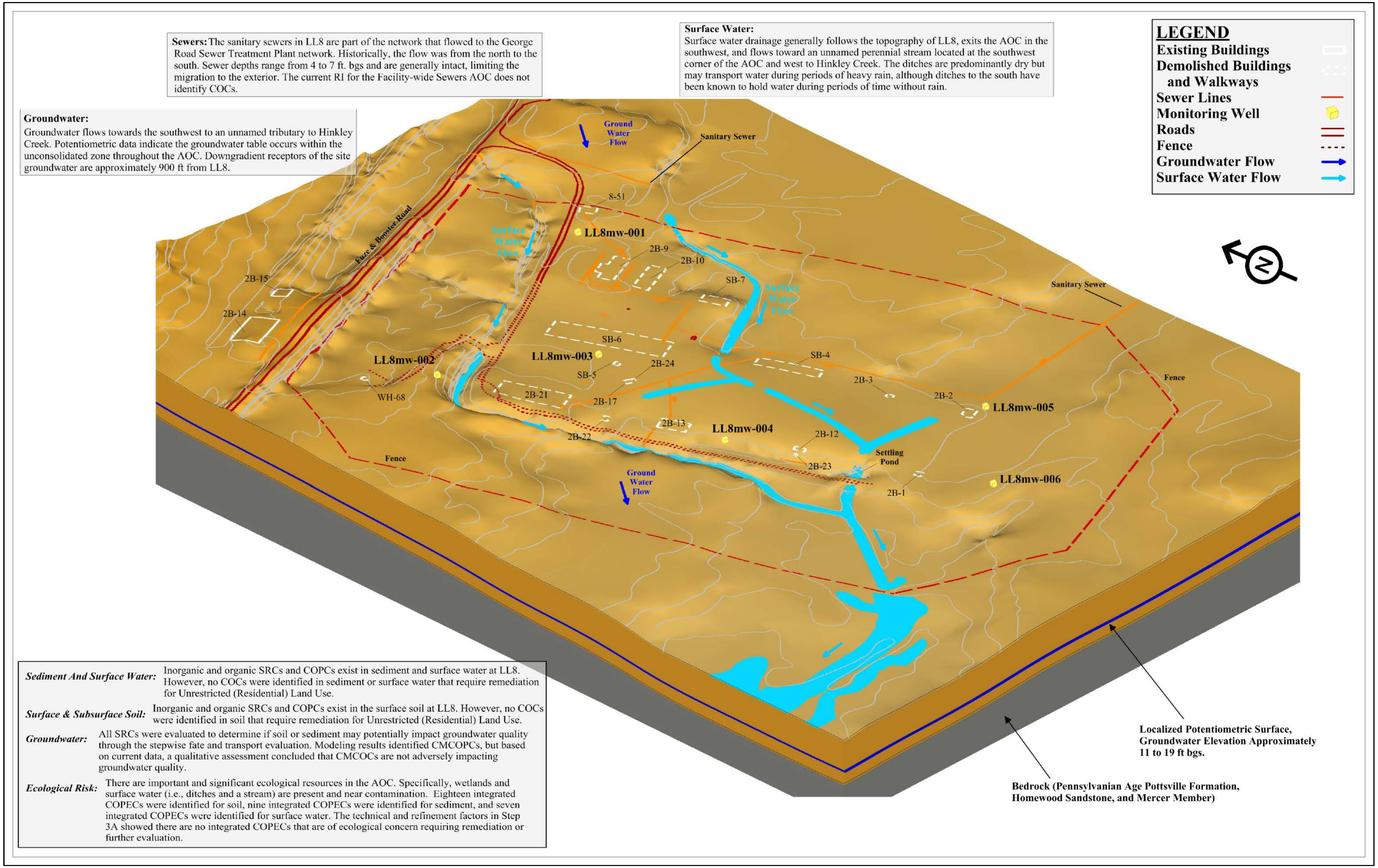
Uncertainties are inherent in the CSM depending on the density and availability of data. The CSM for Load Line 8 is overall well defined using existing data, and major data gaps do not remain to be resolved. However, some uncertainties for the CSM for the Load Line 8 include:

- 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 8 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 at Load Line 8. 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.



Sewers: The sanitary sewers in LL8 are part of the network that flowed to the George Road Sewer Treatment Plant network. Historically, the flow was from the north to the south. Sewer depths range from 4 to 7 ft. bgs and are generally intact, limiting the migration to the exterior. The current RI for the Facility-wide Sewers AOC does not identify COCs.

Surface Water:
Surface water drainage generally follows the topography of LL8, exits the AOC in the southwest, and flows toward an unnamed perennial stream located at the southwest corner of the AOC and west to Hinkley Creek. The ditches are predominantly dry but may transport water during periods of heavy rain, although ditches to the south have been known to hold water during periods of time without rain.

Groundwater:
Groundwater flows towards the southwest to an unnamed tributary to Hinkley Creek. Potentiometric data indicate the groundwater table occurs within the unconsolidated zone throughout the AOC. Downgradient receptors of the site groundwater are approximately 900 ft from LL8.

Sediment And Surface Water: Inorganic and organic SRCs and COPCs exist in sediment and surface water at LL8. However, no COCs were identified in sediment or surface water that require remediation for Unrestricted (Residential) Land Use.

Surface & Subsurface Soil: Inorganic and organic SRCs and COPCs exist in the surface soil at LL8. However, no COCs were identified in soil that require remediation for Unrestricted (Residential) Land Use.

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.

Ecological Risk: There are important and significant ecological resources in the AOC. Specifically, wetlands and surface water (i.e., ditches and a stream) are present and near contamination. Eighteen integrated COPECs were identified for soil, nine integrated COPECs were identified for sediment, and seven integrated COPECs were identified for surface water. The technical and refinement factors in Step 3A showed there are no integrated COPECs that are of ecological concern requiring remediation or further evaluation.

Localized Potentiometric Surface, Groundwater Elevation Approximately 11 to 19 ft bgs.

Bedrock (Pennsylvanian Age Pottsville Formation, Homewood Sandstone, and Mercer Member)

Figure 8-1. Load Line 8 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 8. 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 Load Line 8 environmental investigation, restoration efforts, and the recommendation of no further action for these media.

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 decisions regarding Load Line 8. This RI Report has been prepared in consultation with the Ohio EPA.

Ohio EPA has provided input during the ongoing investigation and report development to ensure the recommendation for Load Line 8 meets the needs of the state of Ohio and fulfills the requirements of the DFFO (Ohio EPA 2004). Ohio EPA provided comments on this RI Report and will provide comments on the subsequent PP and ROD. The Army will obtain Ohio EPA concurrence prior to the final selection and decision for soil, sediment, and surface water at Load Line 8.

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. Code 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, RVAAP has 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 the 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 8. These comments will be considered prior to the final selection of no further action. Responses to these comments will be addressed in the responsiveness summary of the ROD.

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