Revised Draft

Phase II Remedial Investigation Report for Soil, Sediment, and Surface Water at RVAAP-44 Load Line 11

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

Contract No. W912QR-15-C-0046

Prepared for:

US Army Corps
of Engineers®

U.S. Army Corps of Engineers
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None.

14. ABSTRACT

This Phase II Remedial Investigation Report for Load Line 11 presents physical characteristics, geology, and hydrogeology of Load Line 11; 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 11 to attain Unrestricted (Residential) Land Use.

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

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CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Leidos has completed the Revised Draft Phase II Remedial Investigation Report for Soil, Sediment, and Surface Water at RVAAP-44 Load Line 11 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.

6/22/16

Jed Thomas, P.E. Date

Study/Design Team Leader, Main Author

6/22/16

Michael Bolen, P.G. Date

Independent Technical Review Team Leader

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

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

6/22/16

Lisa Jones-Bateman Date

Senior Program Manager

PLACEHOLDER FOR:

Documentation of Ohio EPA Approval of Final Document

(Documentation to be provided once approval is issued.)

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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

ACM	Asbestos-containing Material
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
BHHRA	Baseline Human Health Risk Assessment
Camp Ravenna	Camp Ravenna Joint Military Training Center
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMCOC	Contaminant Migration Chemical of Concern
CMCOPC	Contaminant Migration Chemical of Potential Concern
COC	Chemical of Concern
COPC	Chemical of Potential Concern
COPEC	Chemical of Potential Ecological Concern
CSM	Conceptual Site Model
DAF	Dilution Attenuation Factor
DERR	Division of Environmental Response and Revitalization
DFFO	Director’s Final Findings and Orders
DNT	Dinitrotoluene
DQO	Data Quality Objective
DRO	Diesel Range Organics
EcoSSL	Ecological Soil Screening Level
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESL	Ecological Screening Level
ESV	Ecological Screening Value
EU	Exposure Unit
FA	Functional Area
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
GRO	Gasoline Range Organics
GSSL	Generic Soil Screening Level
HELP	Hydrologic Evaluation of Landfill Performance
HHRA	Human Health Risk Assessment
HLC	Henry’s Law Constant

HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HQ	Hazard Quotient
ILCR	Incremental Lifetime Cancer Risk
INRMP	Integrated Natural Resources Management Plan
IRA	Interim Removal Action
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	Method Detection Limit
NCP	National Contingency Plan
NPA	Non-Production Area
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
OMZA	Outside Mixing Zone Average
OMZM	Outside Mixing Zone Maximum
ORAM	Ohio Rapid Assessment Method
PAH	Polycyclic Aromatic Hydrocarbon
PBA08 RI	Performance-Based Acquisition 2008 Remedial Investigation
PBA08 SAP	Performance-Based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1
PBT	Persistent, Bioaccumulative, and Toxic
PCB	Polychlorinated Biphenyl
PETN	Pentaerythritol tetranitrate
PP	Proposed Plan
ppm	Parts Per Million
PRG	Preliminary Remediation Goals
QA	Quality Assurance
QC	Quality Control
QHEI	Qualitative Habitat Evaluation Index
R	Retardation Factor
RCRA	Resource Conservation and Recovery Act
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
RM	River Mile

ROD	Record of Decision
RRSE	Relative Risk Site Evaluation
RSL	Regional Screening Level
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SERA	Screening Ecological Risk Assessment
SESOIL	Seasonal Soil Compartment
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
TEC	Threshold Effects Concentration
TNT	2,4,6-Trinitrotoluene
TPH	Total Petroleum Hydrocarbons
TR	Target Risk
UCL	Upper Confidence Limit
URF	Unit Risk Factor
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USP&FO	U.S. Property and Fiscal Officer
UXO	Unexploded Ordnance
VOC	Volatile Organic Compound
WOE	Weight-of-Evidence
WQC	Water Quality Criteria

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION AND SCOPE

This document has been revised by Leidos under U.S. Army Corps of Engineers (USACE), Louisville District Contract Number W912QR-15-C-0046. This report replaces the *Draft Phase II Remedial Investigation Report for Soil, Sediment, and Surface Water at RVAAP-44 Load Line 11*, dated January 19, 2012, originally submitted to Ohio Environmental Protection Agency (Ohio EPA). This Remedial Investigation (RI) Report addresses soil, sediment, and surface water at Load Line 11 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 2004a). The DFFO requires conformance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and National Contingency Plan (NCP) 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 11, formerly known as Booster Line #1, is an approximately 48-acre fenced AOC located immediately north and west of Fuze and Booster Spur Road and south of Newton Falls Road in the south-central portion of Camp Ravenna. Load Line 11 was formerly used for producing artillery primers and fuzes. Remaining features at Load Line 11 include a one-lane asphalt perimeter road that enters the AOC from the south and encircles 75% of the former production area (FPA) and an asphalt parking area remains by former Building AP-11.

From 1941–1945, Load Line 11 operated at full capacity to produce artillery primers. Load Line 8 was deactivated at the end of World War II, and the process equipment was placed on standby. From 1951-1957, Load Line 11 was reactivated to produce primers. From 1969-1971, it was reactivated to produce MR ZA4 fuzes. Load Line 11 was finally deactivated and all process equipment was removed in 1971. No historical information exists to indicate Load Line 11 was used for any other processes, other than what is presented above.

ES.1.2 Scope

The scope of this Phase II RI Report is to perform a CERCLA evaluation of soil, sediment, and surface water at Load Line 11 using 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. This report includes sample results and information from the Phase I RI and Interim Removal Action (IRA), and also provides a summary of the Performance-Based Acquisition 2008 Remedial Investigation (PBA08 RI) at Load Line 11 that was performed to supplement data from previous sampling events.

The media of concern associated with Load Line 11 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 additional 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 INTERIM REMOVAL ACTION

In 2001, an IRA was completed at Load Line 11. The IRA was initiated following the Phase I RI activities as an early response action to remove the primary pathways for off-AOC contaminant migration. The IRA included removing sump water from production buildings, grouting selected sanitary sewer manholes, and performing limited excavations from open ditch systems draining the AOC (MKM 2004a).

Sumps located adjacent to Buildings AP-3, AP-5, AP-6, and AP-8 were excavated, removed, and disposed during the 2001 IRA. Approximately 15,000 gal of water were removed from sumps and sewer manholes downgradient of each sump and were filled with bentonite cement to prevent water from infiltrating back into the sumps during excavation and removal operations. Once the water was removed, effluent sewer lines were cut and plugged with mechanical packers and cement grout, which prepared the sumps for removal.

Six drainage ditch locations were excavated based on Phase I RI analytical data showing exceedances of background concentrations and/or Region 9 preliminary remediation goals (PRGs) for residential soil. Elevated concentrations of contaminants in the six ditch locations included metals in all six ditches, volatile organic compounds (VOCs) in two ditches, and semi-volatile organic compounds (SVOCs) and/or pesticides in only one ditch. A total of 230 cubic yards of contaminated soil were removed during the ditch excavation operations. Confirmation samples were collected to verify the removal of contaminated soil and sediment.

One 30 by 30 by 8 ft hot spot area, located in an open field north of Building AP-17, was excavated due to petroleum contamination encountered during RI soil boring activities (MKM 2004a). A total of 130 yd^3 of petroleum-contaminated soil were excavated. Confirmation samples were used to verify the removal of the petroleum-contaminated soil and the excavations were backfilled with approved offsite soil. During the excavation of the hot spot, it was determined that the area needed to be assessed for unexploded ordnance (UXO). Upon excavating test trenches, cable, scrap metal, bolts, and magnetite-containing rock were found. Confirmation samples were then collected from the test trenches. After excavation and determining no UXO was present, the test trenches were backfilled and leveled to the original ground surface elevation.

ES.3 FINDINGS AND RECOMMENDATIONS OF THE REMEDIAL INVESTIGATION

This section presents a summary of data used in this 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.3.1 Data Use and Sample Selection Process

Quality-assured sample data from the Phase I RI (MKM 2005a), confirmation results from the IRA (MKM 2004a), and 2010 and 2012 PBA08 RI were used to evaluate nature and extent of contamination at Load Line 11. These investigations used discrete sampling methods.

All available sample data collected at the locations were evaluated to determine suitability for use in various key RI data screens and evaluations (i.e., nature and extent, fate and transport, risk assessment). 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. incremental sampling methodology (ISM)].

Samples from the Phase I RI and IRA data sets were evaluated to determine if conditions had changed substantively between earlier characterization efforts and the 2010 and 2012 PBA08 RI, as building demolition activities occurred in 2004-2005 after the 2000 and 2001 Phase I RI and IRA confirmation sampling. The samples collected in 2000-2001 were collected within ditch lines adjacent to former buildings and in areas encompassing, but also extending substantially beyond the footprint of the former buildings. The 2001 confirmation sampling was conducted within the footprints of the removal areas after the contaminated soil was removed. Therefore, both data sets were considered representative of current conditions within and surrounding the footprints of the former buildings and removal areas at Load Line 11.

Data collected in 2010 and 2012 as part of the PBA08 RI focused on delineating the extent of contaminants identified in surface soil (0-1 ft bgs), subsurface soil (1-13 ft bgs), sediment, and surface water. The PBA08 RI sampled locations with the greatest likelihood of contamination (e.g., adjacent to production buildings or within sediment accumulation areas, such as ditches) and analyzed for chemicals identified in historical investigations. Additionally, sediment and surface water samples were collected from drainage ditches exiting the AOC.

ES.3.2 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 subsequent to the 2001 IRA was evaluated in this Phase II RI. Data from the Phase I RI, IRA, and 2010 and 2012 PBA08 RI effectively characterized 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 11.

ES.3.2.1 <u>Soil</u>

Locations where explosives were identified as potential contaminants from previous use were thoroughly evaluated, including around former process buildings and across the AOC as a whole. The maximum concentrations of the explosives and propellants were all below their respective SLs and were not considered chemicals of potential concern (COPCs) in the surface and subsurface soil at the FPA and non-production area (NPA).

Arsenic, chromium, lead, and mercury were identified as potential SRCs and as potentially related to the previous site use. When evaluating these chemicals against their SLs [using the trivalent chromium FWCUG for chromium and the regional screening level (RSL) of 400 mg/kg for lead], chromium, lead, and mercury concentrations were all below their SLs; therefore, these chemicals were not considered COPCs for the FPA or NPA in surface and subsurface soil. Arsenic was the only inorganic chemical potentially related to previous AOC operations that is considered a COPC in surface and subsurface soil at the FPA and NPA. Arsenic is considered a COPC in both surface and subsurface soil at the FPA and NPA, with a maximum detected concentration (MDC) of 44.1 mg/kg observed from 6–8 ft bgs at sample location LL11cs-045, which evaluated the effectiveness of the hot spot excavation efforts during the IRA.

With the exception of benzo(a)pyrene at four surface soil sample locations, none of the detected concentrations of SVOCs, VOCs, pesticides, or polychlorinated biphenyls (PCBs) in surface or subsurface soil were above the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. Benzo(a)pyrene is considered a COPC in the surface soil at the FPA and NPA, with an MDC of 0.45 mg/kg at sample location LL11sb-060, which evaluated the drainage ditch northeast of the Entrance Gate.

ES.3.2.2 Sediment and Surface Water

The East Ditch exposure unit (EU) was evaluated with two sediment samples and one surface water sample. No explosives or propellants were detected in the East Ditch sediment and surface water samples. Arsenic was the only inorganic chemical from previous site use that exceeded the SL in the sediment and is considered a COPC. No inorganic chemical concentrations detected in the surface water sample exceeded their respective SLs. One polycyclic aromatic hydrocarbon (PAH) [benzo(a)pyrene] concentration detected in sediment exceeded the SL and was identified as a COPC; however, the benzo(a)pyrene concentration was detected at a concentration below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. SVOCs were not detected in the surface water sample. In addition, no VOCs, pesticides, or PCBs were detected in sediment at the East Ditch. Two pesticides [beta-hexachlorocyclohexane (BHC) and gamma-chlordane] were identified as SRCs at low, estimated concentrations. No VOCs or PCBs were detected in the East Ditch surface water.

The West Ditch EU was evaluated with four sediment samples and one surface water sample. No explosives were detected in West Ditch sediment. The propellant nitrocellulose was detected in the sediment sample LL11sd-096 at a concentration below the SL. No explosives or propellants were detected in the surface water sample. No inorganic chemicals related to previous site use exceeded the SLs except for arsenic in the surface water sample. One PAH [benzo(a)pyrene] exceeded the SL in the West Ditch sediment and was identified as a COPC. Four PAHs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene] exceeded the SLs in the surface water sample and were identified as COPCs. The PAH concentrations detected in the sediment and surface water were all above the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. No PCBs, pesticides, or VOCs were detected in sediment at the West Ditch. One pesticide (beta-BHC) was identified as an SRC and was detected at a low, estimated concentration below laboratory detection limits. No VOCs or PCBs were detected in the West Ditch surface water.

The Sewer Outfall EU was evaluated with one sediment sample. The only SRCs identified were the inorganic chemicals sulfate and sulfide, neither of which has established background concentrations for comparison.

One sediment sample and one surface water sample were collected at the off-AOC location LL11sd/sw-082 located on Sand Creek. Inorganic chemicals were not detected above background concentrations in the sediment; however, six inorganic chemicals were detected above their respective background concentrations for surface water. All the detections were at concentrations below their respective SLs. No explosives, propellants, SVOCs, pesticides, or PCBs were detected in the off-AOC sediment. Two VOCs (carbon disulfide and toluene) were present at low, estimated concentrations below laboratory detection limits.

No explosives, propellants, SVOCs, VOCS, pesticides, or PCBs were observed at this Sand Creek location.

ES.3.3 Summary of Contaminant Fate and Transport

All SRCs identified in the surface soil, subsurface soil, and sediment at Load Line 11 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 (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 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 (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, barium, cobalt, zinc, benzo(b)fluoranthene, naphthalene, and pentaerythritol tetranitrate (PETN) at the FPA and arsenic, cobalt, manganese, and naphthalene at the NPA were the soil CMCOPCs predicted to exceed the screening criteria in groundwater beneath the source area; however, none of these CMCOPCs were predicted to be above their respective groundwater criteria at the downgradient receptor location.
- Benz(a)anthracene and naphthalene at the East Ditch aggregate and antimony, benz(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at the West Ditch aggregate were predicted to exceed the screening criteria in groundwater beneath the source area; however, none of these CMCOPCs were predicted to be above 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 11 that may impact the groundwater beneath the source or at the downstream receptor location. This qualitative assessment concluded that there were no CMCOCs present in soil and sediment that may impact the groundwater beneath the source or at the downstream receptor location. No further action is required of soil and sediment at Load Line 11 for the protection of groundwater.

ES.3.4 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 (Adult and Child). Since the risk management analysis determined there were no unacceptable risks to the Resident Receptor (Adult and Child), it can be concluded that there is no unacceptable risk to the National Guard Trainee and Industrial Receptor.

Media of concern at Load Line 11 are surface soil, subsurface soil, sediment, and surface water. Soil data associated with Load Line 11 were aggregated into surface and subsurface soil at the FPA and NPA. Sediment and surface water were evaluated from ditches within and west of the FPA. The ditches include the East Ditch that flows north and the West Ditch that flows west/northwest and eventually to Sand Creek.

No COCs were identified for the Resident Receptor (Adult and Child) 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. The exposure point concentration (EPC) for benzo(a)pyrene in surface soil at the NPA (0.28 mg/kg) is approximately 1.3 times its FWCUG of 0.221 mg/kg. The EPC for this data aggregate is the MDC (at sample LL11sb-067); benzo(a)pyrene concentrations in the remaining NPA samples ranged from a non-detectable concentration to 0.11 mg/kg. Sample LL11sb-067 was collected in 2010 from the northeastern portion of Load Line 11. No load line operations were conducted in this area.

The EPC for benzo(a)pyrene in the FPA (0.219 mg/kg) was slightly less than the FWCUG (0.221 mg/kg). Other PAHs were identified as COCs because they contribute to sum-of-ratios (SORs) of two at the FPA and NPA. The EPCs of benzo(a)pyrene (0.28 mg/kg and 0.221) are slightly above and slightly below the FWCUG of 0.221 and the SORs are two, indicating cumulative cancer risks to a hypothetical future resident on the order of 1E-05. Reported benzo(a)pyrene concentrations above the FWCUG are scattered (i.e., no hot spots were identified); therefore, no COCs were identified for potential additional remediation.

Four PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene] were identified as COCs for the Resident Receptor (Adult and Child) in surface water collected from the West Ditch. The detected concentrations of benz(a)anthracene (0.00035 mg/L), benzo(b)fluoranthene (0.00041 mg/L), and indeno(1,2,3-cd)pyrene (0.00021) in surface water collected from the West Ditch range from 2–4 times their FWCUG of 0.0001 mg/L, and the detected concentration of benzo(a)pyrene (0.00033 mg/L) was 41 times the FWCUG of 0.000008 mg/L. All of the reported concentrations included a "J" qualifier, indicating they were estimated results below the detection limit of the analytical method. PAHs are present in the environment from natural and anthropogenic sources. Since surface runoff is the potential source of contamination to surface water in the West Ditch, the fact that PAH concentrations are not significantly elevated in soil or sediment indicates there is no identifiable source beyond normal levels of these chemicals to surface water due to runoff from roads and other traffic areas. In addition, incidental exposures of the Resident Receptor (Adult and Child) to surface water at the West Ditch that only intermittently holds water are much less than the incidental exposure that would occur due to ingesting drinking water (i.e., 2 L/day for an adult) and dermal contact while swimming and wading. These exposures were incorporated into the development of the FWCUGs. Thus, these low, estimated concentrations of PAHs were not identified as COCs for remediation in surface water.

Based on the risk management analysis, no COCs were identified to be carried forth in an FS for the Resident Receptor (Adult and Child) in any of the media of concern; therefore, no other receptors were evaluated and no further action is recommended from a human health risk perspective.

ES.3.5 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 11. This contamination was identified using historical and PBA08 RI data. Dry, mid-successional, cold-deciduous shrubland (dominant vegetation type); dry, mid-successional, herbaceous field; and four types of forests were observed on the 48 acres in the AOC. There are important and significant ecological resources in the AOC. Specifically, wetlands and surface water (i.e., two ditches) are present and near contamination. These findings invoked a requirement of a Level II ERA.

The Level II ERA evaluated integrated chemicals of potential ecological concern (COPECs) in soil, sediment, and surface water. Integrated COPECs are identified by screening PBA08 RI and historical data sets against ecological screening values. Twenty integrated COPECs were identified for soil.

Five integrated COPECs were identified for sediment. Five integrated COPECs were identified for surface water. The integrated soil, sediment, and surface water COPECs were further evaluated with technical and refinement factors in Step 3A. The factors in Step 3A showed there are no integrated COPECs that are of ecological concern requiring remediation or further evaluation. Consequently, the Level II Screening ERA for Load Line 11 concludes with a recommendation that no further action is required to be protective of important ecological resources. This supports the conclusion from the Phase I RI, which stated:

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

ES.3.6 Conclusions of the Remedial Investigation

Based on the investigation results, Load Line 11 has been adequately characterized and the recommended path forward is no further action for soil, sediment, and surface water at Load Line 11 to attain Unrestricted (Residential) Land Use. Further investigation is not warranted at this AOC for the following reasons: (1) the IRA conducted in 2001 removed contamination from the primary pathways for off-AOC migration; (2) the current nature and extent of impacted media has been sufficiently characterized; (3) the fate and transport modeling did not identify soil CMCOCs requiring further evaluation or remediation to protect groundwater; (4) there are no CERCLA release-related human health COCs identified in soil, sediment, or surface water requiring further evaluation in an FS or additional remediation; and (5) 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 preparing a ROD to document the final remedy. The ROD will also include a responsiveness summary addressing comments received on the PP.

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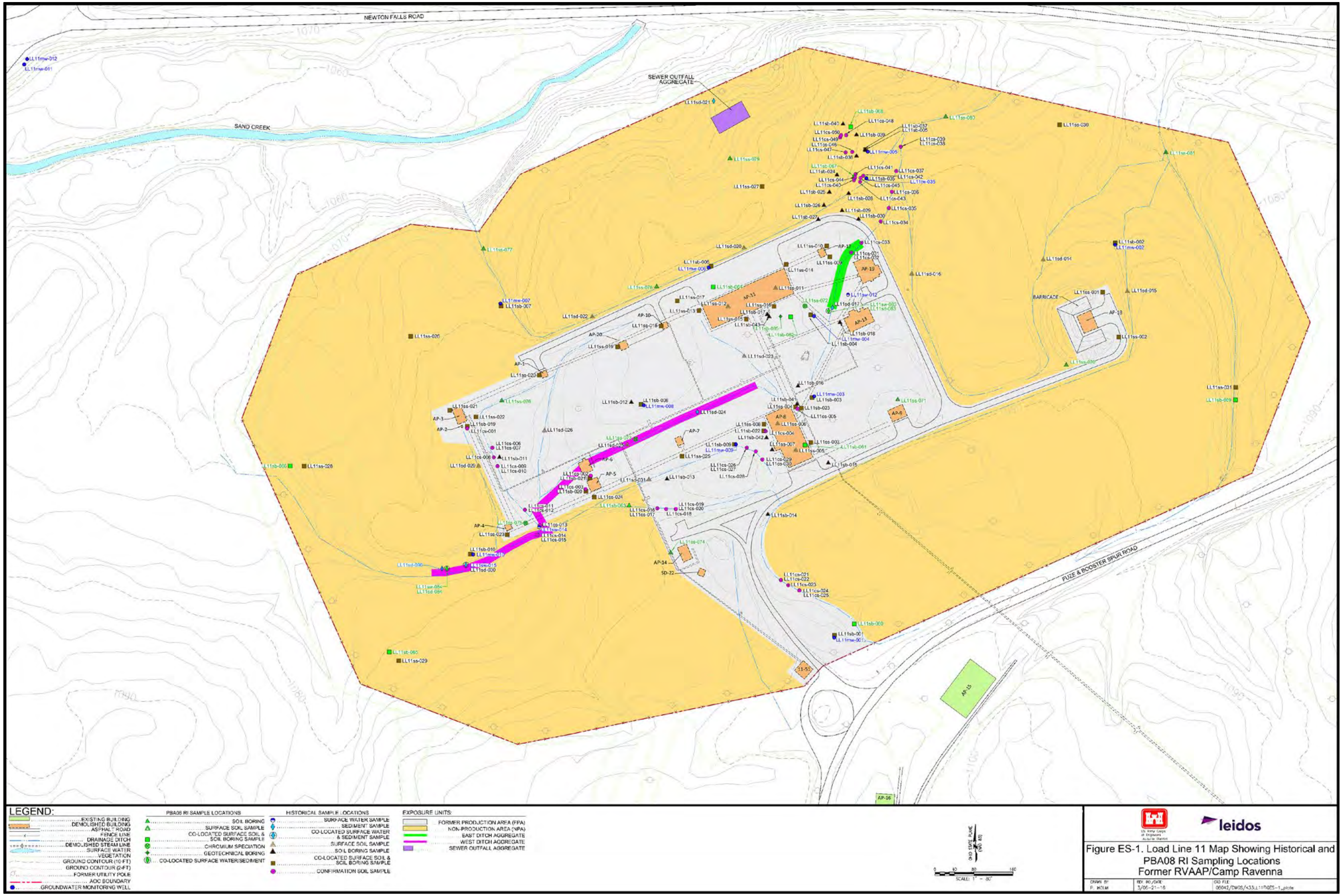

Figure ES-1. Load Line 11 Map Showing Historical and PBA08 RI Sampling Locations - Former RVAAP/Camp Ravenna

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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 Phase II Remedial Investigation (RI) Report addresses soil, sediment, and surface water at Load Line 11 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 11 is designated as area of concern (AOC) RVAAP-44.

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 2004a). 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 Phase II RI Report includes the following components:

- A description of the operational history and environmental setting for the AOC.
- A summary of all historical assessments, removal actions, and investigations at Load Line 11, including an Interim Removal Action (IRA) implemented to remove chemical contamination in 2001 and a Phase I RI performed in 2000 and 2001.
- 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 Phase II RI Report.

1.1 PURPOSE

The purpose of this Phase II RI Report is to use available IRA and 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 11. This report includes sample results and information from the Phase I RI and IRA, and also provides a summary of the Performance-Based Acquisition 2008 Remedial Investigation (PBA08 RI) at Load Line 11 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 Phase II 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 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. Sediment and associated surface water were not evaluated as part of this report as these media are not present at the AOC. 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 11 have been demolished; therefore, they are 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 11; 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, 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 11. These evaluations recommend no further action with respect to the Facility-wide Sewers within Load Line 11. 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 11, 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 11, including the geology, hydrogeology, climate, and population.
- Section 4.0 summarizes previous assessments, investigations, and the IRA at Load Line 11, as well as the data used to support this Phase II RI.
- 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 Phase II 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.

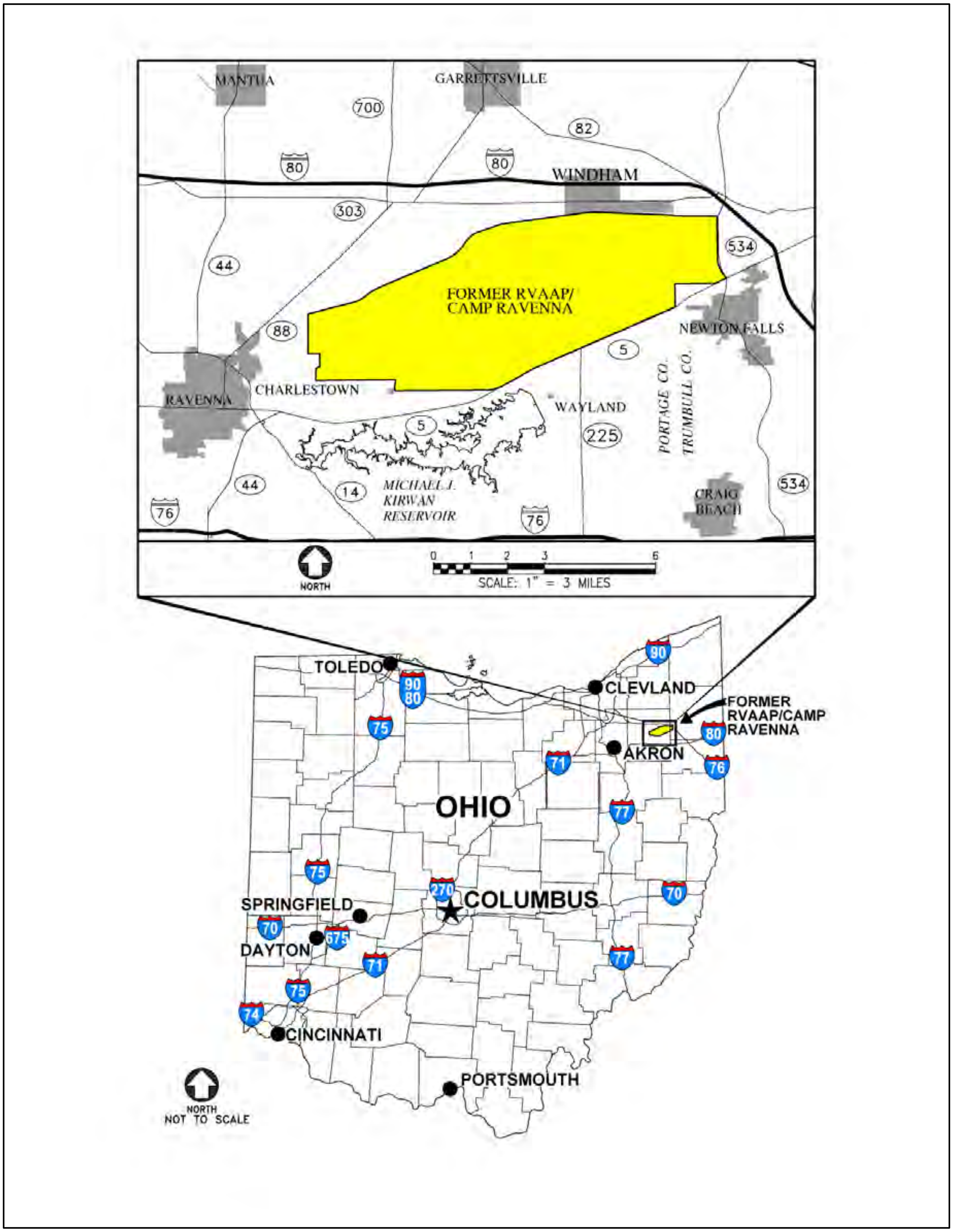

Figure 1–1. General Location and Orientation of Camp Ravenna

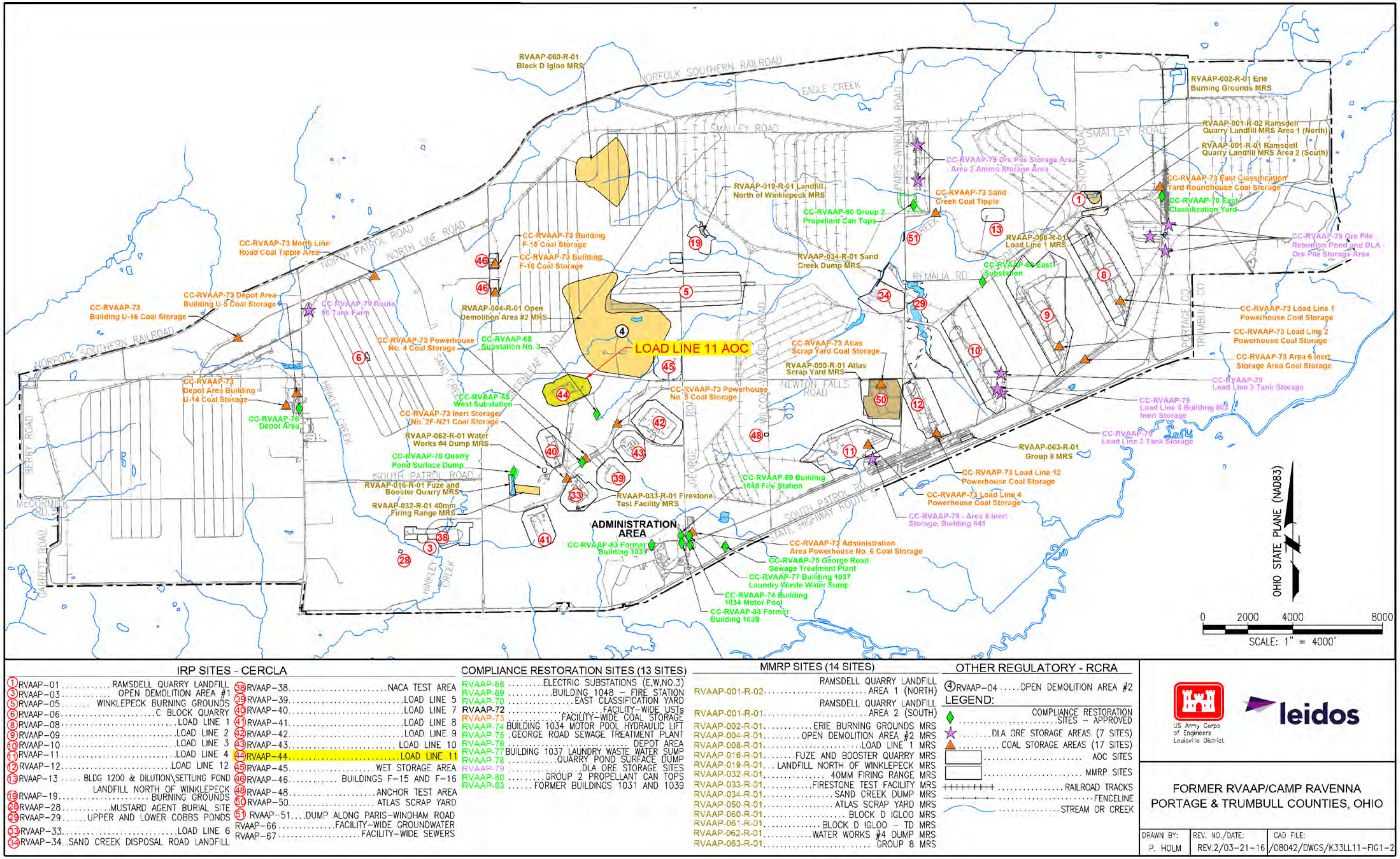

Figure 1–2. Location of AOCs and Munitions Response Sites at Camp Ravenna

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2.0 BACKGROUND

This section provides a description of the facility. In addition, it provides a summary of Load Line 11 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 conducted an Installation Assessment of RVAAP to review the potential for contaminant release at multiple former operations areas, as documented in Installation Assessment of Ravenna Army Ammunition Plant (USATHAMA 1978). The Installation Assessment indicated there is no evidence that bulk handling of the primary explosives lead azide or lead styphnate took place within the boundaries of Load Line 11. 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 and did not manufacture/produce dinitrotoluene (DNT) or TNT. A facility where DNT is manufactured will have the following isomers of DNT in the finished product: 2,4-DNT; 2,6-DNT; 2,5-DNT; 3,4-DNT; 2,3-DNT; and 3,5-DNT. This is not applicable to the former RVAAP. Degradation of TNT to 2,4-DNT occurs in soil; however, 2,4-DNT and 2,6-DNT do not degrade to the lesser isomers. It is the 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 the OHARNG for use as a military training site. Restoration activities at Camp Ravenna are managed by the Army National Guard and OHARNG. Training and related activities at Camp Ravenna include field operations and bivouac training, convoy training, maintaining equipment, C-130 aircraft drop zone operations, helicopter operations, and storing heavy equipment.

2.2 LOAD LINE 11 BACKGROUND INFORMATION

2.2.1 Operational History

Load Line 11, formerly known as Booster Line #1, is an approximately 48-acre fenced AOC located near the southwest corner of the intersection of Fuze and Booster Spur Road and Newton Falls Road, north of Load Line 7, in the south-central portion of Camp Ravenna (Figure 1-2 and Figure 2-1). Load Line 11 was formerly used for producing artillery primers and fuzes.

A description of the operational use at Load Line 11 is as follows (USATHAMA 1978):

- 1941–1945 – The site operated at full capacity to produce artillery primers. Black powder was used to charge the primers. No bulk handling of other explosives occurred at Load Line 11. At the end of World War II, Load Line 11 was deactivated, and the process equipment remained on standby status.
- 1951-1957 – The site was reactivated to produce primers. During reactivation, Load Line 11 produced 9,927,118 MK2A4 percussion primers, 24,482,465 MK2A4 primers, and 1,504,935 MK2A4 repack primers.
- 1969–1971 – The site was reactivated to produce approximately 7,000,000 MR ZA4 fuzes.
- 1971 – The site was deactivated, and process equipment was removed.

No fuel storage tanks were present at Load Line 11 during operations. No historical information exists to indicate Load Line 11 was used for any other processes (including fuel storage and use, burning, etc.) other than what is presented above.

As discussed in Section 4.2, an IRA was conducted in 2001 to remove building sumps, contaminated media within six ditch lines, and a hot spot with petroleum contamination. These activities were conducted by the Army in unison with the Phase I RI.

As discussed in Section 2.2.3, all buildings (including slabs and foundations) were removed in 2004-2006. Remaining features at Load Line 11 include a one-lane asphalt perimeter road that enters the AOC from the south and encircles 75% of the former production area (FPA) and an asphalt parking area remains by former Building AP-11. The Load Line 11 perimeter fence is still in place, but it is not currently maintained. Small construction drainage ditches border the access road.

2.2.2 Potential Sources

Historical facilities at Load Line 11 included 21 production and support buildings ranging in size from 34-8,862 ft^2. 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 presented and described below.

- Buildings AP-15 and AP-16 – Utilized for storage and shipping during the three production eras.
    - Building AP-15 – Inert Material Storage (located outside AOC boundary).
    - Building AP-16 – Shipping Building (located outside AOC boundary).
- Building AP-19 – Employee Dining Hall.
- Building 11-51 – Time Clock – Utilized to clock employees in and out from shifts.
- Drainage ditches.

Table 2-1 presents a summary of potential sources of contamination at Load Line 11. This table identifies potential sources, previous uses, if there were documented releases to the environment, and potential contaminants associated with the previous use. As indicated in Section 2.4.1, Building SD-22, Ejector Station #4 will be evaluated as part of the Facility-wide Sewers RI.

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 include black powder; TNT; RDX; octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane (HMX); nitroglycerine; nitrocellulose; nitroguanidine; and heavy metals (lead, chromium, mercury, and arsenic) from munitions assembly activities; volatile organic compounds (VOCs) were detected at former Building AP-17 that was utilized for storing solvents and at former Building AP-11 where lacquer sealing materials were used on finished primers; and polychlorinated biphenyl (PCB) detections were from on-site transformers. 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.

In summary, the following chemicals were targeted to investigate these potential SRCs:

- Inorganic chemicals – arsenic, chromium, lead, and mercury.
- Explosives – TNT, RDX, HMX, nitroglycerine, nitrocellulose, nitroguanidine.
- Other – PCBs and VOCs.

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

2.2.3 Building Decontamination and Demolition

Multiple activities were conducted at Load Line 11 to demolish buildings, remove footers, and remove remaining infrastructure. The following subsections summarize these activities.

2.2.3.1 2001 Sump Removal

To prevent contaminant migration outside the AOC boundary, building sumps adjacent to Buildings AP-3, AP-5, AP-6, and AP-8 were removed, and selected sanitary sewer manholes were grouted. These activities were conducted as part of the IRA conducted in 2001, as summarized in Section 4.2 and in the *Interim Removal Action at Load Line 11 (AOC-44)* (MKM 2004a).

Approximately 15,000 gal of water was pumped from the sumps through a filter directly into a holding tank and ground applied in an area just west of Buildings AP-3 and AP-4 as approved by Ohio EPA in January 2001. During the water removal at Building AP-3, it was determined that the infiltration rate of groundwater into the sewer-system was significant enough to impede the removal operations. Consequently, the sewer manholes downgradient of each sump were filled with bentonite cement to prevent water from infiltrating back into the sumps during the excavation and removal operations. Once the water was removed, effluent sewer lines were cut and plugged with mechanical packers and cement grout, which prepared the sumps for removal. Sewer lines were not excavated, as the lines exist below the groundwater table. Lead liners were removed from the sumps and recycled. Asbestos liners were removed, double bagged, and disposed as asbestos-containing material (ACM). The sump cavities were backfilled to grade using approximately 190 yd^3 of approved, off-site soil.

2.2.3.2 2004-2005 Building Demolitions

Demolition and removal of buildings at Load Line 11, including building slabs and foundations, were completed in 2004-2005 by the U.S. Army Tank-Automotive and Armaments Command. This was documented in the *Thermal Decomposition and Demolition of Load Line 11 and Buildings F15, 1200, S-4605 and T-4602* (MKM 2005b).

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

- The floors of each building were swept prior to removing transite roofs in order to remove loose paint chips and other potentially contaminated debris.
- All hazardous and non-hazardous material (e.g., fluorescent light fixtures and mercury switches) from the buildings were removed.
- ACM was removed from all buildings by a licensed asbestos removal contractor. ACM removal operations occurred in November 2004 to January 2005. A total of 63,343 ft^2 of transite roofing and 3,341 ft^2 of tar/shingle roofing material were removed from Load Line 11 and Buildings 1200, S4605, and T-4602 combined.
- Unexploded ordnance (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.
- Paint on the interior of each building was sampled to determine regulatory status of the applied dry paints. Sample results showed PCB concentrations in the applied paint at the buildings within Load Line 11 were in excess of 50 parts per million (ppm); therefore, building material was regulated as a PCB Bulk Product waste once demolition began.

During the demolition activities, sidewalks and footers were removed and the basements at Buildings AP-13 and AP-14 were demolished in place to 4 ft bgs. The footers at Buildings AP-3, AP-6, AP-7, AP-10, AP-11, AP-13, AP-14, AP-17, AP-19, and SD-22 were removed to 1 ft bgs. The footers were completely removed at Buildings AP-1, AP-4, AP-5, AP-9, AP-20, and 11-51. The footers at Building AP-18 were removed to 4 ft bgs. Building AP-8 was initially salvaged for use in future emissions testing relative to thermal decontamination operations but has since been demolished. Telephone poles and steam stanchions were also removed and staged north of former Building AP-18 during the demolition event.

Following demolition, all painted brick and structural steel were loaded for off-site disposal as PCB Bulk Product Waste at an approved facility. All unpainted concrete from floor slabs, footers, and blastwalls was deposited in the approved clean hard fill area at Load Line 1.

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 2005 (MKM 2005b). The interior of the AOC is currently vegetated with grasses and shrub/scrub vegetation in unpaved areas and forested around the perimeter.

2.2.3.3 2006 Building Footer Removal

As part of demolition activities performed by Lakeshore Engineering Services, Inc., the footers of former Buildings AP-6, AP-7, AP-10, AP-13, AP-14, AP-17, and AP-19 were removed to a minimum depth of 4 ft bgs, and stockpiled telephone poles and steam stanchions were removed from Load Line 11 for disposal in June-July 2006. These activities were documented in the *Munitions Response for the Demolition of Load Lines 5, 7, Building 1039, Transite Removal at Building T-1604, Removal of Remaining Concrete and Miscellaneous Debris at Load Lines 6, 9, and 11* (LES 2007). Soil near former production buildings was disturbed during building demolition activities, but the work areas were re-graded for drainage purposes and seeded following demolition activities.

2.2.4 AOC Boundary

Load Line 11 is an approximately 48-acre AOC bound by the existing perimeter fence, as presented in Figure 2-1. Load Line 11 is located near the southwest corner of the intersection of Fuze and Booster Spur Road and Newton Falls Road, north of Load Line 7.

As shown in Figure 2-3, the AOC boundary encompasses the FPA and non-production area (NPA). The FPA consists of approximately 11.4 acres and is encompassed within the gravel perimeter road surrounding 75% of the main production area. The buildings within the FPA were historically used to produce primers and fuzes for artillery projectiles, and contained the former production and storage buildings. The NPA is approximately 36.8 acres and includes the areas between the production area perimeter road and perimeter fence.

The surface and subsurface soil investigation at Load Line 11 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 samples collected in ditch lines leading to the northern, western, and eastern fence lines. In addition to the samples collected within the AOC boundaries, this Phase II RI Report discusses sample LL11sd/sw-082 that was collected north of Load Line 11 and north of Newton Falls Road to assess the potential transport beyond the AOC boundary.

2.2.5 Spatial Aggregates

Load Line 11 was divided into two soil spatial aggregates, three sediment spatial aggregates, and two surface water spatial aggregates for evaluation in this Phase II RI Report. The two soil spatial aggregates are the FPA and NPA. The FPA encompasses all production and non-production buildings. The NPA surrounds the FPA to the fence line, where no known activities occurred. The three sediment aggregates are the East Ditch, West Ditch, and Sewer Outfall. The East Ditch is represented by a discrete sediment sample collected at a ditch line which drained portions of the eastern part of the FPA. The West Ditch is represented by a discrete sediment sample collected at a ditch line west of former Building AP-4 which drains the western half of Load Line 11. The Sewer Outfall is represented by a sediment sample collected at the sanitary system overflow outfall north of the FPA. The two surface water aggregates are the East Ditch and West Ditch.

In addition to these aggregates, sediment and surface water samples were collected at off-AOC location LL11sd/sw-082. This location was included as part of the nature and extent evaluation for this Phase II RI.

2.3 POTENTIAL RECEPTORS AT LOAD LINE 11

The following sections discuss potential human and ecological receptors at Load Line 11.

2.3.1 Human Receptors

Camp Ravenna is a controlled-access facility. Load Line 11 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 roads at Load Line 11, the AOC is vegetated with grasses and shrub vegetation in the central portion and has mature forest on the perimeter. Sand Creek runs along the northern perimeter, adjacent to the AOC. Additional information specific to ecological resources at Load Line 11 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 11 but are addressed separately.

2.4.1 Facility-wide Sewers

The defunct sanitary sewers within the perimeter of Load Line 11 are being investigated and assessed as part of the Facility-wide Sewers AOC (RVAAP-67). This includes an evaluation of Building SD-22, Sewer Ejector Station #4. Storm sewers are not present at Load Line 11. Sanitary sewer sediment, outfall sediment, pipe bedding material, and sewer water were evaluated as currently summarized in the *Draft Remedial Investigation/Feasibility Study Report for RVAAP-67 Facility-wide Sewers* (USACE 2012a). The sanitary sewers in the Load Line 11 functional area (FA) are part of the network that flowed to the George Road Sewage Treatment Plant network. When Ejector Station #4 was not functioning, drainage was discharged to the sanitary sewer overflow outfall at the northern portion of the FA (Figure 2-1). 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, and some sewers associated with removed sumps were grouted associated with removed sumps, which limits vertical migration from sewer sediment to the exterior of the piping system.

The Load Line 11 IRA (MKM 2004a), Phase I RI (MKM 2005a), and Explosive Evaluation of Sewers (LES 2007, USACE-CERL 2007) are the historical investigations that specifically addressed the sewer system. Sewer water and sediment samples and one outfall sediment sample were collected from the sanitary sewer manholes at Load Line 11 in 2001 as part of the Phase I RI. The 2001 IRA consisted of removing lead/asbestos-lined sumps and lead-contaminated sediment. The IRA was initiated in unison with the Phase I RI activities as an early response action to remove the primary pathways for off-FA contaminant migration. This IRA included removing sump water from production buildings and grouting selected sanitary sewer manholes. Sewer samples were not collected from the sanitary sewer during this effort.

Samples of sewer and outfall sediment, sewer water, and pipe bedding materials (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 11 FA, and no further sampling was recommended. All SRCs found in the subsurface sewer media samples within the Load Line 11 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 11 FA for the National Guard Trainee or Resident Receptor. The point evaluation identified only manganese as a point evaluation COPC in outfall sediment. Manganese is not impacting downstream receptors; therefore, no further action was recommended from an ecological perspective. In summary, the Facility-wide Sewers RI recommended no further action for the Load Line 11 sanitary sewers. The Facility-wide Sewers RI predated the Technical Memorandum that specified evaluating Commercial/Industrial Land Use;

however, the Load Line 11 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, 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.

In October 2006–2007, the FWGWMP collected groundwater samples from two wells at Load Line 11 (LL11mw-002 and LL11mw-007). In 2009, the FWGWMP collected groundwater data from 10 wells at Load Line 11 (wells LL11mw-001 to LL11mw-010). In October 2010, the FWGWMP collected additional groundwater data from wells LL11mw-001, LL11mw-002, LL11mw-007, and LL11mw-009. Most chemical concentrations in groundwater were below the maximum contaminant level (MCL) or regional screening level (RSL) [target risk (TR) of 1E-05, hazard quotient (HQ) of 1]. The exceptions are discussed below (EQM 2015).

- Arsenic in LL11mw-007 exceeded the MCL (10 µg/L) and RSL of 10^{-5} (0.052 µg/L) in all samples collected.
- Cadmium in LL11mw-004 exceeded the RSL of 10^{-5} (9.2 µg/L) in one sample in the first quarterly sample collected in 2009. The subsequent three samples collected in 2009 all had concentrations below the RSL of 10^{-5}, with a maximum concentration of 5.1 µg/L.
- Manganese in LL11mw-001 to LL11mw-004, LL11mw-009, and LL11mw-010 exceeded the RSL of 10^{-5} (430 µg/L).
- Bis(2-ethylhexyl)phthalate in LL11mw-001, LL11mw-003, and LL11mw-008 exceeded the MCL. All results in LL11mw-003 and LL11mw-008 had detected concentrations below the reporting limit (J-flagged).
- beta-Hexachlorocyclohexane (BHC) exceeded the RSL (TR of 1E-05, HQ of 1) in LL11mw-002 and LL11mw-009. However, all detected concentrations either had estimated concentrations below the reporting limit (J-flagged) or were only present in the laboratory blank (B-flagged).
- 2,6-DNT exceeded the RSL (TR of 1E-05, HQ of 1) in LL11mw-006 and LL11mw-010. However, all detected concentrations were below the reporting limit (J-flagged).

Wells LL11mw-007, LL11mw-011, and LL11mw-012 were added to the FWGWMP in 2012-2013 to evaluate the current levels of contaminants associated with former RVAAP operations, specifically arsenic, iron, and manganese (EQM 2015).

A summary of data from these sampling events is provided below.

- LL11mw-007 – All concentrations were below the MCL or RSL (TR of 1E-05, HQ of 1) except arsenic. Arsenic exceeded the MCL of 10 µg/L in all three samples analyzed in 2012-2013.
- LL11mw-011 – All concentrations were below the MCL or RSL (TR of 1E-05, HQ of 1) in the October 2012 sample except manganese at concentration of 570 µg/L, which is above the RSL (TR of 1E-05, HQ of 1) of 430 µg/L. All other samples analyzed in 2012-2013 for manganese had concentrations lower than the RSL (TR of 1E-05, HQ of 1).
- LL11mw-012 – All concentrations were below the MCL or RSL (TR of 1E-05, HQ of 1).

Additional groundwater level monitoring was performed in May 2014 at all 12 monitoring wells at Load Line 11; however, no samples were collected (EQM 2015). 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 11 will be addressed as part of that AOC.

2.4.3 Fuze and Booster Area Settling Tanks

RVAAP-26, the Fuze and Booster Area Settling Tanks AOC, is comprised of 15 tanks at various load lines located within the former RVAAP. These 15 tanks have also been referred to as “settling basins” or simply “basins” and were used for settling out explosive contamination from wastewater during production activities from 1941–1945 and 1969–1970. The settled sludge was periodically collected from the tanks (every one to three months) and transferred to one of the burning grounds for thermal destruction. The final method of disposition of the water from the tanks is not definitely known. It may have been pumped onto the ground surface or into the sewer systems (USAEHA 1994). The soil surrounding the process buildings sourcing the effluent to the settling tanks may also be of concern because building washout operations historically resulted in the release of wastewater on the ground adjacent to the building exits.

In 1971, all the tanks were emptied, cleaned, and covered. Three of the tanks are former concrete settling tanks located at Load Line 11 that were removed in November 1988. The locations of the concrete settling tanks included one at AP-3 (Black Powder Screening Facility) and two at Building AP-5 (Black Powder Dry House) at Load Line 11. These underground settling tanks (8 by 8 by 8 ft) had a 3,829-gal capacity (Jacobs Engineering 1989).

Regarding all settling tanks in the Fuze and Booster Area, the 1989 Resource Conservation and Recovery Act (RCRA) Facility Assessment states, “there is a high potential for releases to soil and groundwater from this unit. The integrity of the tanks and associated plumbing is not known. Extensive contamination may have occurred (Jacobs Engineering 1989).” Releases from these tanks were suspected, but not known.

As stated in the 2004 Installation Action Plan (RVAAP 2004), the RVAAP-26 Fuze and Booster Area Settling Tanks AOC was considered Response Complete under the Installation Restoration Program since each load line became its own AOC. Explosive contamination in surface and subsurface soil was evaluated during the Phase I RI, IRA, and PBA08 RI, as discussed in Section 4.0.

2.4.4 Munitions Response Sites

No munitions response sites have been documented within Load Line 11.

2.4.5 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 11. Table 2-1 presents potential contaminants that may be present in Load Line 11 media from previous use of the site.

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

Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
Building AP-1	1941-1945, 1951-1957, and 1969-1971: Utilized as black powder service magazine for primer charging.	None	Metals, black powder
Building AP-2	1941-1945, 1951-1957, and 1969-1971: Utilized as a motor house to support black powder screening.	None	Metals, black powder
Building AP-3	1941-1945, 1951-1957, and 1969-1971: Utilized for black powder screening. Sump located on the southern side of AP-3.	None	Metals, black powder
Building AP-4	1941-1945, 1951-1957, and 1969-1971: Utilized as black powder rest house prior to primer charging.	None	Metals, black powder
Buildings AP-5	1941-1945, 1951-1957, and 1969-1971: Utilized as black powder dry house. One sump was located between AP-5 and AP-6.	None	Metals, black powder
Buildings AP-6	1941-1945, 1951-1957, and 1969-1971: Utilized as black powder dry house. Two sets of sumps were associated with Building AP-5 and AP-6: one set was located outside the southwest wall of AP-6 and one set was located between AP-5 and AP-6.	None	Metals, black powder
Buildings AP-7	1941-1945, 1951-1957, and 1969-1971: Utilized as black powder rest house prior to primer charging.	None	Metals, black powder
Buildings AP-8	1941-1945, 1951-1957, and 1969-1971: Utilized for artillery primer loading and served as an administrative building. Black powder charging operations were shifted from Building AP-8 to AP-11 in later years. Two sets of sumps, one on the east side and one on the west side, were associated with this building and were connected to the sewer mains of the facility.	None	Metals, black powder
Building AP-9	1941-1945: Utilized as a final product shipping building during WWII. 1951-1957: Utilized as primer rest house. 1969-1971: Served as the percussion element storage and operation staging building.	None	Metals, black powder
Building AP-10	1941-1945, 1951-1957, and 1969-1971: Utilized as percussion element service magazine prior to primer charging.	None	Metals, black powder
Building AP-11	1941-1945, 1951-1957: Utilized for black powder charging operations. 1969-1971: Served as the major assembly and shipping building for MK2A4 primers, and also used to apply lacquer sealing materials.	None	Metals, black powder, lacquers
Buildings AP-13 and AP-14	1941-1945, 1951-1957, and 1969-1971: Utilized as change houses where workers changed out of work clothing at end of shift.	None	Metals, explosives
Building AP-17	1941-1945, 1951-1957, and 1969-1971: Utilized as a solvent storage facility.	None	Solvents
Building AP-18	1941-1945, 1951-1957, and 1969-1971: Utilized for storage of percussion elements. There was an earthen barricade around Building AP-18. Historical map indicated AP-18 used for black powder storage in 1951-1957.	None	Metals, black powder

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

Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
Building AP-20	1941-1945, 1951-1957, and 1969-1971: Served as a quality assurance (QA) primer sensitivity testing facility.	None	Metals, black powder
Transformers	Historical PCB Disposition Records indicated 3 transformers serviced all Load Line 11 buildings. All transformers were tested for PCBs and all contained PCBs (60, 165, and 663 ppm). All transformers was removed on November 3, 1992 and stored at Building 854 (RVAAP-27, PCB Storage) awaiting final disposition by the Defense Reutilization Material Office (DRMO).	None	PCBs

Target metals = Lead, chromium, mercury, and arsenic.
Target explosives = Black powder; 2,4,6-trinitrotoluene; octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane; and hexahydro-1,3,5-trinitro-1,3,5-triazine.
PCB = Polychlorinated biphenyl.
WWII = World War II.

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

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

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

CAMP RAVENNA JOINT MILITARY TRAINING CENTER RARE SPECIES LIST
December 2014

F. State Special Interest

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

Note: The Integrated Natural 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 threatened (USFWS 2016) and state threatened (ODNR 2016).

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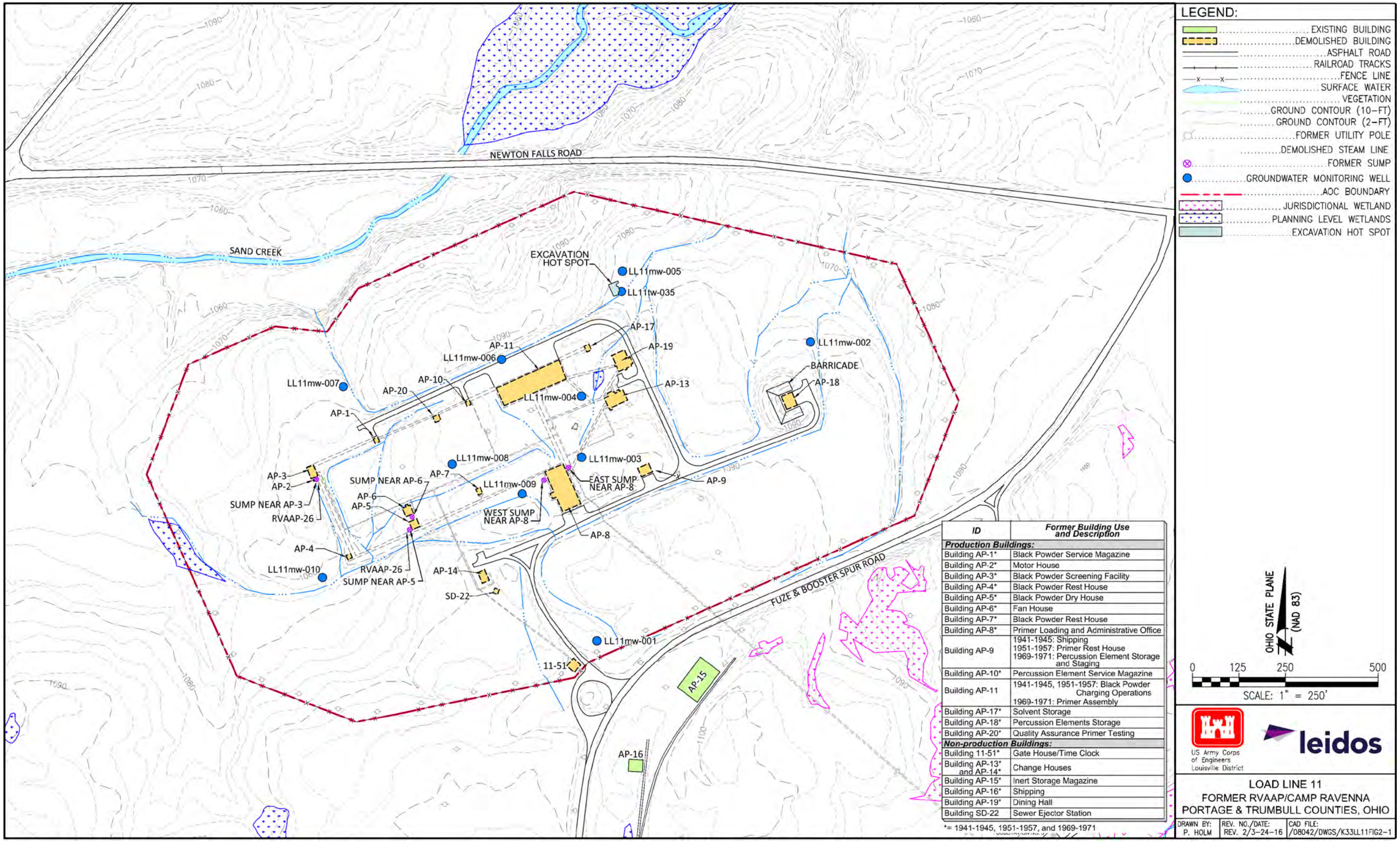
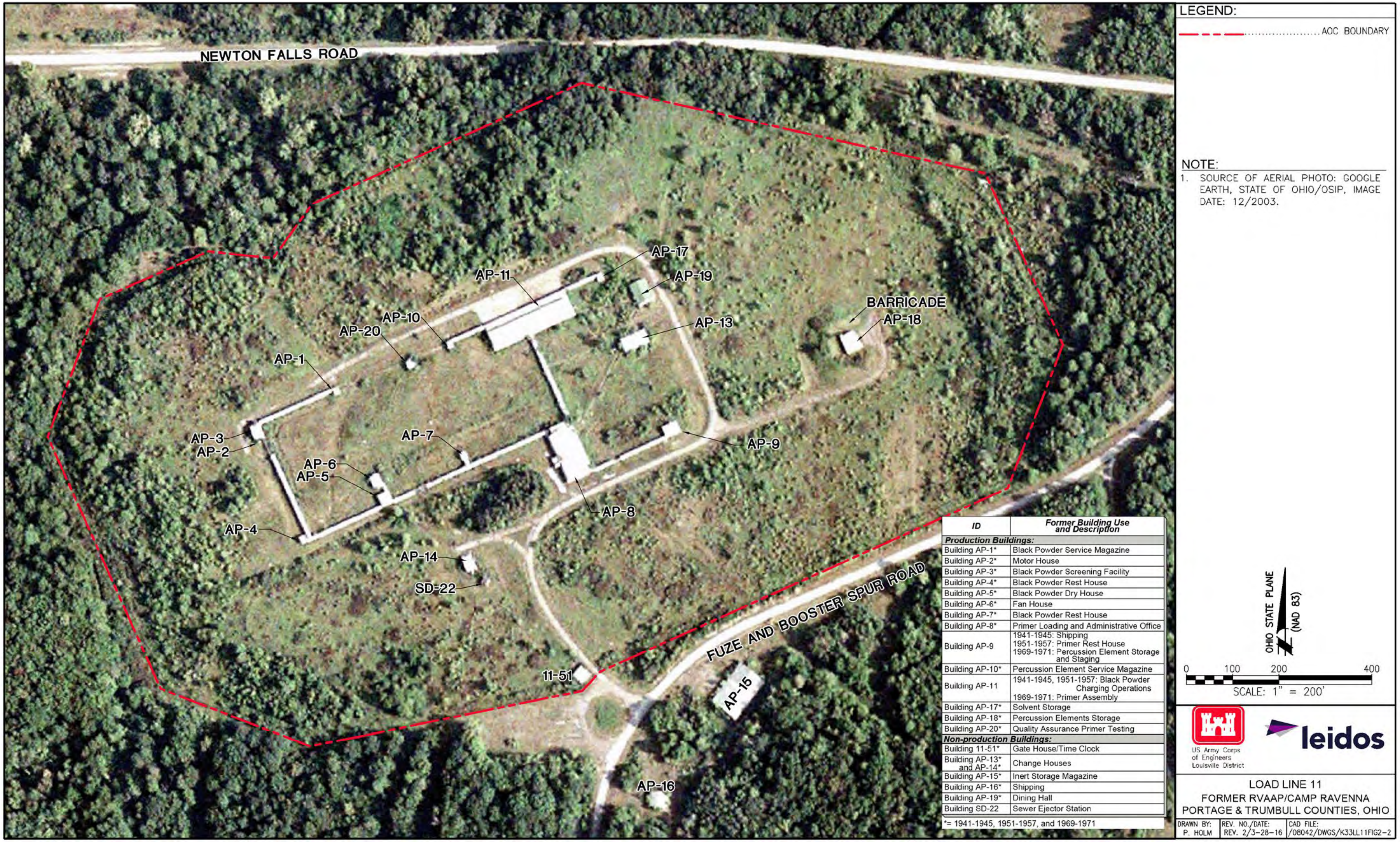


ID	Former Building Use and Description
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
Building AP-9	1941-1945: Shipping 1951-1957: Primer Rest House 1969-1971: Percussion Element Storage and Staging
Building AP-10*	Percussion Element Service Magazine
Building AP-11	1941-1945, 1951-1957: Black Powder Charging Operations 1969-1971: Primer Assembly
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

Figure 2–1. Load Line 11 Site Features



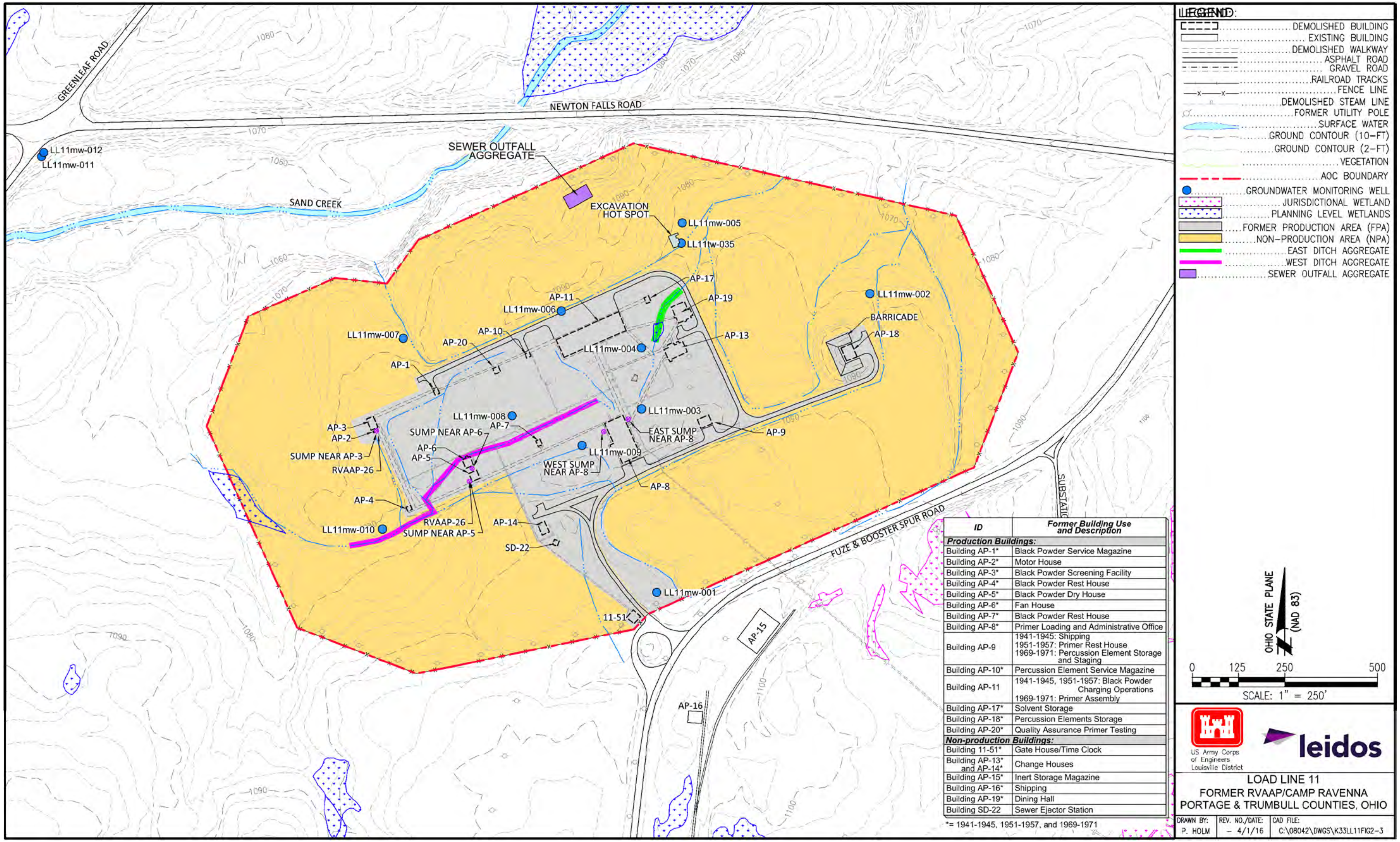
NOTE:

1. SOURCE OF AERIAL PHOTO: GOOGLE EARTH, STATE OF OHIO/OSIP, IMAGE DATE: 12/2003.

ID	Former Building Use and Description
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
Building AP-9	1941-1945: Shipping 1951-1957: Primer Rest House 1969-1971: Percussion Element Storage and Staging
Building AP-10*	Percussion Element Service Magazine
Building AP-11	1941-1945, 1951-1957: Black Powder Charging Operations 1969-1971: Primer Assembly
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

Figure 2–2. Load Line 11 Site Features Prior to Building Demolition (Aerial Photo dated 12/2003)



ID	Former Building Use and Description
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
Building AP-9	1941-1945: Shipping 1951-1957: Primer Rest House 1969-1971: Percussion Element Storage and Staging
Building AP-10*	Percussion Element Service Magazine
Building AP-11	1941-1945, 1951-1957: Black Powder Charging Operations 1969-1971: Primer Assembly
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

US Army Corps of Engineers
Louisville District

leidos

LOAD LINE 11
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
P. HOLM	– 4/1/16	C:\08042\DWGS\K33LL11FIG2-3

Figure 2–3. Load Line 11 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 11 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-age 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 11 is an approximately 48-acre AOC located near the southwest corner of the intersection of Fuze and Booster Spur Road and Newton Falls Road, north of Load Line 7, in the south-central portion of Camp Ravenna (Figure 1-2). A fence exists as the perimeter boundary of the AOC, although it is not currently maintained.

All buildings and structures within the Load Line 11 fence line 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 following the building decontamination and demolition activities discussed in Section 2.2.3. Remaining features at Load Line 11 include a one-lane asphalt access road that enters the AOC from the south and encircles 75% the FPA (Figures 2-1 and 3-1). An asphalt parking area remains by former Building AP-11. Small drainage ditches border some portions of the access road, and drainage conveyances are located throughout the AOC boundary. Vacant, wooded land is located directly to the south and southwest.

Topographic relief at the AOC is moderate, with a topographic high in the central portion of the AOC and gentle slopes to the north and northeast outside of the FPA. Ground elevations within Load Line 11 range from approximately 1,070–1,100 ft amsl (Figure 3-1). Surface water follows topographic relief and drains into ditches that exit the AOC. Sand Creek is immediately to the north of the AOC boundary.

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 11 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 at 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 11

The bedrock formation underlying the unconsolidated deposits at Load Line 11, as inferred from existing geologic data, is the Pennsylvanian-age Pottsville Formation, Homewood Sandstone Member (Figure 3-3). The Homewood Sandstone Member is the uppermost unit of the Pottsville Formation. It typically occurs as a caprock on bedrock highs in the subsurface and ranges from well-sorted, coarse-grained, white quartzose sandstone to a tan, poorly sorted, clay-bonded, micaceous, medium- to fine-grained sandstone. Thin shale layers are prevalent in the Homewood member as indicated by a darker gray shade of color. Historical investigations have not encountered bedrock at Load Line 11 with an average borehole depth of 17 ft bgs and a maximum depth of 23 ft bgs. Bedrock was not encountered during PBA08 RI drilling activities where the maximum depth of boreholes was 13 ft bgs (Appendix A).

The primary soil type found at Load Line 11 is the Mahoning silt loam (MgB) (2-6% slopes) which covers over 85% of the AOC. The northern boundary of the AOC is comprised of Rittman silt loam (RsC2) (2-6% slopes) and the very eastern portion of the AOC is Wadsworth silt loam (WaB) (2-6% slopes) (USDA 2010). 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. The Mahoning silt loam has low permeability, with rapid runoff and seasonal wetness. The Rittman silt loam is a deep, moderately eroded, moderately well drained soil formed in silty clay or clay loam glacial till plains or moraines, generally where bedrock is greater than 6 ft bgs. The Wadsworth silt loam is a somewhat poorly drained, low permeability soil formed in silty clay loam glacial till.

The Phase I RI identified the Mahoning silt loam (2-6% slopes) as the primary soil type present at Load Line 11. The composition of unconsolidated deposits at Load Line 11 varies laterally and vertically across the AOC but generally consists of clay to sand-rich silt tills with interbedded sands and gravel lenses throughout. Deposits are generally stiff, moderately plastic, and tend to hold water. Cross-sections of the Load Line 11 subsurface were created from monitoring well lithology records to illustrate lateral distribution and variation of the discontinuous glacial sediment (MKM 2005a). Geotechnical analyses conducted during the Phase I RI indicated a grain size distribution of 0-20.9% gravel, 13.2-27.6% sand fractions, 17.1-60.3% silt fractions, and 27.2-69.5% clay fractions. Geotechnical classifications indicate the sample collected from 1-3 ft bgs was a lean clay with little sand, and the 4-6 ft bgs and 8-10 ft bgs samples were silts with increasing sand content with depth (MKM 2005a).

Geologic descriptions and geotechnical analyses of subsurface soil samples collected during the PBA08 RI are generally consistent with the conclusions from the Phase I RI. Overall, the PBA08 RI observed shallow clays followed by sandy silts and silty sands, and trace discontinuous gravel was observed. When encountered, groundwater was observed in soil borings from 4.6-9.2 ft bgs. Analyses of undisturbed geotechnical samples (Shelby tubes) collected during the PBA08 RI indicate a low permeability of 1.7E-06 to 1.7E-07 cm/sec for unconsolidated deposits at Load Line 11. A summary of the PBA08 RI geotechnical analyses, including porosity, density, and moisture content, is presented in Section 5.5. PBA08 RI boring logs containing geologic descriptions of unconsolidated deposits at Load Line 11 are presented in Appendix A.

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 infiltrating 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 11 Hydrologic/Hydrogeologic Setting

Ten groundwater monitoring wells were installed at Load Line 11 during the Phase I RI. Initial depths to groundwater varied from 5–17 ft bgs. Monitoring wells at the AOC ranged in completion from 15.55–22.35 ft bgs. All monitoring wells at Load Line 11 were screened in the Homewood Sandstone to monitor groundwater in the unconsolidated zone. Two additional monitoring wells LL11mw-011 (unconsolidated) and LL11mw-012 (bedrock) were installed under the FWGWMP in 2012.

All monitoring well groundwater elevations were collected under the FWGWMP. 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 north toward Sand Creek. The hydraulic gradient at the AOC is 0.017 ft/ft.

Water level elevations at the AOC range from 1,068.40-1,091.73 ft amsl (less than 0.08-13.6 ft below top of casing) with the highest elevation at the bedrock well LL11mw-001. Potentiometric data indicate the groundwater table occurs within the unconsolidated zone throughout the AOC.

Results of slug tests performed at 10 monitoring wells (wells LL11mw-001 to LL11mw-010) during the Phase I RI indicate an average hydraulic conductivity of 3.49E-05 cm/s for the uppermost bedrock interval (MKM 2005a). Table 3-1 presents the hydraulic conductivity for each well at Load Line 11.

3.4.3 Surface Water

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

3.4.3.1 Regional Surface Water

Camp Ravenna resides within the Mahoning River watershed, which is part of the Ohio River basin. The west branch of the Mahoning River is the main surface stream in the area. The west branch flows adjacent to the west end of the facility, generally in a north to south direction, before flowing into the Michael J. Kirwan Reservoir, located to the south of State Route 5 (Figure 1-1). The west branch flows out of the reservoir and parallels the southern Camp Ravenna boundary before joining the Mahoning River east of Camp Ravenna. The western and northern portions of Camp Ravenna display low hills and a dendritic surface drainage pattern. The eastern and southern portions are characterized by an undulating to moderately level surface, with less dissection of the surface drainage. The facility is marked with marshy areas and flowing and intermittent streams whose headwaters are located in the upland areas of the facility.

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

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

These watercourses have many associated tributaries. Sand Creek, with a drainage area of 13.9 square miles, 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 to direct runoff to drainage ditches and settling ponds. In addition, the storm sewer system was one of the primary drainage mechanisms for process effluent while production facilities were operational.

3.4.3.2 Load Line 11 Surface Water

Surface water at Load Line 11 occurs intermittently as storm water runoff within constructed or natural drainage ditches or conveyances along the north, west, and central portions of the FPA (Figure 3-1). Surface water flow is the primary migration pathway for contamination to leave the AOC flowing through ditches or surface water drainage features that exit the AOC. A storm sewer system is not present at Load Line 11.

The primary drainage routes for surface water (Figure 3-1) are the East Ditch that flows north and the West Ditch that flows west-northwest, both leading to Sand Creek immediately north of the AOC boundary. Sand Creek drains to the northeast into the south fork of Eagle Creek. The ditches tend to hold water for extended periods due to the low permeability of soil at Load Line 11 (MKM 2005a). During the PBA08 RI, surface water was observed at the AOC, flowing through ditches in some areas.

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 11 during the Phase I RI

Monitoring Well ID	Screened Interval (ft bgs)	Geologic Material Adjacent to Screen	Hydraulic Conductivity (cm/s)
LL11-mw001	11.37–21.37	Clayey Silt/Sand	1.74E-05
LL11-mw002	6.3–16.3	Clayey Silt	6.32E-05
LL11-mw003	5.9–15.9	Sandy Silt	6.48E-05
LL11-mw004	6.05–16.05	Clayey Silt	2.34E-07
LL11-mw005	6.17–16.17	Sandy Silt/Silty Clay/Sand	4.69E-06
LL11-mw006	5.55–15.55	Sandy Silt	6.81E-05
LL11-mw007	12.35–22.35	Sandy Silt/Silty Sand	7.16E-06
LL11-mw008	5.55–15.55	Silt/Sand	3.95E-05
LL11-mw009	6.65–16.65	Sandy Silt/Sand/Silty Clay	3.23E-05
LL11-mw010	10.85–20.85	Sandy Silt/Silty Sand	5.13E-05

Source: *Report for the Remedial Investigation at Load Line 11 (AOC 44)* (MKM 2005a).
AOC = Area of Concern.
bgs = Below ground surface.
cm/s = Centimeters per second.
ft = Feet.
ID = Identification.

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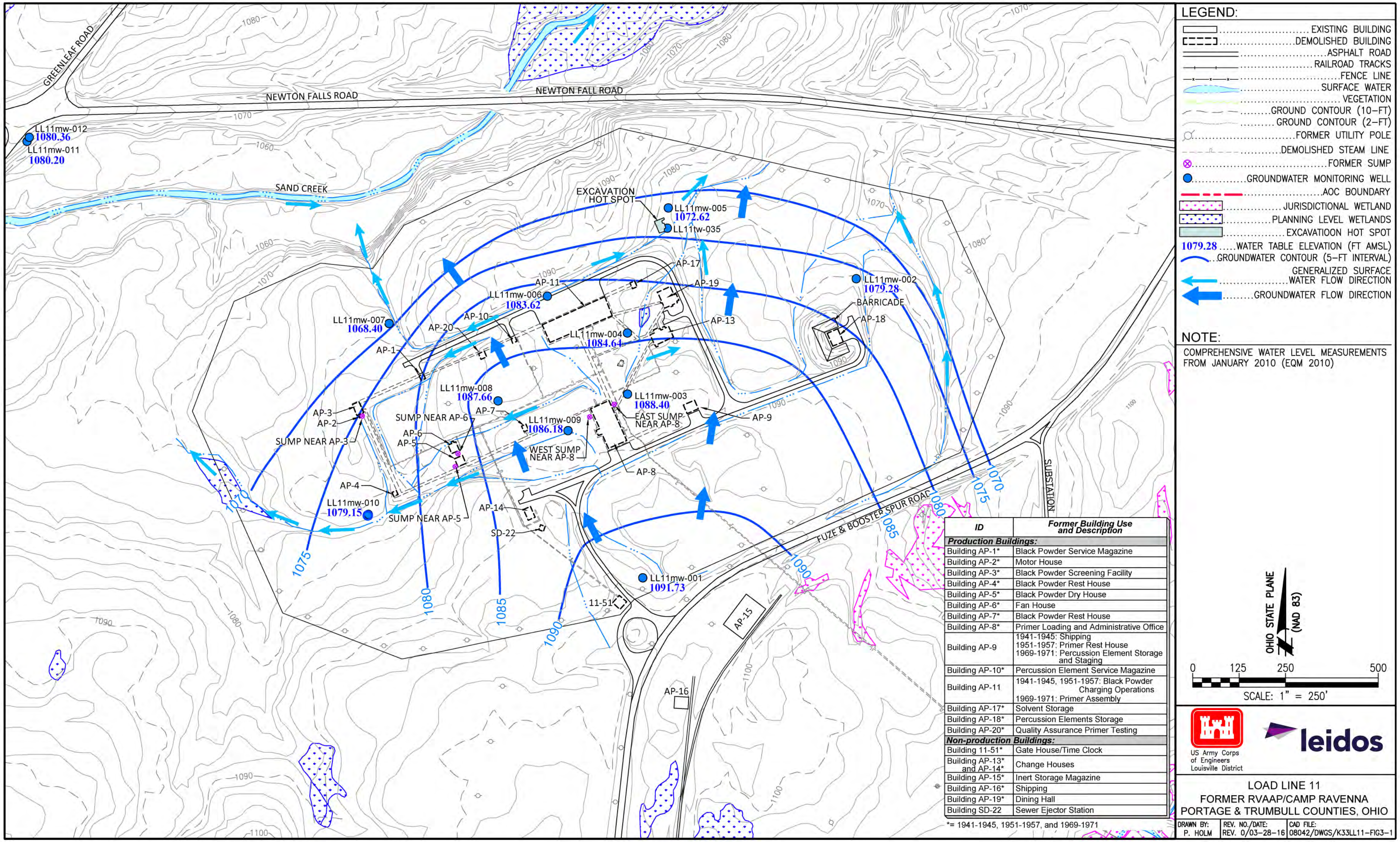
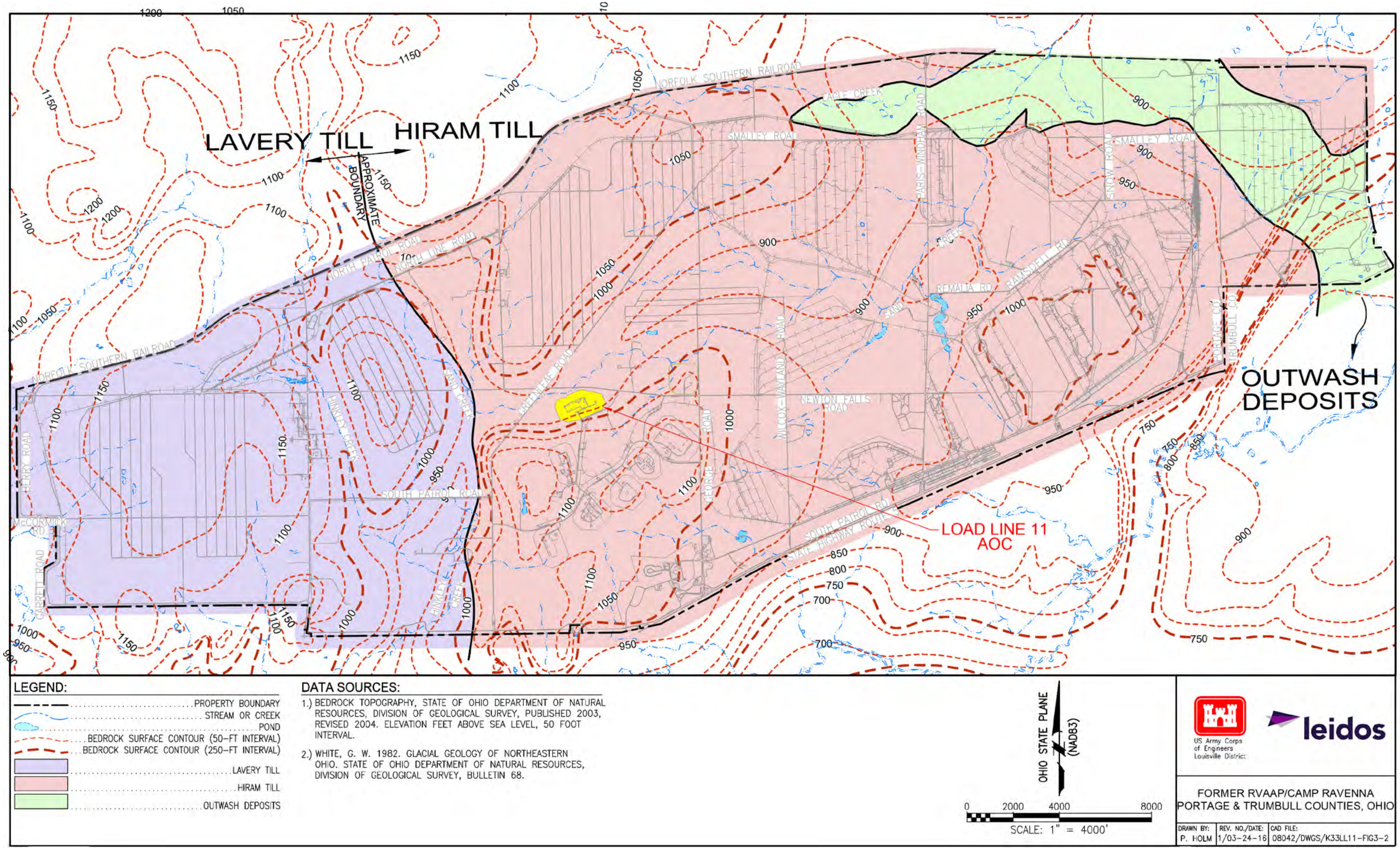


ID	Former Building Use and Description
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
Building AP-9	1941-1945: Shipping 1951-1957: Primer Rest House 1969-1971: Percussion Element Storage and Staging
Building AP-10*	Percussion Element Service Magazine
Building AP-11	1941-1945, 1951-1957: Black Powder Charging Operations 1969-1971: Primer Assembly
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

Figure 3–1. Topography, Groundwater Flow, and Surface Water Flow at Load Line 11



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

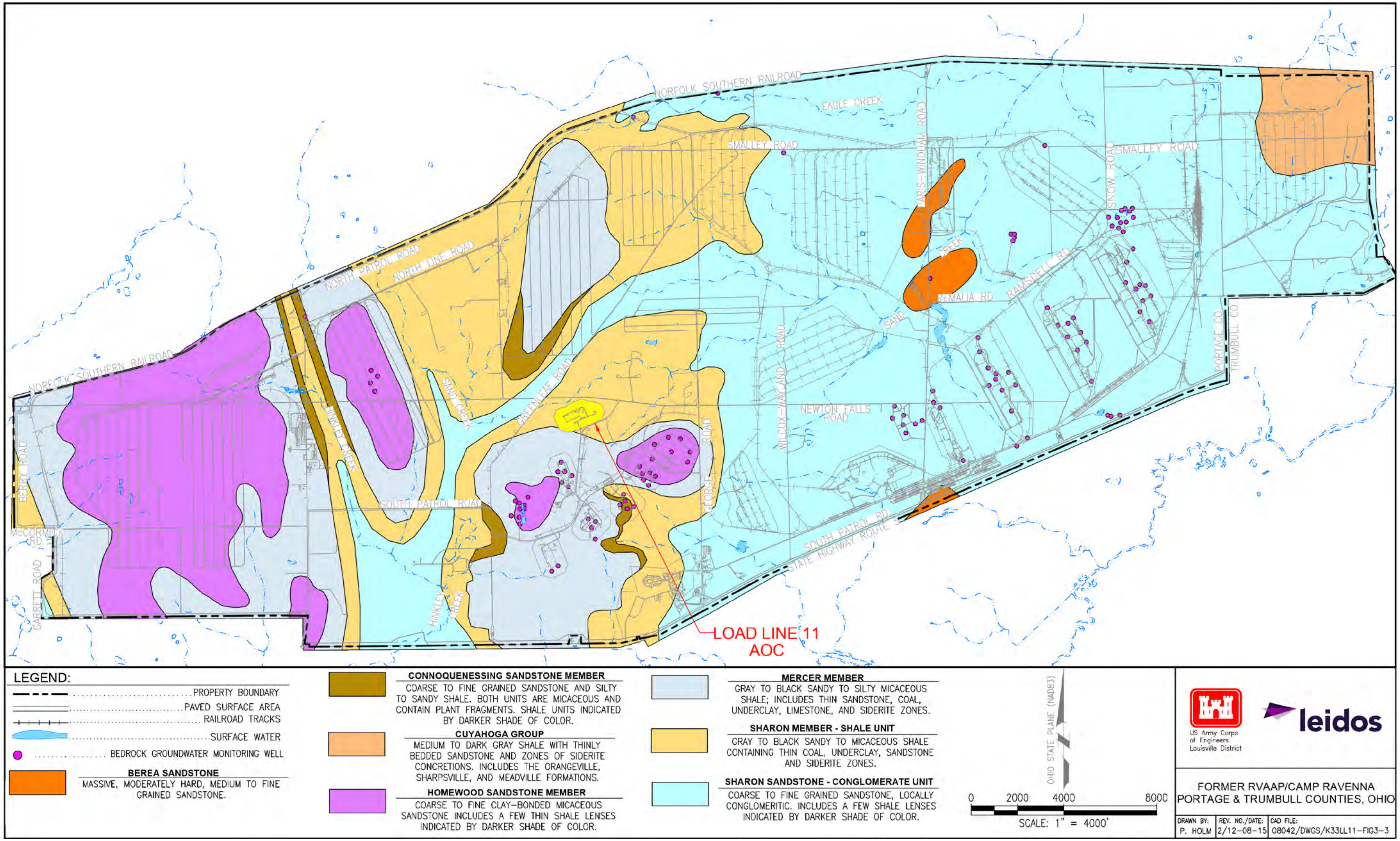


Figure 3–3. Geologic Bedrock Map and Stratigraphic Description of Units on Camp Ravenna

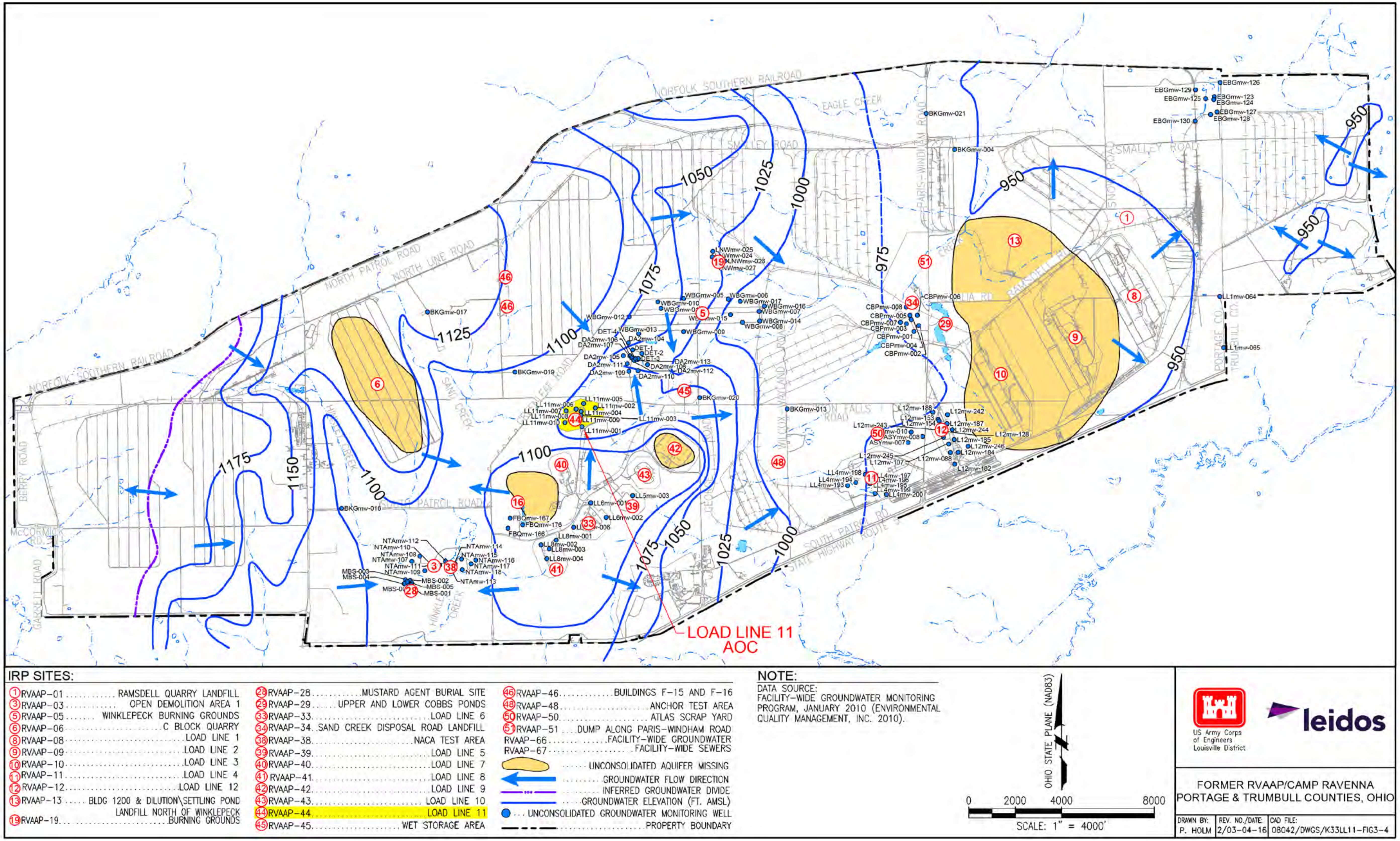


Figure 3–4. Potentiometric Surface of Unconsolidated Aquifer at Camp Ravenna

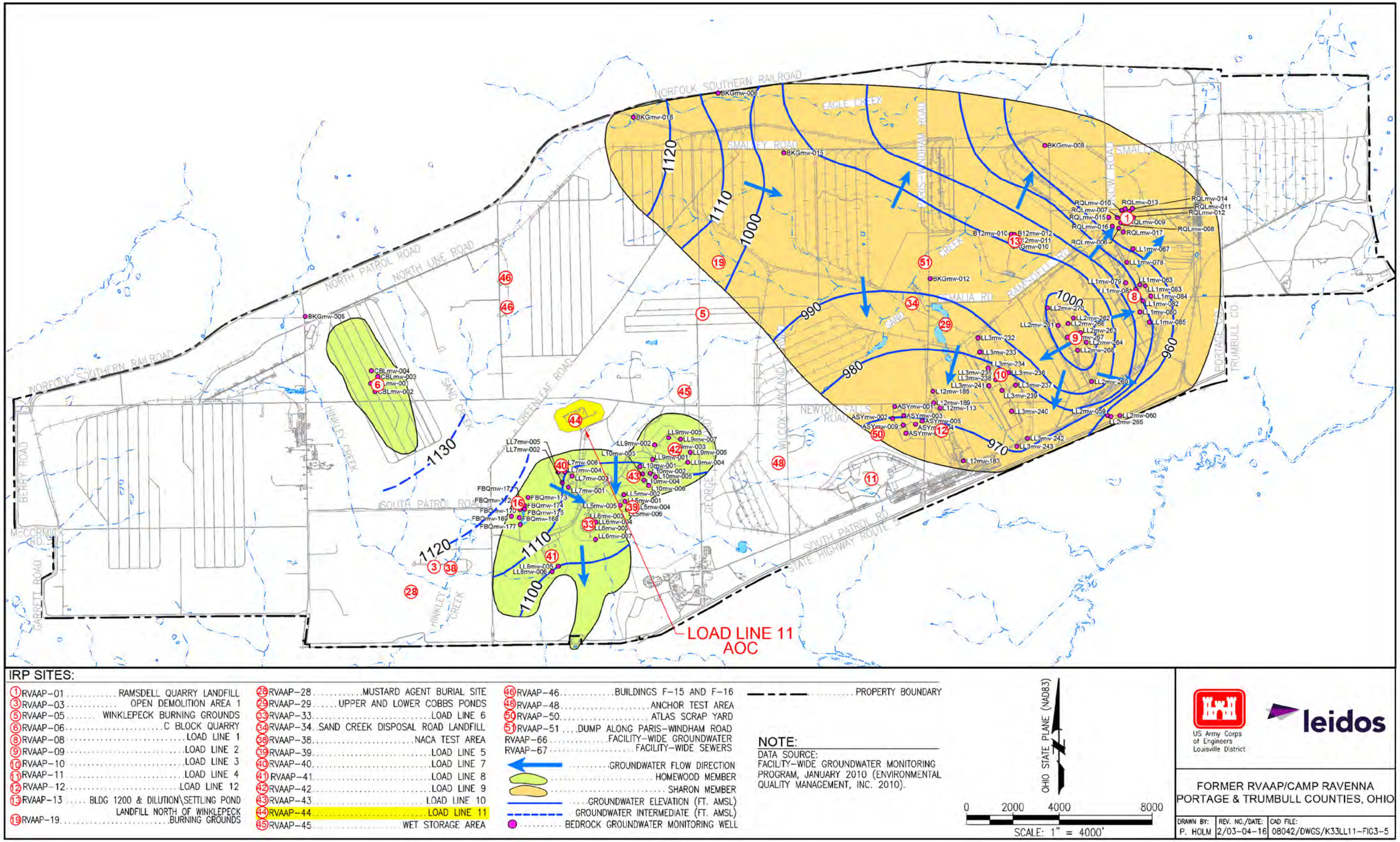


Figure 3–5. Potentiometric Surface of Bedrock Aquifers at Camp Ravenna

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4.0 SITE ASSESSMENTS, REMOVAL ACTIONS, INVESTIGATIONS, AND DATA ASSEMBLY

This section summarizes all previous site assessments and investigations conducted at Load Line 11. These previous activities include assessments to prioritize the AOC and investigations that collected data used in support of this RI.

4.1 LOAD LINE 11 PREVIOUS ASSESSMENTS AND EVALUATIONS

This section summarizes previous assessments and evaluations conducted at Load Line 11. 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 11 as part of the assessment. The assessment identified the following conditions at RVAAP as applicable to Load Line 11 (USATHAMA 1978):

- Areas of RVAAP, including the production areas (i.e., Load Lines 5, 7, 8, 10, 11, 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;
- Black powder was the only explosive waste identified for Load Line 11;
- Load lines were rehabilitated in 1951; and
- No environmental stress was identified at RVAAP.

4.1.2 RCRA Facility Assessment

The purpose of the RCRA Facility Assessment was to perform a visual inspection of known AOCs and conduct historical documentation research to identify new AOCs and solid waste management units, as applicable (Jacobs 1989). The RCRA Facility Assessment did not include specific assessments or conclusions regarding Load Line 11, and no sampling was performed at Load Line 11 as part of the assessment. However, the RVAAP-26 Fuze and Booster Area Settling Tanks AOC was included in the assessment, as discussed in Section 2.4.3.

4.1.3 RVAAP Preliminary Assessment

The *Preliminary Assessment for the Characterization of Areas of Contamination* researched RVAAP history, process operations, and historical data to identify AOCs (USACE 1996). Load Line 11 was not included in the assessment, with the exception of the RVAAP-26 Fuze and Booster Area Settling Tanks AOC, as discussed in Section 2.4.3.

The assessment provided the following general conclusions for RVAAP AOCs (all conclusions may not apply to Load Line 11; rather, these are general conclusions for all AOCs):

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

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

4.1.4 Relative Risk Site Evaluation for Newly Added Sites

In 1998, the U.S. Army Center for Health Promotion and Preventative Medicine completed the *Relative Risk Site Evaluation for Newly Added Sites* (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 Relative Risk Site Evaluation (RRSE) score of "high," and the remaining 8 were assigned a score of "medium."

The RRSE also included collecting surface soil, sediment, and subsurface soil samples at Load Line 11. The data collected at the site "…are minimal Level III data, as defined by U.S. EPA, and are not intended to be used as definitive evidence of contamination presence or absence or to support health risk assessment." This section summarizes the samples collected as part of the RRSE data, the chemicals detected, and the associated prioritization recommendations, but the analytical results are not presented and are not used in subsequent evaluations in this Phase II RI Report.

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 11 (RV-441 to RV-446). In addition, sample RV-264A, collected during the 1997 RRSE, was included as part of the data set. These samples were analyzed for explosives and inorganic chemicals. The groundwater pathway (human receptor endpoint) was evaluated using 1996 RRSE data from one subsurface soil sample (RV-264B) collected from 10-12 ft bgs, adjacent to the concrete settling tank east of Building AP-3. This sample was analyzed for explosives and inorganic chemicals.

One sediment sample (RV-447) was collected during this evaluation; however, surface water was not evaluated as part of the RRSE as surface water was considered an intermittent source.

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

The groundwater, surface soil, sediment, 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. 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.
3. 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.
4. Surface water
    a. Not evaluated. While surface water is intermittently present at Load Line 11, 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 11 as a "high-priority" AOC due to potentially contaminated sediment potentially migrating to Sand Creek and affecting human and ecological receptors, including state endangered species (USACHPPM 1998).

4.2 LOAD LINE 11 INTERIM REMOVAL ACTION

An IRA took place from January–June 2001 to remove contamination in primary migration pathways at Load Line 11 in accordance with the approved *Sampling and Analysis Plan Addendum for the Interim Removal Action at Load Line 11 (AOC 44)* (MKM 2004b). This section summarizes the IRA activities and information provided in the *LL-11 Interim Removal Action Report* (MKM 2004a).

The IRA was performed in parallel with the Phase I RI activities described in Section 4.3: removing sump water from production buildings, grouting selected sanitary sewer manholes, excavating contaminated ditch lines, and removing the petroleum-contaminated soil hot spot. Figure 4-1 presents the locations sampled under the IRA. Table 4-1 presents the sample locations, associated operations, and suite of chemicals analyzed as part of the IRA confirmation sampling. Tables 4-2 through 4-4 present the results of the analytes detected from samples collected during the IRA confirmation sampling.

The information and results from this IRA were included with the Phase I RI data when the Phase I RI HHRA and ERA were developed. As a result, all findings and recommendations relative to subsequent remedial efforts are provided in the Phase I RI Report (MKM 2005a) and used to support this Phase II RI Report.

4.2.1 Sump Excavation

Five sedimentation sumps were excavated, removed, and disposed during the IRA. These sumps were located adjacent to Buildings AP-3, AP-5, AP-6, and AP-8. During the initial sump removal operations, a fibrous liner material was found attached to the lead lining in each of the sumps. Bulk samples of the material were collected and submitted for asbestos analysis. Analytical results indicated the fibrous material was comprised of 60% chrysotile asbestos. As a result, the sumps were excavated and removed in accordance with federal (40 CFR Part 61, Subpart M) and state (OAC 3745-20) asbestos emission control regulations; the fibrous material was placed into plastic bags by asbestos abatement workers.

As part of the removal activities, approximately 15,000 gal of water were removed from sumps adjacent to process Buildings AP-3, AP-5, AP-6, and AP-8. During the water removal at Building AP-3, it was determined that the infiltration rate of groundwater into the sewer system was significant enough to impede removal operations. Consequently, the sewer manholes downgradient of each sump were filled with bentonite cement to prevent water from infiltrating back into the sumps during the excavation and removal operations. Once the water was removed, effluent sewer lines were cut and plugged with mechanical packers and cement grout, which prepared the sumps for removal.

Upon removing the sumps, one confirmation sample was collected from the bottom of each excavation [five total and one quality assurance (QA)/quality control (QC) sample]. The depths of confirmation samples LL11cs-001 to LL11cs-005 ranged from 5-6 ft bgs. The sump excavation confirmation samples were analyzed for explosives, target analyte list (TAL) metals, cyanide, sulfide, sulfate and nitrate. In addition, 10% of the samples were also analyzed for VOCs, semi-volatile organic compound (SVOCs), propellants, and pesticides/PCBs. Explosives and cyanide were not detected in any of the five sump excavations.

4.2.2 Ditch Excavation

Phase I RI sampling at six drainage ditch locations exhibited elevated concentrations of metals, VOCs, SVOCs, pesticides, and/or PCBs. These six drainage ditch locations were LL11sd-013, LL11sd-018, LL11sd-019, LL11sd-026, LL11sd-027, and LL11sd-033.

Field screening for metals using X-ray fluorescence and nitrates using a Hach N Trak® soil test kit was performed to define lateral extent of the excavation. Figure 4-1 depicts the excavation extent of the ditches to a depth of 2 ft bgs. A total of 230 yds^3 of contaminated soil was removed during the ditch excavation operations using a track-mounted excavator. The list below describes the drainage ditch locations that had a removal action performed, the targeted chemicals, and the associated confirmation samples.

- Ditch southeast of Building AP-3 (at RI sample point LL11sd-027):
    - Targeted metals and VOC contamination.
    - Confirmation sample locations LL11cs-006 to LL11cs-010 are associated with this removal action. (Sample location LL11cs-010 was considered sediment in the IRA Report but was reclassified as soil in this Phase II RI Report.)
- Ditch east of Building AP-4 (at RI sample point LL11sd-028):
    - Targeted metals and VOC contamination.
    - Confirmation soil sample locations LL11cs-011 to LL11cs-014 and sediment sample location LL11cs-015 are associated with this removal action.
- Ditch north of Building AP-14 (at RI sample point LL11sd-032):
    - Targeted metals, SVOC, and pesticide contamination.
    - Confirmation soil sample locations LL11cs-016 to LL11cs-020 are associated with this removal action. (Sample locations LL11cs-016 and LL11cs-020 were considered sediment in the IRA Report but were reclassified as soil in this Phase II RI Report.)
- Ditch east of Load Line 11 entrance road (at RI sample point LL11sd-013):
    - Targeted metals contamination.
    - Confirmation soil sample locations LL11cs-021 to LL11cs-025 are associated with this removal action. (Sample locations LL11cs-021 and LL11cs-025 were considered sediment in the IRA Report but were reclassified as soil in this Phase II RI Report.)
- Ditch west of Building AP-8 (at RI sample point LL11sd-033):
    - Targeted metals contamination.

    - Confirmation soil sample locations LL11cs-026 to LL11cs-030 are associated with this removal action. (Sample locations LL11cs-026 and LL11cs-030 were considered sediment in the IRA Report but were reclassified as soil in this Phase II RI Report.)
- Ditch north of Building AP-19 (at RI sample points LL11sd-018 and LL11sd-019):
    - Targeted metals contamination.
    - Confirmation soil sample locations LL11cs-032 to LL11cs-039 and sediment sample location LL11cs-031 are associated with this removal action. (Sample location LL11cs-039 was considered sediment in the IRA Report but was reclassified as soil in this Phase II RI Report.)

4.2.3 Hot Spot Excavation

One 30 by 30 by 8 ft hot spot area, located in an open field north of Building AP-17, was excavated on March 22, 2001 due to petroleum contamination encountered during RI soil boring activities (MKM 2004a). This hot spot was identified from soil borings collected during the initial installation of monitoring well LL11mw-005. (The monitoring well was relocated approximately 50 ft northeast of the original location.)

To determine the lateral and vertical extent of contamination, a grid of soil borings were installed at 50 ft centers. Soil samples were collected from 2-4, 4-6, 6-8, or 8-10 ft bgs. Field assessments field (e.g., headspace readings, visual and olfactory observations) were used to determine if a sample was to be sent to an off-site laboratory. Samples sent to the off-site laboratory were analyzed for explosives, TAL metals, cyanide, VOCs, and SVOCs.

Field readings and laboratory results indicated that the contamination was between 4 and 8 ft bgs. In March 2001, a total of 130 yd^3 of petroleum-contaminated soil was excavated at the hot spot area from 4-8 ft bgs. The upper 4 ft of the excavated soil was staged separately for reuse at Load Line 11. The hot spot removal location is presented on Figure 4-1.

Following excavation operations, six confirmation samples (LL11cs-040 to LL11cs-045) were collected at the bottom of the excavation (approximately 8 ft bgs) to verify that the petroleum-contaminated soil was removed. The confirmation samples were analyzed for VOCs, SVOCs, explosives, propellants, TAL metals, pesticides, PCBs, cyanide, sulfide, sulfate, nitrate, total petroleum hydrocarbons-diesel range organics (TPH-DRO), and total petroleum hydrocarbons-gasoline range organics (TPH-GRO). Upon obtaining approval to complete the hot spot removal, the excavation was backfilled with approved off-site soil.

4.2.4 Test Trench Excavations

UXO technicians encountered an area of high magnetometer readings north-northwest of the hot spot area while clearing the excavation area for the hot spot. During the excavation of the hot spot, it was determined that the area needed to be assessed for UXO. Upon excavating test trenches, cable, scrap metal, bolts, and magnetite-containing rock were found.

Confirmation samples LL11cs-046 to LL11cs-050 were collected from the test trenches from 3-4 ft bgs. As with the hot spot confirmation samples, these samples were analyzed for VOCs, SVOCs, explosives, propellants, TAL metals, pesticides, PCBs, cyanide, sulfide, sulfate, nitrate, TPH-DRO, and TPH-GRO.

Excavation of test trenches and confirmation samples indicated that no UXO was present. Upon this determination, the test trenches were backfilled and leveled to the original ground surface elevation.

4.3 LOAD LINE 11 REMEDIAL INVESTIGATIONS

This section summarizes previous investigations conducted at Load Line 11. These investigations collected data of sufficient provenance and quality to be used to support the evaluations in this RI, including the nature and extent, fate and transport, HHRA, and/or ERA.

The *Report for the Remedial Investigation at Load Line 11 (AOC 44)* (MKM 2005a) (herein referred to as the Phase I RI Report) 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 Phase II RI Report; however, an updated screening process and the addition of new data and information may result in a different list of SRCs and/or COPCs.

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

4.3.1 Phase I Remedial Investigation

In 2000-2001, sampling was conducted at Load Line 11 in accordance with the *Sampling and Analysis Plan Addendum for the Remedial Investigation at Load Line 11* (MKM 2000; herein referred to as the Load Line 11 SAP Addendum). The Phase I RI was performed to accomplish the following:

- Define the vertical and horizontal extent of contamination at Load Line 11,
- Gather sufficient data to conduct a Baseline Human Health Risk Assessment (BHHRA) and a Screening Ecological Risk Assessment (SERA),
- Define potential transport pathways and receptor populations, and
- Provide sufficient data for selecting remedial action alternatives.

The data from the RI sampling was used to direct IRA excavation/removal operations (discussed in Section 4.2) and was incorporated into an evaluation of risk for the AOC, followed by recommendations for remedial efforts, as necessary. Because the IRA confirmation results represent existing site conditions, those confirmation results were included in the Phase I RI risk assessment. Results of this Phase I RI are presented in the Phase I RI Report (MKM 2005a) and are summarized in the following subsections.

4.3.1.1 Field Activities

In addition to the activities performed under the IRA, the following field activities were conducted during the Phase I RI in June 2000-March 2001 at Load Line 11 to assess the potential impacts from former operations:

- Collected discrete surface soil (0–1 ft bgs) samples,
- Collected subsurface soil (less than 1 ft bgs) samples,
- Collected surface water samples from ditches,
- Collected sediment samples from ditches,
- Collected subfloor samples in Buildings AP-8 and AP-11,
- Collected samples adjacent to sumps, and
- Surveyed sampling locations.

The following activities also took place; however, these activities are pertinent to other co-located AOCs associated with Load Line 11 (e.g., Facility-wide Groundwater and Facility-wide Sewers) and are not discussed in this section:

- Installed, developed, and sampled 10 monitoring wells;
- Conducted in-situ permeability testing (slug tests);
- Collected sump sediment/sludge samples;
- Collected sump water samples;
- Collected sanitary sewer manhole water samples;
- Collected sanitary sewer manhole sediment/sludge samples;
- Collected geotechnical samples from monitoring well borings; and
- Surveyed monitoring well locations.

Soil (surface and subsurface), sediment, and surface water samples were analyzed for TAL metals explosives, and anions. Additionally, 10% of samples were analyzed for RVAAP full-suite analytes. Hot spot locations near initial RI sampling locations with elevated VOC concentrations were analyzed for VOCs and SVOCs, and selected locations for TPH-DRO and TPH-GRO.

Figure 4-2 presents the locations sampled under the Phase I RI. Table 4-5 presents the sample locations, associated operations, and suite of chemicals analyzed as part of the Phase I RI. Tables 4-6 through 4-9 present the results of the analytes detected from samples collected during the Phase I RI.

Analytical laboratory procedures were completed in accordance with applicable professional standards, USEPA requirements, government regulations and guidelines, and specific project goals and requirements. Samples were analyzed as specified by the Facility-wide Sampling and Analysis Plan (FWSAP) current at the time of the investigation (USACE 1996) and the Load Line 11 SAP Addendum (MKM 2000). The data quality objectives (DQOs) were established for the Phase I RI 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 (100% complete), was usable, and that it satisfied the DQOs for the project.

4.3.1.2 Nature and Extent of Contamination

A total of 22 metals, 2 SVOCs, and 2 propellants were detected in surface soil (0–1 ft bgs), and 8 metals, 1 propellant, and 1 PCB were detected in subsurface soil (1–13 ft bgs) above RVAAP background concentrations (USACE 2001b) and/or Region 9 residential soil preliminary remediation goals (PRGs) at that time. The four metals and one SVOC detected in surface water were above RVAAP background concentrations and/or Region 9 tap water PRGs. A total of 20 metals, 1 propellant, and 1 SVOC were detected in sediment above RVAAP background concentrations and/or Region 9 residential soil PRGs. Figure 4-5 presents locations that exceed current screening criteria.

4.3.1.3 Baseline Human Health Risk Assessment

A BHHRA was included in the Phase I RI Report (MKM 2005a) for Load Line 11. The BHHRA utilized the screening process in effect at that time, based on the protocol established in the *RVAAP Facility-Wide Human Health Risk Assessor Manual* dated January 2004 to identify potential contaminants of concern (USACE 2005b). [This assessment predated the *RVAAP Facility-Wide Human Health Risk Assessor Manual – Amendment 1* (USACE 2005b) (herein referred to as the FWHHRAM)]. Risks were evaluated for the receptors available at that time [National Guard Trainee (the primary receptor of concern), National Guard Resident/Trainer, Hunter/Trapper, Security Guard/Maintenance Worker, and Resident Farmer (Adult and Child)]. The COPCs identified in the quantitative BHHRA are summarized in Table 4-10.

The BHHRA indicated that several significant uncertainties associated with the risk assessment were identified and must be considered carefully when making any risk management decisions, including the fact that the nature and extent of the contamination in soil, sediment, surface water, and groundwater at Load Line 11 had not been completely defined. Therefore, the results of the BHHRA are preliminary and subject to change based on the additional data and information presented in this Phase II RI Report.

4.3.1.4 Screening Ecological Risk Assessment

The SERA compared chemical concentrations detected in Load Line 11 environmental media to RVAAP facility-wide background concentrations for inorganic chemicals and ecological screening values (ESVs). The SERA followed screening methodology guidance presented in the *2003 RVAAP Facility-Wide Ecological Risk Work Plan* (USACE 2003a) (herein referred to as the FWERWP) and *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2003). Chemicals were retained if they did not have screening values. Table 4-11 presents a summary of the COPCs identified per type of species based on the ecological risk calculations.

The SERA concluded no unacceptable ecological risks were identified at Load Line 11. No COPCs were retained for direct toxicity to terrestrial plants, soil invertebrates, sediment invertebrates (benthos), and aquatic organisms. Refining conservative assumptions used during food chain modeling led to determining that the risks were acceptable. Refinement included using less conservative bioavailability, less conservative dietary benchmarks (LOAELs), more realistic average exposure scenarios (not maximum), and considering aquatic habitat quality in the site drainage ditches.

4.3.1.5 Conclusions

The Phase I RI Report (MKM 2005a) provided the following conclusions applicable to Load Line 11:

- Potential risk exists to the National Guard Trainee due to manganese exposure based on conservative toxicity and exposure values used to calculate potential risk.
- Potential risk exists in using unconsolidated groundwater for domestic purposes due to arsenic concentrations. As arsenic is a naturally occurring metal, future groundwater monitoring was recommended to determine if arsenic concentrations was a background condition.
- There may be a need for remedial action or land use controls to limit future use of Load Line 11.
- No additional action is recommended based on ecological risk.

4.3.2 PBA08 Remedial Investigation

In November 2008, Science Applications International Corporation (SAIC) scientists performed a site walk of Load Line 11. The site walk was conducted to develop the *Performance-based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1* (PBA08 SAP) (USACE 2009), which supplemented the Phase I RI in this Phase II RI Report and completed the RI phase of the CERCLA process. Numerous physical changes occurred at Load Line 11 between the Phase I RI and IRA sampling, and the development of the PBA08 SAP. As discussed in Section 2.2.3, building demolition activities took place in 2004-2005, and footer removal occurred 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 11 RI. Section 4.5.4 discusses the suitability and use of samples collected to support this RI, with respect to changes in AOC conditions. The PBA08 SAP was reviewed and approved by representatives of the Army and Ohio EPA in January 2010.

As part of the PBA08 RI DQOs, an initial screening approach was used to help focus the investigation on specific chemicals and areas to be further evaluated by assessing the nature and extent of contamination observed in historical samples (Section 3.2.2 of the PBA08 SAP). Decision flowcharts for PBA08 RI surface and subsurface sampling are presented in Figures 4-3 and 4-4, respectively. The screening approach presented in the PBA08 SAP compared sample results from previous investigations at Load Line 11 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 FWHHRAM (USACE 2005b). The most protective FWCUGs for the Resident Farmer (Adult and Child) and National Guard Trainee were referred to as “screening criteria.” Previous results were also compared to FWCUGs at the higher TR of 1E-05 and HQ of 1 to facilitate identifying potential source areas that may require additional sampling to refine the extent of contamination. Table 4-12 lists the chemicals with detected concentrations that exceeded screening criteria at the time of the PBA08 SAP in historical soil samples.

In February-April 2010, the PBA08 RI was implemented by collecting surface and subsurface soil and surface water samples using discrete sampling techniques, and collecting sediment using composite sampling techniques. The results of the PBA08 RI sampling, combined with the results of the Phase I RI and IRA, 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.

4.3.2.1 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 4-13 presents the specific rationale for each surface soil sample collected during the PBA08 RI in April 2010. Table 4-14 presents the results of the analytes detected from surface soil samples collected during the PBA08 RI in April 2010. All PBA08 RI and historical sample locations used in this evaluation are presented on Figure 4-7.

Nine source area investigation discrete samples were collected in ditches not previously investigated, downgradient of former operational areas and former buildings, and at locations where historical screening criteria exceedances were observed to vertically delineate contamination (Figure 4-5). The sample locations in the PBA08 SAP were derived from the sample polygons provided during the development of the PBA08 SAP. One incremental sampling methodology (ISM) sample (10% of the total number of discrete samples collected) was analyzed for RVAAP full suite analytes.

4.3.2.2 Surface Soil Sampling Rationale – Chromium Speciation

As part of the PBA08 RI, three discrete chromium speciation samples were collected to evaluate the potential contribution of hexavalent chromium to the total chromium concentrations in soil. Samples 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). Two samples were collected from areas previously identified as having elevated total chromium concentrations (LL11sb-004 and LL11cs-011), and one sample was collected from an area previously identified as having a total chromium concentration near background concentrations (LL11sd-025). The rationale for all samples collected as part of the PBA08 RI is summarized in Table 4-15. The locations of these samples are presented in Figure 4-5 and results are presented in Table 4-14.

4.3.2.3 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.

Soil samples from 10 soil borings installed in 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 4-16 presents the specific rationale for each subsurface soil sample collected for the PBA08 RI. Results of detected analytes are presented in Table 4-17.

The subsurface soil sampling depth intervals were documented in the PBA08 SAP. Each soil boring was sampled at 0–1, 1–4, 4–7, and 7–13 ft bgs. 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 sample collected from the 7–13 ft bgs 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, if any chemical concentration exceeded screening criteria in the 4–7 ft bgs sample, the 7-13 ft bgs sample was analyzed. One of the archived 7–13 ft bgs samples was analyzed because there were preliminary screening criteria exceedances for arsenic (24.7 mg/kg) in the 4–7 ft bgs sample interval from LL11sb-065. In addition, at least 10% of all subsurface samples from 7–13 ft bgs were submitted for laboratory analysis to ensure adequate characterization of the subsurface soil to 13 ft bgs. One sample collected from the 7–13 ft bgs sample interval was submitted for laboratory analysis for this purpose.

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

Two geotechnical samples were collected from one boring location to provide soil data for fate and transport modeling. Geotechnical data is provided in Appendix D. A pilot boring was installed with a Geoprobe at sample location LL11sb-085 to a depth of 6.5 ft bgs (where shallow bedrock was encountered) to allow lithological characterization of the soil and determine the appropriate geotechnical sample intervals (Appendix A). The geotechnical sample location was offset from the pilot boring and drilled with hollow stem auger attachments. Geotechnical samples were collected beneath the hollow stem augers directly into the Shelby Tube. Undisturbed Shelby Tube samples were collected from 2–3.9 and 4-5.5 ft bgs. The Shelby Tubes were sealed with wax, capped, and submitted for laboratory geotechnical analysis for porosity, bulk density, moisture content, total organic carbon, grain size fraction analysis, and permeability.

4.3.2.4 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 during the PBA08 RI from ditches and shallow conveyances within and exiting the AOC. The samples were collected in accordance with the following decision rules approved in the PBA08 SAP:

- At AOCs where overland flow of contaminants could occur to nearby perennial streams, those streams will be sampled. The sample locations may be outside of the AOC boundaries, but the samples represent the areas potentially impacted by the AOCs (Load Line 11).
- At points where contamination may migrate out of the AOC area, such as a ditch or a stream near the AOC boundary, samples were collected to characterize current conditions and determine whether contaminant migration may occur at surface water runoff exit points.

In addition to the samples collected within the AOC boundaries, this Phase II RI Report discusses the surface water and sediment samples collected at potential exit points from the Fuze and Booster Hill area (which includes Load Lines 5 through 11) and near the southern boundary of RVAAP/Camp Ravenna to determine nature and extent. Although not within the AOC boundary, this report evaluates sample LL11sd/sw-082 that was collected north of Load Line 11 and north of Newton Falls Road to assess the potential transport beyond the AOC boundary.

The surface water grab samples were collected by the handheld bottle method in accordance with Section 4.3 of the PBA08 SAP and analyzed for the RVAAP full-suite analytes. Additionally, water quality parameters for temperature, pH, conductivity, dissolved oxygen, and turbidity were collected using calibrated water quality meters (Hanna Instrument Models 9828 and 98703). The sediment samples were collected in accordance with Section 4.2 of the PBA08 SAP. 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. 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. Two sediment samples (and their associated QA/QC samples) were analyzed for explosives, TAL metals, PCBs, and SVOCs, while one sample was analyzed for RVAAP full-suite analytes. Table 4-18 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 4-19 and Table 4-20 for surface water and sediment, respectively.

4.3.2.5 Changes from the Work Plan

Significant changes to the PBA08 SAP are documented in 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). These changes are presented on Table 4-21. New coordinates for all station locations can be found on the field sampling logs.

4.3.2.6 August 2012 Sediment Sample

In August 2012, one sediment sample (LL11sd-096-5874-SD) was re-collected from the West Ditch for RVAAP full-suite analyses because the previous sediment sample LL11sd-084-5595-SD was analyzed only for TAL metals, explosives, SVOCs, and VOCs (Figure 4-5). The ditch was dry; therefore, no additional surface water sample was collected. The location of this sample is presented on Figure 4-5. Table 4-20 presents the analytes detected from the additional sediment sample collected in August 2012. There were several chemical concentrations in sediment exceeding background concentrations, and these results are included as part of the SRC screen for the West Ditch exposure unit (EU) and in the HHRA and ERA.

4.4 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 4.5.2 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 for determining background concentrations.

Soil samples were collected from each of the background monitoring well locations from three intervals: 0–1, 1–3, and greater than 3 ft bgs. Because boring locations were changed during sampling based on the lithological requirements for well screen intervals, all depth intervals for soil were not sampled for each boring. Background soil samples were analyzed for TAL metals, cyanide, SVOCs, total organic carbon, 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 4-22.

4.5 DATA EVALUATION METHOD

Data evaluation methods for Load Line 11 are consistent with those established in the FWCUG Report and specified in the PBA08 SAP (USACE 2009). The processes used to evaluate the analytical data involved three general steps: (1) defining data aggregates; (2) conducting data verification, reduction, and screening; and (3) presenting data.

4.5.1 Definition of Aggregates

Load Line 11 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 EUs and guidance established in the FWHHRAM and FWCUG Report. Data aggregates for evaluating the nature and extent of contamination at Load Line 11 are as follows:

- **Surface Soil (0-1 ft bgs):** Using the above data aggregation criteria, surface soil within the geographic area of Load Line 11 was subdivided into two spatial aggregates: FPA and NPA. The FPA aggregate is defined as the area encompassed within the perimeter road surrounding the Load Line 11 main production area. The NPA aggregate is defined as the area between the production area perimeter road and the fence line. The FPA contains all known or potential primary contaminant sources such as the former operational buildings. The former buildings located within the NPA were limited to administrative and storage functions.

- **Subsurface Soil (less than 1 ft bgs):** Includes data from discrete sample intervals 1–4, 4–7, and 7–13 ft bgs. This medium is subdivided into two spatial aggregates, the FPA and NPA, on the same basis as surface soil.
- **Sediment:** Sediment was subdivided into three spatial aggregates. The East Ditch aggregate is represented by a discrete sediment sample collected at a ditch line which drained portions of the eastern part of the FPA. The West Ditch aggregate is represented by a discrete sediment sample collected at a ditch line west of former Building AP-4 which drains the western half of Load Line 11. The Sewer Outfall aggregate is represented by a sediment sample collected at the sanitary system overflow outfall north of the FPA.
- **Surface Water:** This medium is subdivided into the East Ditch and West Ditch spatial aggregates on the same basis as sediment. The drainage ditches only intermittently convey surface water. Although the Sewer Outfall is defined as a spatial aggregate for sediment, no surface water is available for this sample location, as it is predominantly dry.

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

4.5.2 Data Verification, Reduction, and Screening

4.5.2.1 Data Verification

Data verification was performed on 55 surface and subsurface soil samples (including QC duplicates) collected during the PBA08 RI in March 2010 and April 2011. Data from the Phase I RI and IRA 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.

4.5.2.2 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 QC splits and field duplicates, as well as rejected results, were excluded from the data screening process. As stated in Section 5.4.7 of the FWSAP, "The duplicate is submitted as 'blind' to the laboratory and is used to determine whether the field sampling technique is reproducible and to check the accuracy of reported laboratory results." Therefore, duplicates are not used in the data screening process. All analytes having at least one detected value were included in the data reduction process.

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

4.5.2.3 Data Screening

After reduction, the data were screened to identify SRCs using the processes outlined below. All surface and 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., EPA RSLs, FWCUGs, and ESVs) was conducted: (1) in the fate and transport evaluation (Section 6.0) to identify CMCOPCs, (2) in the HHRA to identify human health COPCs and COCs (Section 7.2), and (3) in the ERA to evaluate COPECs (Section 7.3). Figure 4-6 illustrates the screening process to identify SRCs and COPCs at Load Line 11 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 4-23). 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) (hereafter referred to as the Position Paper for Human Health CUGs) establish the protocol for frequency of detection and WOE screening. These guidance documents denote that analytes (with 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. The WOE evaluated magnitude and location (clustering) of detected results and if the distribution of detected results indicated a potential source of the chemical. If the detected results for a chemical showed: (1) no clustering; (2) concentrations were not substantially elevated relative to detection limit; and (3) the chemical did not have an evident source, the results were considered spurious, and the chemical was eliminated from further consideration. This screening was applied to all organic and inorganic chemicals with the exception of explosives and propellants; all detected explosives and propellants were considered SRCs regardless of frequency of detection. The frequency-of-detection screening was performed for surface soil and subsurface soil, because these data sets were comprised of 20 or more samples.

4.5.3 Data Presentation

Data summary statistics and screening results for SRCs in surface and subsurface soil, sediment, and surface water at Load Line 11 are presented for each medium and spatial aggregate. Analytical results for SRCs are also presented in data summary tables: Tables 4-24 and 4-25 for surface soil, Tables 4-26 and 4-27 for subsurface soil, Tables 4-28 through and 4-30 for sediment, and Tables 4-31 and 4-32 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 11 have sample identifications beginning with “LL11.”

The tables in Appendix D present the analytical results for samples collected during the PBA08 RI, Phase I RI, and IRA. Sample locations from the IRA and two RIs are presented on Figure 4-7. Analytical results are grouped by media (e.g., surface soil, subsurface soil, sediment, surface water), spatial aggregate (i.e., FPA, NPA, West Ditch, East Ditch, Sewer Outfall), and class of analyte (e.g., explosives, inorganic chemicals) for ease of reference.

4.5.4 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 4-33 presents the designated use for all available Load Line 11 samples.

4.5.4.1 Surface and Subsurface Soil

Surface and subsurface soil samples at Load Line 11 were collected during the 2000–2001 Phase I RI, 2001 IRA, and the PBA08 RI. Samples were collected during the Phase I RI from June 2000-March 2001, and the results indicated the need for an IRA to remove contaminated soil and infrastructure from Load Line 11. Soil excavations were conducted at building sumps in the FPA and the hot spot northeast of former Building AP-17. Samples collected within these excavated areas prior to the removal actions were eliminated from evaluation in the screening in this Phase II RI, as these data are no longer representative of media located at the Load Line 11. These samples are not carried forward in the nature and extent evaluation or risk assessments to evaluate and characterize Load Line 11. These sample locations include:

- LL11sb-031 from 4-6 ft bgs,
- LL11sb-031A from 6-8 ft bgs,
- LL11sb-032 from 4-6 ft bgs,
- LL11sb-033 from 6-8 ft bgs,
- LL11sb-034 from 2-4 ft bgs, and
- LL11sb-036 from 4-6 ft bgs.

Confirmatory samples collected following the removal actions were retained for SRC screening purposes, as these results are considered representative of current conditions at Load Line 11. These samples are presented in Table 4-33. No disturbance activities were conducted in the intervening time between collection and the PBA08 RI activities. Historical surface soil samples collected beneath building slabs prior to removal were retained for nature and extent evaluation only. These locations were likely disturbed during slab removal, but the soil itself was not removed. Historical subsurface soil samples were collected below a depth of 13 ft bgs and retained for evaluating contaminant migration and nature and extent, but these samples were not utilized in the SRC screening.

The RRSE samples RV-264A, RV-264B, and RV-441 to RV-446 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."

Additionally, two subsurface soil samples (from two soil borings) were collected during the PBA08 RI for geotechnical analysis only.

4.5.4.2 Sediment

Sediment samples were collected during the Phase I RI in 2000-2001, and the results indicated the need for an IRA to remove contaminated sediment and infrastructure (e.g. sumps) from Load Line 11. Excavations were conducted within contaminated ditch lines. Samples collected within these excavated areas prior to the removal actions were eliminated from evaluation in the PBA08 RI screening, as these data are no longer representative of media located at the Load Line 11. These samples are not carried forward in the nature and extent evaluation or risk assessments to evaluate and characterize Load Line 11. These sample locations include:

- LL11sd-002 at 3 ft bgs,
- LL11sd-003 at 3 ft bgs,
- LL11sd-005 at 7 ft bgs,
- LL11sd-013 from 0-1 ft bgs,
- LL11sd-018 from 0-0-5 ft bgs,
- LL11sd-019 from 0-1 ft bgs,
- LL11sd-027 from 0-0-5 ft bgs,
- LL11sd-028 from 0-0-5 ft bgs,
- LL11sd-032 from 0-1 ft bgs, and
- LL11sd-033 from 0-1 ft bgs.

Confirmatory samples collected following the removal actions were retained for SRC screening purposes, as these results are considered representative of current conditions at Load Line 11.

For sediment data from the West Ditch and East Ditch, if a PBA08 RI sample was obtained from a historical sample location, the PBA08 RI result was considered to represent current conditions and was screened for SRCs. If the drainage had changed in a production area after IRA excavations or building demolition, the historical sample was not used in the screening. All historical sediment and surface water samples superseded in the SRC screen by PBA08 RI data were used only for evaluating contaminant nature and extent (e.g., temporal trends) and contaminant transport.

Sediment samples collected from the sanitary sewer system during the Phase I RI and Facility-wide Sewers RI are not included in the evaluation within this report, as those samples are evaluated as part of the Facility-wide Sewers AOC (designated as RVAAP-67).

One sediment sample (RV-447) was collected during 1998 RRSE The RRSE sample RV-447 was not included in this RI evaluation, as the RRSE data collected at the site "…are minimal Level III data, as defined by U.S. EPA, and are not intended to be used as definitive evidence of contamination presence or absence or to support health risk assessment."

4.5.4.3 Surface Water

As noted in Sections 2.2.3 and 4.2.1, sump water was sampled then removed, filtered, and discharged to the ground during IRA sump excavation and removal activities at former Buildings AP-3, AP-5, AP-6, and AP-8. Surface water samples were collected during the Phase I RI in 2000-2001, where sediment was later excavated from contaminated ditch lines during the IRA. Samples collected within these excavated areas prior to the removal actions were eliminated from evaluation in the PBA08 RI screening, as these data are no longer representative of media located at the Load Line 11. These samples are not carried forward in the nature and extent evaluation or risk assessments to evaluate and characterize Load Line 11. These sample locations include:

- LL11sw-001,
- LL11sw-002,
- LL11sw-003,
- LL11sw-004,
- LL11sw-005,
- LL11sw-006, and
- LL11sw-013.

Surface water samples collected from the sanitary sewer system during the Phase I RI are not included in the evaluation within this report, as those samples are evaluated as part of the Facility-wide Sewers AOC (designated as RVAAP-67).

All previous surface water samples from the Phase I RI were collected using discrete sample methods, as were those collected under the PBA08 RI. Both the historical and PBA08 RI data were utilized in screening for SRCs and COPCs and carried forward into the risk assessment, with the exception of samples considered not representative of current conditions, or collected from contaminated ditch lines prior to IRA activities.

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Table 4–1. IRA Confirmation Sample Locations

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
LL11cs-001	5–6	Metals, explosives, anions	Sump Removal near Building AP-3	1941-1945, 1951-1957, and 1969-1971: Building AP-3 utilized for black powder screening. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-002	5–6	Full suite, anions	Sump Removal near Building AP-6	1941-1945, 1951-1957, and 1969-1971: Building AP-6 utilized as black powder rest house. Evaluated effectiveness of excavation efforts during the IRA activities. QC sample collected.	None	Metals, black powder
LL11cs-003	5–6	Metals, explosives, anions	Sump Removal at Building AP-5	1941-1945, 1951-1957, and 1969-1971: Building AP-5 utilized as a black powder dry house. Evaluate effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-004	5–6	Full suite, anions	West Sump Removal at Building AP-8	1941-1945, 1951-1957, and 1969-1971: Building AP-8 utilized for artillery primer loading and served as an administrative building. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-005	5–6	Full suite, anions	East Sump Removal at Building AP-8	1941-1945, 1951-1957, and 1969-1971: Building AP-8 utilized for artillery primer loading and served as an administrative building. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-006	0–1	Metals, VOCs	Drainage Ditch Excavation	Drainage ditch southeast of Building AP-3 (Black Powder Screening) excavated at LL11sd-027. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-007	1–2	Metals, VOCs	Drainage Ditch Excavation	Drainage ditch southeast of Building AP-3 (Black Powder Screening) excavated at LL11sd-027. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-008	1–2	Metals, VOCs	Drainage Ditch Excavation	Drainage ditch southeast of Building AP-3 (Black Powder Screening) excavated at LL11sd-027. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-009	1–2	Metals, VOCs	Drainage Ditch Excavation	Drainage ditch southeast of Building AP-3 (Black Powder Screening) excavated at LL11sd-027. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-010	0–1	Metals, VOCs	Drainage Ditch Excavation	Drainage ditch southeast of Building AP-3 (Black Powder Screening) excavated at LL11sd-027. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-011	0–1	Metals, VOCs	Drainage Ditch Excavation	Drainage ditch east of Building AP-4 (Black Powder Rest House) excavated at LL11sd-026. Evaluated effectiveness of excavation efforts during the IRA activities. QC sample collected.	None	Metals, black powder
LL11cs-012	1–2	Metals, VOCs	Drainage Ditch Excavation	Drainage ditch east of Building AP-4 (Black Powder Rest House) excavated at LL11sd-026. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-013	1–2	Metals, VOCs	Drainage Ditch Excavation	Drainage ditch east of Building AP-4 (Black Powder Rest House) excavated at LL11sd-026. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-014	1–2	Metals, VOCs	Drainage Ditch Excavation	Drainage ditch east of Building AP-4 (Black Powder Rest House) excavated at LL11sd-026. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-015	0–1	Metals, VOCs	Drainage Ditch Excavation	Drainage ditch east of Building AP-4 (Black Powder Rest House) excavated at LL11sd-026. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-016	0–1	VOCs, pesticides, PCBs, SVOCs	Drainage Ditch Excavation	Drainage ditch just north of Building AP-14 (Change House) excavated at LL11sd-032. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives
LL11cs-017	1–2	VOCs, pesticides, PCBs, SVOCs	Drainage Ditch Excavation	Drainage ditch just north of Building AP-14 (Change House) excavated at LL11sd-032. Evaluated effectiveness of excavation efforts during the IRA activities. QC sample collected.	None	Metals, explosives
LL11cs-018	1–2	VOCs, pesticides, PCBs, SVOCs	Drainage Ditch Excavation	Drainage ditch just north of Building AP-14 (Change House) excavated at LL11sd-032. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives
LL11cs-019	1–2	VOCs, pesticides, PCBs, SVOCs	Drainage Ditch Excavation	Drainage ditch just north of Building AP-14 (Change House) excavated at LL11sd-032. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives
LL11cs-020	0–1	VOCs, pesticides, PCBs, SVOCs	Drainage Ditch Excavation	Drainage ditch, on the south end of the AOC just east of the entrance road, excavated at LL11sd-013. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives
LL11cs-021	0–1	Metals	Drainage Ditch Excavation	Drainage ditch, on the south end of the AOC just east of the entrance road, excavated at LL11sd-013. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives
LL11cs-022	1–2	Metals	Drainage Ditch Excavation	Drainage ditch, on the south end of the AOC just east of the entrance road, excavated at LL11sd-013. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives
LL11cs-023	1–2	Metals	Drainage Ditch Excavation	Drainage ditch, on the south end of the AOC just east of the entrance road, excavated at LL11sd-013. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives
LL11cs-024	1–2	Metals	Drainage Ditch Excavation	Drainage ditch, on the south end of the AOC just east of the entrance road, excavated at LL11sd-013. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives
LL11cs-025	0–1	Metals	Drainage Ditch Excavation	Drainage ditch, on the south end of the AOC just east of the entrance road, excavated at LL11sd-013. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives

Table 4–1. IRA Confirmation Sample Locations (continued)

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
LL11cs-026	1–2	Metals	Drainage Ditch Excavation	Drainage ditch west Building AP-8 (artillery primer loading) excavated at LL11sd-033. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-027	1–2	Metals	Drainage Ditch Excavation	Drainage ditch west Building AP-8 (artillery primer loading) excavated at LL11sd-033. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-028	1–2	Metals	Drainage Ditch Excavation	Drainage ditch west Building AP-8 (artillery primer loading) excavated at LL11sd-033. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-029	1–2	Metals	Drainage Ditch Excavation	Drainage ditch west Building AP-8 (artillery primer loading) excavated at LL11sd-033. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-030	0–1	Metals	Drainage Ditch Excavation	Drainage ditch west Building AP-8 (artillery primer loading) excavated at LL11sd-033. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, black powder
LL11cs-031	0–1	Metals	Drainage Ditch Excavation	Drainage ditch north of Buildings AP-19 (dining hall) (also east of Building AP-17 [solvent storage], excavated at LL11sd-018 and LL11sd-019. Evaluated effectiveness of excavation efforts during the IRA activities. QC sample collected.	None	Metals, explosives, solvents
LL11cs-032	1–2	Metals	Drainage Ditch Excavation	Drainage ditch north of Buildings AP-19 (dining hall) (also east of Building AP-17 [solvent storage], excavated at LL11sd-018 and LL11sd-019. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives, solvents
LL11cs-033	1–2	Metals	Drainage Ditch Excavation	Drainage ditch north of Buildings AP-19 (dining hall) (also east of Building AP-17 [solvent storage], excavated at LL11sd-018 and LL11sd-019. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives, solvents
LL11cs-034	1–2	Metals	Drainage Ditch Excavation	Drainage ditch north of Buildings AP-19 (dining hall) (also east of Building AP-17 [solvent storage], excavated at LL11sd-018 and LL11sd-019. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives, solvents
LL11cs-035	1–2	Metals	Drainage Ditch Excavation	Drainage ditch north of Buildings AP-19 (dining hall) (also east of Building AP-17 [solvent storage], excavated at LL11sd-018 and LL11sd-019. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives, solvents
LL11cs-036	1–2	Metals	Drainage Ditch Excavation	Drainage ditch north of Buildings AP-19 (dining hall) (also east of Building AP-17 [solvent storage], excavated at LL11sd-018 and LL11sd-019. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives, solvents
LL11cs-037	1–2	Metals	Drainage Ditch Excavation	Drainage ditch north of Buildings AP-19 (dining hall) (also east of Building AP-17 [solvent storage], excavated at LL11sd-018 and LL11sd-019. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives, solvents
LL11cs-038	1–2	Metals	Drainage Ditch Excavation	Drainage ditch north of Buildings AP-19 (dining hall) (also east of Building AP-17 [solvent storage], excavated at LL11sd-018 and LL11sd-019. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives, solvents
LL11cs-039	0–1	Metals	Drainage Ditch Excavation	Drainage ditch north of Buildings AP-19 (dining hall) (also east of Building AP-17 [solvent storage], excavated at LL11sd-018 and LL11sd-019. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Metals, explosives, solvents
LL11cs-040	3–7	Full suite, anions, TPH-DRO/GRO	Hot Spot Excavation	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005. As a result of the contamination, LL11mw-005 was relocated approximately 50 ft northeast of the original location. Evaluated effectiveness of excavation efforts during the IRA activities. QC sample collected.	None	Solvents, petroleum
LL11cs-041	3–7	Full suite, anions, TPH-DRO/GRO	Hot Spot Excavation	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005. As a result of the contamination, LL11mw-005 was relocated approximately 50 ft northeast of the original location. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Solvents, petroleum
LL11cs-042	3–7	Full suite, anions, TPH-DRO/GRO	Hot Spot Excavation	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005. As a result of the contamination, LL11mw-005 was relocated approximately 50 ft northeast of the original location. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Solvents, petroleum
LL11cs-043	3–7	Full suite, anions, TPH-DRO/GRO	Hot Spot Excavation	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005. As a result of the contamination, LL11mw-005 was relocated approximately 50 ft northeast of the original location. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Solvents, petroleum
LL11cs-044	7–8	Full suite, anions, TPH-DRO/GRO	Hot Spot Excavation	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005. As a result of the contamination, LL11mw-005 was relocated approximately 50 ft northeast of the original location. Evaluated effectiveness of excavation efforts during the IRA activities.	None	Solvents, petroleum
LL11cs-045	7–8	Full suite, anions, TPH-DRO/GRO	Hot Spot Excavation	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at	None	Solvents, petroleum

Table 4–1. IRA Confirmation Sample Locations (continued)

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
				LL11sb-005 for installing LL11mw-005. As a result of the contamination, LL11mw-005 was relocated approximately 50 ft northeast of the original location. Evaluated effectiveness of excavation efforts during the IRA activities. QC sample collected.		
LL11cs-046	3–4	Full suite, anions, TPH-DRO/GRO	Test Pit Excavation	An area of high magnetometer readings was encountered by the UXO technicians north-northwest of the hot spot; while clearing the excavation area for the hot spot. During excavation of the hot spot, it was determined that the area needed to be assessed for UXO. Upon excavation, cable, scrap metal, bolts, and magnetite-containing rock were found. After excavation, and determining no UXO was present, the test trenches were backfilled and leveled to the original ground surface elevation. Confirmation samples collected.	None	Metals, explosives
LL11cs-047	3–4	Full suite, anions, TPH-DRO/GRO	Test Pit Excavation	An area of high magnetometer readings was encountered by the UXO technicians north-northwest of the hot spot; while clearing the excavation area for the hot spot. During excavation of the hot spot, it was determined that the area needed to be assessed for UXO. Upon excavation, cable, scrap metal, bolts, and magnetite-containing rock were found. After excavation, and determining no UXO was present, the test trenches were backfilled and leveled to the original ground surface elevation. Confirmation samples collected.	None	Metals, explosives
LL11cs-048	3–4	Full suite, anions, TPH-DRO/GRO	Test Pit Excavation	An area of high magnetometer readings was encountered by the UXO technicians north-northwest of the hot spot; while clearing the excavation area for the hot spot. During excavation of the hot spot, it was determined that the area needed to be assessed for UXO. Upon excavation, cable, scrap metal, bolts, and magnetite-containing rock were found. After excavation, and determining no UXO was present, the test trenches were backfilled and leveled to the original ground surface elevation. Confirmation samples collected.	None	Metals, explosives
LL11cs-049	3–4	Full suite, anions, TPH-DRO/GRO	Test Pit Excavation	An area of high magnetometer readings was encountered by the UXO technicians north-northwest of the hot spot; while clearing the excavation area for the hot spot. During excavation of the hot spot, it was determined that the area needed to be assessed for UXO. Upon excavation, cable, scrap metal, bolts, and magnetite-containing rock were found. After excavation, and determining no UXO was present, the test trenches were backfilled and leveled to the original ground surface elevation. Confirmation samples collected.	None	Metals, explosives
LL11cs-050	3–4	Metals, explosives, pesticides, PCBs, SVOCs, anions, TPH-DRO/GRO	Test Pit Excavation	An area of high magnetometer readings was encountered by the UXO technicians north-northwest of the hot spot; while clearing the excavation area for the hot spot. During excavation of the hot spot, it was determined that the area needed to be assessed for UXO. Upon excavation, cable, scrap metal, bolts, and magnetite-containing rock were found. After excavation, and determining no UXO was present, the test trenches were backfilled and leveled to the original ground surface elevation. Confirmation samples collected.	None	Metals, explosives

AOC = Area of concern.
bgs = Below ground surface.
ft = Feet.
IRA = Interim remedial action.
PCB = Polychlorinated biphenyl.
QC= Quality control.
RI = Remedial investigation.
SVOC = Semi-volatile organic compound.
TPH-GRO/DRO = Total petroleum hydrocarbons/gasoline range organics/diesel range organics.
UXO = Unexploded ordnance.
VOC = Volatile organic compound.

Table 4–2. Analytes Detected in IRA Confirmation Surface Soil Samples

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**NPA**
Station		**LL11cs-006**	**LL11cs-010**	**LL11cs-011**	**LL11cs-011**	**LL11cs-016**	**LL11cs-020**	**LL11cs-021**	**LL11cs-025**	**LL11cs-030**	**LL11cs-039**
Sample ID		**LL11cs-006-0001-SD**	**LL11cs-010-0001-SD**	**LL11cs-011-0001-FD**	**LL11cs-011-0001-SD**	**LL11cs-016-0001-SD**	**LL11cs-020-0001-SO**	**LL11cs-021-0001-SD**	**LL11cs-025-0001-SD**	**LL11cs-030-0001-SD**	**LL11cs-039-0001-SD**
Date		**03/21/01**	**03/21/01**	**03/23/01**	**03/23/01**	**03/23/01**	**03/23/01**	**03/21/01**	**03/21/01**	**03/21/01**	**03/20/01**
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	**Background Criteria**	**TAL Metals, VOCs**	**TAL Metals, VOCs**	**TAL Metals, VOCs**	**TAL Metals, VOCs**	**Pesticides/PCBs, SVOCs, VOCs**	**Pesticides/PCBs, SVOCs, VOCs**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**
Analyte											
Metals (mg/kg)											
Aluminum	17700	14500	9340	**18300***	**23600***	NR	NR	13400	**23800***	13600	7940
Antimony	0.96	<0.32U	<0.23U	**1.1***	0.5	NR	NR	<0.37U	0.46	<0.26U	<0.32U
Arsenic	15.4	9.3	15	14.9	**22.6***	NR	NR	8.2	8.8	10.9	<4.3U
Barium	88.4	81.8	52	62.5	70.6	NR	NR	68.5	**94.7***	65.8	61.1
Beryllium	0.88	0.72	0.49	0.69	0.84	NR	NR	0.7	**1.1***	0.56	0.61
Cadmium	0	**0.71***	**0.33***	<0.19U	<0.16U	NR	NR	**0.44***	**0.58***	<0.2U	**0.57***
Calcium	15800	2860	1790	1740	1490	NR	NR	3220	3660	3610	2160
Chromium	17.4	**20.4***	13.9	**23.2***	**28.4***	NR	NR	15.7	**26.3***	**18.1***	10.8
Cobalt	10.4	9.7	**10.6***	7.4	7.4	NR	NR	9.9	**16.6***	5.6	**10.7***
Copper	17.7	**21.9***	16.1	**19.2***	**23.8***	NR	NR	14.6	**27.9***	9.8	9.3
Cyanide	0	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Iron	23100	23000	21300	**25600***	**38300***	NR	NR	16400	**27000***	**25100***	20600
Lead	26.1	**102***	**31.2***	26.1	17	NR	NR	**26.8***	**42.4***	12.4	<8.6U
Magnesium	3030	**3600***	2740	**3800***	**4450***	NR	NR	1830	2940	**3550***	1500
Manganese	1450	283	356	211	147	NR	NR	410	342	260	443
Mercury	0.036	**0.074***	<0.042U	**0.049***	<0.043U	NR	NR	**0.07***	**0.08***	<0.043U	<0.048U
Nickel	21.1	**23.7***	20.9	20.5	**22.6***	NR	NR	17	**33.2***	15.4	12
Potassium	927	**1950***	**1480***	**2150***	**2910***	NR	NR	**1500***	**2660***	**1620***	675
Selenium	1.4	<0.64U	<0.48U	0.61	0.94	NR	NR	0.63	1.3	0.55	0.86
Sodium	123	**232***	**172***	**827***	**943***	NR	NR	**189***	**278***	**185***	**655***
Thallium	0	<0.21U	<0.15U	<0.22U	**0.21***	NR	NR	<0.25U	<0.28U	<0.17U	<0.21U
Vanadium	31.1	25.8	16.8	30.3	**38.8***	NR	NR	22	**32***	25.2	20.9
Zinc	61.8	**137***	**71.3***	**75.5***	**63.8***	NR	NR	**219***	**465***	55.2	**176***
Anions (mg/kg)											
Nitrate	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Sulfide	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Explosives and Propellants (mg/kg)											
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Nitroguanidine	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)											
Benz(a)anthracene	None	NR	NR	NR	NR	<0.53U	**0.27J***	NR	NR	NR	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	**0.16J***	**0.34J***	NR	NR	NR	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	<0.53U	**0.39J***	NR	NR	NR	NR
Benzo(ghi)perylene	None	NR	NR	NR	NR	<0.53U	**0.24J***	NR	NR	NR	NR
Benzo(k)fluoranthene	None	NR	NR	NR	NR	<0.53U	<0.51U	NR	NR	NR	NR
Chrysene	None	NR	NR	NR	NR	**0.17J***	**0.34J***	NR	NR	NR	NR
Fluoranthene	None	NR	NR	NR	NR	**0.29J***	**0.6***	NR	NR	NR	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	NR	<0.53U	**0.27J***	NR	NR	NR	NR
Phenanthrene	None	NR	NR	NR	NR	<0.53U	**0.26J***	NR	NR	NR	NR
Pyrene	None	NR	NR	NR	NR	<0.53U	**0.67***	NR	NR	NR	NR

Table 4–2. Analytes Detected in IRA Confirmation Surface Soil Samples (continued)

Aggregate		FPA	FPA	FPA	FPA	FPA	FPA	FPA	FPA	FPA	NPA
Station		**LL11cs-006**	**LL11cs-010**	**LL11cs-011**	**LL11cs-011**	**LL11cs-016**	**LL11cs-020**	**LL11cs-021**	**LL11cs-025**	**LL11cs-030**	**LL11cs-039**
Sample ID		**LL11cs-006-0001-SD**	**LL11cs-010-0001-SD**	**LL11cs-011-0001-FD**	**LL11cs-011-0001-SD**	**LL11cs-016-0001-SD**	**LL11cs-020-0001-SO**	**LL11cs-021-0001-SD**	**LL11cs-025-0001-SD**	**LL11cs-030-0001-SD**	**LL11cs-039-0001-SD**
Date		**03/21/01**	**03/21/01**	**03/23/01**	**03/23/01**	**03/23/01**	**03/23/01**	**03/21/01**	**03/21/01**	**03/21/01**	**03/20/01**
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	**Background Criteria**	**TAL Metals, VOCs**	**TAL Metals, VOCs**	**TAL Metals, VOCs**	**TAL Metals, VOCs**	**Pesticides/PCBs, SVOCs, VOCs**	**Pesticides/PCBs, SVOCs, VOCs**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**
Analyte											
Pesticides/PCBs (mg/kg)											
PCB-1254	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
gamma-Chlordane	None	NR	NR	NR	NR	<0.0064U	<0.0064U	NR	NR	NR	NR
VOCs (mg/kg)											
Acetone	None	**0.008***	<0.006U	<0.007U	<0.007U	<0.008U	<0.008U	NR	NR	NR	NR

FPA = Former Production Area.
ft = Feet.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
NPA= Non-production Area.
NR = Not reported/not analyzed.
PCB = Polychlorinated biphenyl.
SVOC = Semi-volatile organic compound.
TAL = Target analyte list.
U = Not detected.
VOC = Volatile organic compound.
*** = Result exceeds background criteria or no background criteria was available.**
< = Less than.

Table 4–3. Analytes Detected in IRA Confirmation Subsurface Soil Samples

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL11cs-001**	**LL11cs-002**	**LL11cs-002**	**LL11cs-003**	**LL11cs-004**	**LL11cs-005**	**LL11cs-007**	**LL11cs-008**	**LL11cs-009**
Sample ID		**LL11cs-001-0001-SO**	**LL11cs-002-0001-FD**	**LL11cs-002-0001-SO**	**LL11cs-003-0001-SO**	**LL11cs-004-0001-SO**	**LL11cs-005-0001-SO**	**LL11cs-007-0001-SO**	**LL11cs-008-0001-SO**	**LL11cs-009-0001-SO**
Date		**01/24/01**	**01/26/01**	**01/26/01**	**01/26/01**	**02/21/01**	**02/21/01**	**03/21/01**	**03/21/01**	**03/21/01**
Depth (ft)		**5.0 - 6.0**	**5.0 - 6.0**	**5.0 - 6.0**	**5.0 - 6.0**	**5.0 - 6.0**	**5.0 - 6.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**
Parameters Analyzed		**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals, VOCs**	**TAL Metals, VOCs**	**TAL Metals, VOCs**
Analyte	**Background Criteria**									
Metals (mg/kg)										
Aluminum	19500	7750	12800	15000	12400	7450	12500	6910	13600	11700
Antimony	0.96	0.41	0.24	0.91	<0.22U	0.28	0.35	<0.21U	<0.24U	<0.23U
Arsenic	19.8	8.4	11.2	6.3	13.8	17.5	17.4	12.5	13.7	16.6
Barium	124	40.4	73.1	74.6	65.8	27.7	81.9	32.1	62.4	55.2
Beryllium	0.88	0.38	0.57	0.6	0.49	0.45	0.7	<0.3U	0.58	0.54
Cadmium	0	**0.47***	**0.26***	<0.16U	**0.19***	<0.15U	<0.15U	<0.15U	<0.17U	<0.19U
Calcium	35500	24000	11000	10300	7610	1190	1770	1080	1870	13800
Chromium	27.2	9.8	16.2	17.6	13.9	11.3	16.8	11	16.7	17.5
Cobalt	23.2	5.6	10.1	9.2	8	7.9	7.6	5.6	9.4	8.6
Copper	32.3	18.5	20	18.2	17.2	19.7	17.6	15.1	17.4	22.7
Cyanide	0	<0.54U	<0.4U	<0.5U	<0.47U	<0.0059U	<0.0058U	NR	NR	NR
Iron	35200	17000	23000	23100	21600	21300	20800	18300	22500	25400
Lead	19.1	**31.7***	**39***	**61.4***	**28.1***	11.1	12.7	11.5	16	**20.2***
Magnesium	8790	7270	4040	4160	3160	2490	2930	1890	3300	5730
Manganese	3030	422	353	336	369	222	313	294	300	249
Mercury	0.044	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.039U	<0.043U	<0.04U
Nickel	60.7	14.2	21	21.4	20	19.4	22.5	13.7	20.6	23.8
Potassium	3350	1370	1850	2330	1580	1470	1800	977	1800	1820
Selenium	1.5	<0.33U	<0.04U	0.44	<0.34U	0.48	<0.38U	<0.38U	<0.43U	<0.47U
Sodium	145	91.7	115	117	83.6	<73.4U	108	121	**207***	**198***
Thallium	0.91	<0.13U	0.17	<0.16U	<0.15U	<0.14U	<0.15U	<0.14U	<0.16U	0.19
Vanadium	37.6	15.3	23.2	25.9	22.9	13.4	20.4	11.2	22.8	19
Zinc	93.3	78.9	85.9	63.5	66.7	79.2	59	40.1	51.9	57.3
Anions (mg/kg)										
Nitrate	None	<0.73U	**5.8***	**1***	**4.5***	<0.075U	**15***	NR	NR	NR
Sulfate	None	<16.1U	<17.9U	<17.8U	<15.4U	**21***	**19.9***	NR	NR	NR
Sulfide	None	**15.1***	**43.9***	**48.4***	**18.7***	<8.6U	<8.5U	NR	NR	NR
Miscellaneous (mg/kg)										
TPH-DRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
TPH-GRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Explosives/Propellants (mg/kg)										
Nitrocellulose	None	NR	NR	NR	NR	1.7*	1.7*	NR	NR	NR
SVOCs (mg/kg)										
Benz(a)anthracene	None	NR	<0.42U	<0.42U	NR	<0.38U	<0.38U	NR	NR	NR
Benzo(a)pyrene	None	NR	0.15J*	<0.42U	NR	<0.38U	<0.38U	NR	NR	NR
Benzo(b)fluoranthene	None	NR	<0.42U	<0.42U	NR	<0.38U	<0.38U	NR	NR	NR
Chrysene	None	NR	<0.42U	<0.42U	NR	<0.38U	<0.38U	NR	NR	NR
Fluoranthene	None	NR	<0.42U	<0.42U	NR	<0.38U	<0.38U	NR	NR	NR
Phenanthrene	None	NR	<0.42U	<0.42U	NR	<0.38U	<0.38U	NR	NR	NR
Pyrene	None	NR	<0.42U	<0.42U	NR	<0.38U	<0.38U	NR	NR	NR

Table 4–3. Analytes Detected in IRA Confirmation Subsurface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL11cs-001**	**LL11cs-002**	**LL11cs-002**	**LL11cs-003**	**LL11cs-004**	**LL11cs-005**	**LL11cs-007**	**LL11cs-008**	**LL11cs-009**
Sample ID		**LL11cs-001-0001-SO**	**LL11cs-002-0001-FD**	**LL11cs-002-0001-SO**	**LL11cs-003-0001-SO**	**LL11cs-004-0001-SO**	**LL11cs-005-0001-SO**	**LL11cs-007-0001-SO**	**LL11cs-008-0001-SO**	**LL11cs-009-0001-SO**
Date		**01/24/01**	**01/26/01**	**01/26/01**	**01/26/01**	**02/21/01**	**02/21/01**	**03/21/01**	**03/21/01**	**03/21/01**
Depth (ft)		**5.0 - 6.0**	**5.0 - 6.0**	**5.0 - 6.0**	**5.0 - 6.0**	**5.0 - 6.0**	**5.0 - 6.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**
Parameters Analyzed		**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals, VOCs**	**TAL Metals, VOCs**	**TAL Metals, VOCs**
Analyte	**Background Criteria**									
Pesticides/PCBs (mg/kg)										
PCB-1254	None	NR	**0.16***	**0.023***	NR	<0.0097U	<0.0096U	NR	NR	NR
VOCs (mg/kg)										
Acetone	None	NR	**0.019***	<0.006U	NR	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U
Carbon tetrachloride	None	NR	<0.006U	<0.006U	NR	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U
Toluene	None	NR	<0.006U	<0.006U	NR	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U

Table 4–3. Analytes Detected in IRA Confirmation Subsurface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL11cs-012**	**LL11cs-017**	**LL11cs-017**	**LL11cs-018**	**LL11cs-019**	**LL11cs-022**	**LL11cs-023**	**LL11cs-024**	**LL11cs-026**
Sample ID		**LL11cs-012-0001-SO**	**LL11cs-017-0001-FD**	**LL11cs-017-0001-SO**	**LL11cs-018-0001-SO**	**LL11cs-019-0001-SO**	**LL11cs-022-0001-SO**	**LL11cs-023-0001-SO**	**LL11cs-024-0001-SO**	**LL11cs-026-0001-SD**
Date		**03/23/01**	**03/23/01**	**03/23/01**	**03/23/01**	**03/23/01**	**03/21/01**	**03/21/01**	**03/21/01**	**03/21/01**
Depth (ft)		**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**
Parameters Analyzed										
Analyte	**Background Criteria**	**TAL Metals, VOCs**	**Pesticides/PCBs, SVOCs, VOCs**	**Pesticides/PCBs, SVOCs, VOCs**	**Pesticides/PCBs, SVOCs, VOCs**	**Pesticides/PCBs, SVOCs, VOCs**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**
Metals (mg/kg)										
Aluminum	19500	12100	NR	NR	NR	NR	6260	15700	13200	12900
Antimony	0.96	<0.32U	NR	NR	NR	NR	<0.23U	<0.23U	<0.23U	0.5
Arsenic	19.8	7.5	NR	NR	NR	NR	15.7	11.5	11.3	11.6
Barium	124	**127***	NR	NR	NR	NR	35.9	82.8	58.8	89.4
Beryllium	0.88	**1.2***	NR	NR	NR	NR	<0.32U	**0.99***	0.47	**1.2***
Cadmium	0	<0.15U	NR	NR	NR	NR	<0.16U	<0.19U	<0.19U	**0.24***
Calcium	35500	1030	NR	NR	NR	NR	408	1020	745	12300
Chromium	27.2	16.1	NR	NR	NR	NR	8.8	21.9	16	14.1
Cobalt	23.2	12.5	NR	NR	NR	NR	6.4	13.9	6.9	6.8
Copper	32.3	22.8	NR	NR	NR	NR	19.4	26	16.1	12.6
Cyanide	0	NR	NR	NR	NR	NR	NR	NR	NR	NR
Iron	35200	26900	NR	NR	NR	NR	18700	**47600***	20800	18500
Lead	19.1	9	NR	NR	NR	NR	17.3	10.8	7.8	**26.2***
Magnesium	8790	3750	NR	NR	NR	NR	1650	3780	2310	5430
Manganese	3030	673	NR	NR	NR	NR	592	1030	203	654
Mercury	0.044	<0.039U	NR	NR	NR	NR	<0.039U	<0.039U	<0.041U	<0.048U
Nickel	60.7	36	NR	NR	NR	NR	13.9	27.9	15.7	13.4
Potassium	3350	2080	NR	NR	NR	NR	883	2700	1640	1430
Selenium	1.5	<0.37U	NR	NR	NR	NR	<0.4U	<0.47U	<0.48U	0.9
Sodium	145	**1010***	NR	NR	NR	NR	122	**245***	**155***	**241***
Thallium	0.91	<0.21U	NR	NR	NR	NR	<0.16U	<0.15U	<0.16U	<0.19U
Vanadium	37.6	20.8	NR	NR	NR	NR	10.2	26.5	20.5	18.1
Zinc	93.3	62.9	NR	NR	NR	NR	54.8	67.5	51.8	65.8
Anions (mg/kg)										
Nitrate	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Sulfate	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Sulfide	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Miscellaneous (mg/kg)										
TPH-DRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
TPH-GRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Explosives/Propellants (mg/kg)										
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)										
Benz(a)anthracene	None	NR	<0.39U	<0.39U	<0.39U	**0.17J***	NR	NR	NR	NR
Benzo(a)pyrene	None	NR	<0.39U	<0.39U	<0.39U	**0.2J***	NR	NR	NR	NR
Benzo(b)fluoranthene	None	NR	<0.39U	<0.39U	<0.39U	**0.22J***	NR	NR	NR	NR
Chrysene	None	NR	<0.39U	<0.39U	<0.39U	**0.21J***	NR	NR	NR	NR
Fluoranthene	None	NR	<0.39U	<0.39U	<0.39U	**0.33J***	NR	NR	NR	NR
Phenanthrene	None	NR	<0.39U	<0.39U	<0.39U	**0.17J***	NR	NR	NR	NR
Pyrene	None	NR	<0.39U	<0.39U	<0.39U	**0.41J***	NR	NR	NR	NR

Table 4–3. Analytes Detected in IRA Confirmation Subsurface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL11cs-012**	**LL11cs-017**	**LL11cs-017**	**LL11cs-018**	**LL11cs-019**	**LL11cs-022**	**LL11cs-023**	**LL11cs-024**	**LL11cs-026**
Sample ID		**LL11cs-012-0001-SO**	**LL11cs-017-0001-FD**	**LL11cs-017-0001-SO**	**LL11cs-018-0001-SO**	**LL11cs-019-0001-SO**	**LL11cs-022-0001-SO**	**LL11cs-023-0001-SO**	**LL11cs-024-0001-SO**	**LL11cs-026-0001-SD**
Date		**03/23/01**	**03/23/01**	**03/23/01**	**03/23/01**	**03/23/01**	**03/21/01**	**03/21/01**	**03/21/01**	**03/21/01**
Depth (ft)		**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**
Parameters Analyzed		**TAL Metals, VOCs**	**Pesticides/PCBs, SVOCs, VOCs**	**Pesticides/PCBs, SVOCs, VOCs**	**Pesticides/PCBs, SVOCs, VOCs**	**Pesticides/PCBs, SVOCs, VOCs**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**
Analyte	**Background Criteria**									
Pesticides/PCBs (mg/kg)										
PCB-1254	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
VOCs (mg/kg)										
Acetone	None	<0.006U	<0.006U	<0.006U	<0.006U	<0.007U	NR	NR	NR	NR
Carbon tetrachloride	None	<0.006U	<0.006U	<0.006U	<0.006U	<0.007U	NR	NR	NR	NR
Toluene	None	<0.006U	<0.006U	<0.006U	<0.006U	<0.007U	NR	NR	NR	NR

Table 4–3. Analytes Detected in IRA Confirmation Subsurface Soil Samples (continued)

Aggregate	**Background Criteria**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11cs-027**	**LL11cs-028**	**LL11cs-029**	**LL11cs-032**	**LL11cs-033**	**LL11cs-013**	**LL11cs-014**	**LL11cs-034**	**LL11cs-035**
Sample ID		**LL11cs-027-0001-SO**	**LL11cs-028-0001-SO**	**LL11cs-029-0001-SO**	**LL11cs-032-0001-SO**	**LL11cs-033-0001-SO**	**LL11cs-013-0001-SO**	**LL11cs-014-0001-SO**	**LL11cs-034-0001-SO**	**LL11cs-035-0001-SO**
Date		**03/21/01**	**03/21/01**	**03/21/01**	**03/20/01**	**03/20/01**	**03/23/01**	**03/23/01**	**03/20/01**	**03/20/01**
Depth (ft)		**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**
Parameters Analyzed		**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals, VOCs**	**TAL Metals, VOCs**	**TAL Metals**	**TAL Metals**
Analyte										
Metals (mg/kg)										
Aluminum	19500	15800	14500	10500	9150	13900	**24500***	13800	13400	12200
Antimony	0.96	0.34	0.51	0.26	<0.29U	<0.28U	<0.35U	<0.32U	<0.28U	<0.28U
Arsenic	19.8	11.9	15.1	15	<3.8U	<1.9U	<2.3U	6	<1.9U	<3.8U
Barium	124	79	95.3	68.7	72	52.8	**167***	71	87.8	41.6
Beryllium	0.88	0.53	0.7	0.53	0.51	0.5	**1.3***	0.8	0.73	0.69
Cadmium	0	<0.2U	<0.16U	<0.18U	<0.19U	<0.18U	<0.19U	**0.37***	**0.38***	**0.22***
Calcium	35500	922	1440	2680	392	1240	2880	3200	1970	930
Chromium	27.2	16.7	18.5	14.8	10.5	19.5	24.3	17.1	15.8	16.5
Cobalt	23.2	8	12.1	9.5	12.6	5.5	3.3	11.7	10	8.9
Copper	32.3	16.8	20.5	21.8	19.4	18.6	25.2	21.6	13.1	25.6
Cyanide	0	NR	NR	NR	NR	NR	NR	NR	NR	NR
Iron	35200	20400	31200	25100	22300	23100	9560	20300	25800	29800
Lead	19.1	7.6	9.2	13.2	<1.9U	<1.9U	12.3	**26.4***	<1.9U	<1.9U
Magnesium	8790	2670	2850	3770	1920	2950	2380	2890	2380	2940
Manganese	3030	180	1140	508	488	102	103	201	861	242
Mercury	0.044	<0.04U	<0.04U	<0.039U	<0.043U	<0.041U	<0.043U	**0.054***	<0.044U	<0.039U
Nickel	60.7	17.7	23.8	27.1	15.7	17.2	12.2	24.7	17.1	21.4
Potassium	3350	1820	2260	1600	872	1330	2600	1680	1480	1470
Selenium	1.5	<0.49U	<0.4U	<0.45U	0.6	<0.44U	<0.48U	1.1	0.85	<0.43U
Sodium	145	**172***	**182***	**193***	**623***	**928***	**951***	**831***	**923***	**1050***
Thallium	0.91	<0.16U	<0.16U	<0.15U	<0.19U	<0.19U	<0.23U	0.22	<0.19U	<0.19U
Vanadium	37.6	21.7	24.9	16.9	16.3	22.6	30.2	22.7	25.6	20.3
Zinc	93.3	57.4	62.3	59.5	47.2	57.3	77.8	**201***	**147***	61.8
Anions (mg/kg)										
Nitrate	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Sulfate	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Sulfide	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Miscellaneous (mg/kg)										
TPH-DRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
TPH-GRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Explosives/Propellants (mg/kg)										
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)										
Benz(a)anthracene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Chrysene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Phenanthrene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pyrene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 4–3. Analytes Detected in IRA Confirmation Subsurface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11cs-027**	**LL11cs-028**	**LL11cs-029**	**LL11cs-032**	**LL11cs-033**	**LL11cs-013**	**LL11cs-014**	**LL11cs-034**	**LL11cs-035**
Sample ID		**LL11cs-027-0001-SO**	**LL11cs-028-0001-SO**	**LL11cs-029-0001-SO**	**LL11cs-032-0001-SO**	**LL11cs-033-0001-SO**	**LL11cs-013-0001-SO**	**LL11cs-014-0001-SO**	**LL11cs-034-0001-SO**	**LL11cs-035-0001-SO**
Date		**03/21/01**	**03/21/01**	**03/21/01**	**03/20/01**	**03/20/01**	**03/23/01**	**03/23/01**	**03/20/01**	**03/20/01**
Depth (ft)		**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**
Parameters Analyzed										
Analyte	**Background Criteria**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**TAL Metals, VOCs**	**TAL Metals, VOCs**	**TAL Metals**	**TAL Metals**
					Pesticides/PCBs (mg/kg)					
PCB-1254	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
					VOCs (mg/kg)					
Acetone	None	NR	NR	NR	NR	NR	<0.007U	<0.008U	NR	NR
Carbon tetrachloride	None	NR	NR	NR	NR	NR	<0.007U	<0.008U	NR	NR
Toluene	None	NR	NR	NR	NR	NR	<0.007U	<0.008U	NR	NR

Table 4–3. Analytes Detected in IRA Confirmation Subsurface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11cs-036**	**LL11cs-037**	**LL11cs-038**	**LL11cs-040**	**LL11cs-040**	**LL11cs-041**	**LL11cs-042**	**LL11cs-043**	**LL11cs-044**
Sample ID		**LL11cs-036-0001-SO**	**LL11cs-037-0001-SO**	**LL11cs-038-0001-SO**	**LL11cs-040-0001-FD**	**LL11cs-040-0001-SO**	**LL11cs-041-0001-SO**	**LL11cs-042-0001-SO**	**LL11cs-043-0001-SO**	**LL11cs-044-0001-SO**
Date		**03/20/01**	**03/20/01**	**03/20/01**	**03/22/01**	**03/22/01**	**03/22/01**	**03/22/01**	**03/22/01**	**03/22/01**
Depth (ft)		**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**3.0 - 7.0**	**3.0 - 7.0**	**3.0 - 7.0**	**3.0 - 7.0**	**3.0 - 7.0**	**7.0 - 8.0**
Parameters Analyzed		**TAL Metals**	**TAL Metals**	**TAL Metals**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**
Analyte	**Background Criteria**									
Metals (mg/kg)										
Aluminum	19500	9250	8960	6670	11400	12100	8170	9500	9380	4900
Antimony	0.96	<0.29U	<0.25U	<0.27U	<0.27U	<0.28U	<0.27U	<0.26U	<0.27U	<0.28U
Arsenic	19.8	<1.9U	<1.7U	<1.8U	19.7	16.2	17.3	16.1	15.6	13.6
Barium	124	83.2	33.7	27.1	30.9	32.2	26.7	33.3	30.6	28.2
Beryllium	0.88	0.58	0.47	<0.36U	0.41	0.42	0.34	0.38	0.38	<0.37U
Cadmium	0	**0.31***	<0.18U	<0.18U	<0.18U	<0.2U	<0.17U	<0.18U	<0.17U	<0.18U
Calcium	35500	823	508	620	688	762	216	489	435	162
Chromium	27.2	13.3	12.5	8.5	12.1	12.6	9.3	12	11.5	5.9
Cobalt	23.2	**24.7***	6.7	3.4	7.2	7.8	6.7	7	6.2	4.9
Copper	32.3	20.5	18.4	6	20.5	22.4	18.4	18	17.7	14.4
Cyanide	0	NR	NR	NR	**0.018***	**0.015***	<0.0053U	<0.0044U	<0.0052U	<0.0052U
Iron	35200	24300	22400	14800	22400	22700	17800	19900	18600	13700
Lead	19.1	<1.9U	<1.7U	<1.8U	11.4	15.4	9.3	9.5	9.9	8.2
Magnesium	8790	2730	2190	1800	2020	2120	1580	2220	1930	1060
Manganese	3030	1930	218	165	304	341	324	274	222	228
Mercury	0.044	<0.038U	<0.039U	<0.04U	<0.04U	<0.04U	<0.04U	<0.041U	<0.04U	<0.041U
Nickel	60.7	33.5	16.9	10.6	14.2	15	12.2	15.8	13.5	10.6
Potassium	3350	1090	1020	688	831	942	873	1010	1080	691
Selenium	1.5	<0.43U	0.63	0.78	<0.46U	<0.51U	<0.42U	<0.45U	<0.43U	<0.46U
Sodium	145	**807***	**724***	**608***	<18.2U	<20.4U	<16.7U	<18.1U	<17.2U	<18.3U
Thallium	0.91	<0.19U	<0.17U	<0.18U	<0.18U	<0.19U	<0.18U	<0.17U	<0.18U	<0.18U
Vanadium	37.6	14.8	15.1	13.5	19.4	20.6	13.6	14.8	15.1	9.1
Zinc	93.3	60.6	50.9	29	48.7	51.9	48.3	53.8	49.7	48.7
Anions (mg/kg)										
Nitrate	None	NR	NR	NR	**0.44***	**0.88***	**0.72***	**0.48***	**0.4***	**0.62***
Sulfate	None	NR	NR	NR	**27.8***	**23.1***	**40***	**19.8***	**18.1***	**29.9***
Sulfide	None	NR	NR	NR	**16.3***	<8.9U	<8.9U	<9U	<9.3U	<8.9U
Miscellaneous (mg/kg)										
TPH-DRO	None	NR	NR	NR	<7.2U	<7.4U	<7.2U	<7.6U	**34***	<7.4U
TPH-GRO	None	NR	NR	NR	<0.061U	<0.061U	<0.06U	<0.062U	**0.054J***	<0.061U
Explosives/Propellants (mg/kg)										
Nitrocellulose	None	NR	NR	NR	**0.46***	**1.5***	0.77*	0.86*	**0.83***	**0.97***
SVOCs (mg/kg)										
Benz(a)anthracene	None	NR	NR	NR	<0.39U	<0.39U	<0.39U	<0.4U	<0.4U	<0.4U
Benzo(a)pyrene	None	NR	NR	NR	<0.39U	<0.39U	<0.39U	<0.4U	**0.12J***	<0.4U
Benzo(b)fluoranthene	None	NR	NR	NR	<0.39U	<0.39U	<0.39U	<0.4U	<0.4U	<0.4U
Chrysene	None	NR	NR	NR	<0.39U	<0.39U	<0.39U	<0.4U	<0.4U	<0.4U
Fluoranthene	None	NR	NR	NR	<0.39U	<0.39U	<0.39U	<0.4U	**0.16J***	<0.4U
Phenanthrene	None	NR	NR	NR	<0.39U	<0.39U	<0.39U	<0.4U	<0.4U	<0.4U
Pyrene	None	NR	NR	NR	<0.39U	<0.39U	<0.39U	<0.4U	<0.4U	<0.4U

Table 4–3. Analytes Detected in IRA Confirmation Subsurface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11cs-036**	**LL11cs-037**	**LL11cs-038**	**LL11cs-040**	**LL11cs-040**	**LL11cs-041**	**LL11cs-042**	**LL11cs-043**	**LL11cs-044**
Sample ID		**LL11cs-036-0001-SO**	**LL11cs-037-0001-SO**	**LL11cs-038-0001-SO**	**LL11cs-040-0001-FD**	**LL11cs-040-0001-SO**	**LL11cs-041-0001-SO**	**LL11cs-042-0001-SO**	**LL11cs-043-0001-SO**	**LL11cs-044-0001-SO**
Date		**03/20/01**	**03/20/01**	**03/20/01**	**03/22/01**	**03/22/01**	**03/22/01**	**03/22/01**	**03/22/01**	**03/22/01**
Depth (ft)		**1.0 - 2.0**	**1.0 - 2.0**	**1.0 - 2.0**	**3.0 - 7.0**	**3.0 - 7.0**	**3.0 - 7.0**	**3.0 - 7.0**	**3.0 - 7.0**	**7.0 - 8.0**
Parameters Analyzed										
Analyte	**Background Criteria**	**TAL Metals**	**TAL Metals**	**TAL Metals**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**
Pesticides/PCBs (mg/kg)										
PCB-1254	None	NR	NR	NR	<0.01U	<0.01U	<0.0099U	<0.01U	<0.01U	<0.01U
VOCs (mg/kg)										
Acetone	None	NR	NR	NR	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U
Carbon tetrachloride	None	NR	NR	NR	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U
Toluene	None	NR	NR	NR	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U

Table 4–3. Analytes Detected in IRA Confirmation Subsurface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11cs-045**	**LL11cs-045**	**LL11cs-046**	**LL11cs-047**	**LL11cs-048**	**LL11cs-049**	**LL11cs-050**
Sample ID		**LL11cs-045-0001-FD**	**LL11cs-045-0001-SO**	**LL11cs-046-0001-SO**	**LL11cs-047-0001-SO**	**LL11cs-048-0001-SO**	**LL11cs-049-0001-SO**	**LL11cs-050-0001-SO**
Date		**03/22/01**	**03/22/01**	**03/22/01**	**03/22/01**	**03/22/01**	**03/22/01**	**03/22/01**
Depth (ft)		**7.0 - 8.0**	**7.0 - 8.0**	**3.0 - 4.0**	**3.0 - 4.0**	**3.0 - 4.0**	**3.0 - 4.0**	**3.0 - 4.0**
Parameters Analyzed		**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs**
Analyte	**Background Criteria**							
Metals (mg/kg)								
Aluminum	19500	7620	7030	11500	9980	10500	12600	13200
Antimony	0.96	<0.25U	<0.28U	<0.26U	<0.24U	<0.26U	<0.26U	0.39
Arsenic	19.8	**36.4***	**44.1***	9.6	13.9	13.6	10.4	**33.6***
Barium	124	83.7	82.3	80	36.2	40.6	57.4	**4190***
Beryllium	0.88	0.39	<0.38U	0.61	0.37	0.35	0.44	**3.2***
Cadmium	0	<0.19U	<0.19U	<0.19U	<0.16U	<0.17U	<0.17U	<0.25U
Calcium	35500	271	246	1500	682	655	983	4730
Chromium	27.2	10.9	10.1	12.3	10.6	11.4	14.7	14.1
Cobalt	23.2	14.7	17.4	8.1	6.8	7.5	8.4	5.5
Copper	32.3	20.2	18.5	9.2	11.4	10.8	9.6	**62.3***
Cyanide	0	<0.0045U	<0.0044U	**0.1***	**0.0097***	**0.046***	**0.051***	**0.25***
Iron	35200	27500	27500	16800	17400	16200	18900	**54800***
Lead	19.1	17.9	9.5	17.7	10	8.2	17.3	**160***
Magnesium	8790	1970	1970	1840	1890	1970	2440	786
Manganese	3030	1420	1630	1040	411	394	598	173
Mercury	0.044	<0.041U	<0.04U	**0.047***	<0.037U	<0.039U	<0.04U	<0.045U
Nickel	60.7	23.5	25.1	13.5	12.4	11.3	13.5	10.9
Potassium	3350	1190	1060	896	834	1050	1050	1130
Selenium	1.5	<0.48U	<0.47U	0.56	<0.41U	<0.43U	0.68	<0.61U
Sodium	145	<19.2U	<18.9U	<19.2U	<16.3U	<17.1U	53.1	**1530***
Thallium	0.91	<0.16U	<0.18U	0.2	<0.16U	<0.17U	<0.17U	**2.5***
Vanadium	37.6	11.6	9.7	20.3	18.4	18.7	24.8	21.8
Zinc	93.3	64.7	66.6	49.3	37.8	37.5	46.7	**390***
Anions (mg/kg)								
Nitrate	None	**0.47***	**0.55***	**0.79***	**0.61***	**0.71***	**0.83***	**2.9***
Sulfate	None	**27***	**35***	**13.6***	**19.5***	**44.9***	**25.7***	**29.7***
Sulfide	None	**14.3***	<9.1U	**12.2***	<8.7U	<9U	<8.4U	<9U
Miscellaneous (mg/kg)								
TPH-DRO	None	<7.7U	<7.3U	<7.6U	<6.9U	<7.4U	<7.3U	<8.5U
TPH-GRO	None	<0.062U	<0.061U	<0.061U	**0.026J***	<0.06U	<0.06U	NR
Explosives/Propellants (mg/kg)								
Nitrocellulose	None	**0.9***	**0.89***	**0.84***	**0.93***	**0.87***	**0.9***	NR
SVOCs (mg/kg)								
Benz(a)anthracene	None	<0.41U	<0.4U	<0.4U	<0.37U	<0.38U	<0.4U	<0.45U
Benzo(a)pyrene	None	<0.41U	<0.4U	<0.4U	<0.37U	<0.38U	<0.4U	<0.45U
Benzo(b)fluoranthene	None	<0.41U	<0.4U	<0.4U	<0.37U	<0.38U	<0.4U	<0.45U
Chrysene	None	<0.41U	<0.4U	<0.4U	<0.37U	<0.38U	<0.4U	<0.45U
Fluoranthene	None	<0.41U	<0.4U	<0.4U	<0.37U	<0.38U	<0.4U	<0.45U
Phenanthrene	None	<0.41U	<0.4U	<0.4U	<0.37U	<0.38U	<0.4U	<0.45U
Pyrene	None	<0.41U	<0.4U	<0.4U	<0.37U	<0.38U	<0.4U	<0.45U

Table 4–3. Analytes Detected in IRA Confirmation Subsurface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11cs-045**	**LL11cs-045**	**LL11cs-046**	**LL11cs-047**	**LL11cs-048**	**LL11cs-049**	**LL11cs-050**
Sample ID		**LL11cs-045-0001-FD**	**LL11cs-045-0001-SO**	**LL11cs-046-0001-SO**	**LL11cs-047-0001-SO**	**LL11cs-048-0001-SO**	**LL11cs-049-0001-SO**	**LL11cs-050-0001-SO**
Date		**03/22/01**	**03/22/01**	**03/22/01**	**03/22/01**	**03/22/01**	**03/22/01**	**03/22/01**
Depth (ft)		**7.0 - 8.0**	**7.0 - 8.0**	**3.0 - 4.0**	**3.0 - 4.0**	**3.0 - 4.0**	**3.0 - 4.0**	**3.0 - 4.0**
Parameters Analyzed		**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs**
Analyte	**Background Criteria**							
Pesticides/PCBs (mg/kg)								
PCB-1254	None	<0.01U	<0.01U	<0.0099U	<0.0093U	<0.0098U	<0.01U	<0.011U
VOCs (mg/kg)								
Acetone	None	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	NR
Carbon tetrachloride	None	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	NR
Toluene	None	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	NR

FPA = Former production area.
ft = Feet.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
NPA= Non-production area.
NR = Not reported/not analyzed.
PCB = Polychlorinated biphenyl.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
TAL = Target analyte list.
TPH-GRO/DRO = Total petroleum hydrocarbons-gasoline range organics/diesel range organics.
U = Not detected.
VOC = Volatile organic compound.
*** = Result exceeds background criteria or no background criteria was available.**
< = Less than.

Table 4–4. Analytes Detected in IRA Confirmation Sediment Samples

Aggregate	**Background Criteria**	**East Ditch EU**	**East Ditch EU**	**East Ditch EU**
Station		**LL11cs-031**	**LL11cs-031**	**LL11cs-031**
Sample ID		**LL11cs-031-0001-FD**	**LL11cs-031-0001-SD**	**LL11cs-031-0001-FD**
Date		**03/20/01**	**03/20/01**	**03/20/01**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed		**TAL Metals**	**TAL Metals**	**TAL Metals**
Analyte				
Metals (mg/kg)				
Aluminum	13900	**21000***	10600	**17700***
Antimony	0	<0.37U	<0.36U	**0.41***
Arsenic	19.5	<2.5U	<2.4U	11.6
Barium	123	87.5	85.2	86.3
Beryllium	0.38	**0.71***	**0.61***	**0.82***
Cadmium	0	**0.29***	**0.47***	<0.17U
Calcium	5510	1980	2390	2170
Chromium	18.1	**27.1***	16.5	**20.5***
Cobalt	9.1	8.7	8.2	7.9
Copper	27.6	20.6	19.7	26.3
Iron	28200	**33100***	19200	**30000***
Lead	27.4	<9.8U	<9.6U	14.7
Magnesium	2760	**3880***	2140	**3080***
Manganese	1950	882	754	193
Nickel	17.7	**22.3***	15.2	**19.8***
Potassium	1950	**2000***	856	**1980***
Selenium	1.7	0.64	**2***	0.5
Sodium	112	**1180***	**817***	**938***
Thallium	0.89	<0.25U	<0.24U	0.23
Vanadium	26.1	**43.9***	24.2	26.1
Zinc	532	81	234	65.3
Anions				
Sulfate	None	NR	NR	NR
Sulfide	None	NR	NR	NR
Explosives (mg/kg)				
Nitrocellulose	None	NR	NR	NR
Pesticides/PCBs (mg/kg)				
PCB-1254	None	NR	NR	NR
VOCs (mg/kg)				
Acetone	None	NR	NR	<0.006U

EU = Exposure unit.
ft = Feet.
ID = Identification.
mg/kg = Milligrams per kilogram.
NR = Not reported/not analyzed.
PCB = Polychlorinated biphenyl.
TAL = Target analyte list.
VOC = Volatile organic compound.
U = Not detected.
*** = Result exceeds background criteria or no background criteria was available.**
< = Less than.

Table 4–5. Phase I RI Sampling Locations

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
LL11sb-001	0–1	Full suite, anions	Southern portion of NPA, northeast of Entrance Gate	Characterize an area not previously sampled. Installed monitoring well LL11mw-002. QC sample collected.	None	Metals, explosives
LL11ss-001	0–1	Full suite, anions	Building AP-18	1941-1945, 1951-1957, and 1969-1971: Utilized for storage of percussion elements. QC sample collected.	None	Metals, explosives
	1–3	Metals, explosives, anions				
LL11ss-002	0–1	Metals, explosives, anions	Building AP-18	1941-1945, 1951-1957, and 1969-1971: Utilized for storing percussion elements.	None	Metals, explosives
	1–3	Metals, explosives, anions				
LL11sb-002	0–1	Metals, explosives, anions	Eastern end of NPA	Characterize an area not previously sampled, downgradient of Building AP-18 (1941-1945, 1951-1957, and 1969-1971: Utilized for storing percussion elements). Installed monitoring well LL11mw-002.	None	Metals, explosives
	6–8	Metals, explosives, anions				
LL11sb-003	0–1	Metals, explosives, anions	East of Building AP-8	Characterize an area not previously sampled, downgradient of Building AP-8 (1941-1945, 1951-1957, and 1969-1971: Utilized for storing percussion elements). Installed monitoring well LL11mw-003.	None	Metals, black powder
LL11ss-003	0–1	Metals, explosives, anions	Buildings AP-8	1941-1945, 1951-1957, and 1969-1971: Building AP-8 utilized for artillery primer loading and served as an administrative building.	None	Metals, black powder
	1–3	Metals, explosives, anions				
LL11ss-004	0–1	Metals, explosives, anions	Buildings AP-8	1941-1945, 1951-1957, and 1969-1971: Building AP-8 utilized for artillery primer loading and served as an administrative building. QC sample (0-1) collected.	None	Metals, black powder
	1–3	Metals, explosives, anions				
LL11sb-004	0–1	Metals, explosives, anions	Southeast of Building AP-11	Characterize an area not previously sampled, downgradient of Building AP-11 (1941-1945, 1951-1957: Utilized for black powder charging operations. 1969-1971: Served as the major assembly and shipping building for MK2A4 primers, and also used to apply lacquer sealing materials). Installed monitoring well LL11mw-004.	None	Metals, black powder, lacquers
	10-12	Metals, explosives, anions				
LL11ss-005	0–1	Metals, explosives, anions	Buildings AP-8	1941-1945, 1951-1957, and 1969-1971: Building AP-8 utilized for artillery primer loading and served as an administrative building. Subfloor sample collected inside AP-8.	None	Metals, black powder
LL11sb-005	0–1	Full suite, anions	Downgradient of Hot Spot	Characterized area downgradient of petroleum-contaminated soil hot spot. Installed monitoring well LL11mw-005.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
	6–8	Metals, explosives, anions				
LL11ss-006	0–1	Metals, explosives, anions	Buildings AP-8	1941-1945, 1951-1957, and 1969-1971: Building AP-8 utilized for artillery primer loading and served as an administrative building. Sample collected inside AP-8.	None	Metals, black powder
LL11sb-006	0–1	Metals, explosives, anions	North of Building AP-11	Across the road from Building AP-11 near drainage ditch. 1941-1945, 1951-1957: Utilized for black powder charging operations. 1969-1971: Served as the major assembly and shipping building for MK2A4 primers, and also used to apply lacquer sealing materials. Installed monitoring well LL11mw-006.	None	Metals, black powder, lacquers
	2–4	Metals, explosives, anions				
LL11sb-007	0–1	Metals, explosives, anions	Adjacent to Northern Ditch	Drainage ditch leading north prior to exiting the AOC. Installed monitoring well LL11mw-007.	None	Metals, explosives
LL11ss-007	1–3	Metals, explosives, anions	Buildings AP-8	1941-1945, 1951-1957, and 1969-1971: Building AP-8 utilized for artillery primer loading and served as an administrative building.	None	Metals, black powder
LL11ss-008	0–1	Metals, explosives, anions	Buildings AP-8	1941-1945, 1951-1957, and 1969-1971: Building AP-8 utilized for artillery primer loading and served as an administrative building.	None	Metals, black powder
	1–3	Metals, explosives, anions				
LL11sb-008	0–1	Metals, explosives, anions	Central area of FPA	Characterize an area not previously sampled. Installed monitoring well LL11mw-008. QC sample (12-13) collected.	None	Metals, explosives
	12-13	Metals, explosives, anions				
LL11ss-009	0–1	Full suite, anions	Building AP-17	1941-1945, 1951-1957, and 1969-1971: Utilized as a solvent storage facility.	None	Solvents
	1–3	Metals, explosives, anions				
LL11sb-009	0–1	Metals, explosives, anions	Adjacent to drainage ditch west of Building AP-8	Characterized area adjacent to drainage ditch west of Building AP-8 not previously sampled. 1941-1945, 1951-1957, and 1969-1971: Building AP-8 utilized for artillery primer loading and served as an administrative building. Installed monitoring well LL11mw-009.	None	Metals, black powder
	4–6	Metals, explosives, anions				
LL11sb-010	0–1	Metals, explosives, anions	Southwest of Building AP-4	Characterize an area downgradient of Building AP-4 not previously sampled. 1941-1945, 1951-1957, and 1969-1971: Utilized as black powder rest house prior to primer charging. Installed monitoring well LL11mw-008.	None	Metals, black powder
LL11ss-010	0–1	Metals, explosives, anions	Building AP-17	1941-1945, 1951-1957, and 1969-1971: Utilized as a solvent storage facility. QC sample (0-1) collected.	None	Solvents
	1–3	Full suite, anions				
LL11ss-011	0–1	Metals, explosives, anions	Building AP-11	1941-1945, 1951-1957: Utilized for black powder charging operations. 1969-1971: Served as the major assembly and shipping building for MK2A4 primers, and also used to apply lacquer sealing materials. Subfloor sample collected inside building (east end).	None	Metals, black powder, lacquers
LL11sb-011	4–6	Metals, explosives, anions	Sewer Line in Western End of FPA	Evaluated Load Line 11 sewer line adjacent to sewer thrust point or manhole where sewer integrity was potentially suspect. Sewer soil sample was collected at elevations representing the elevation of the sewer system, starting at the elevation equal to the total manhole depth and extending to two ft below the total manhole depth.	None	Metals, explosives

Table 4–5. Phase I RI Sampling Locations (continued)

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
LL11ss-012	0–1	Full suite, anions	Building AP-11	1941-1945, 1951-1957: Utilized for black powder charging operations. 1969-1971: Served as the major assembly and shipping building for MK2A4 primers, and also used to apply lacquer sealing materials. Subfloor sample collected inside building (west end).	None	Metals, black powder, lacquers
LL11sb-012	8-10	Full suite, anions	Sewer Line in Center of FPA	Evaluated Load Line 11 sewer line adjacent to sewer thrust point or manhole where sewer integrity was potentially suspect. Sewer soil sample was collected at elevations representing the elevation of the sewer system, starting at the elevation equal to the total manhole depth and extending to two ft below the total manhole depth. QC sample collected.	None	Metals, explosives
LL11ss-013	0–1	Metals, explosives, anions	Building AP-11	1941-1945, 1951-1957: Utilized for black powder charging operations. 1969-1971: Served as the major assembly and shipping building for MK2A4 primers, and also used to apply lacquer sealing materials.	None	Metals, black powder, lacquers
	1–3	Full suite, cyanide				
LL11sb-013	8-10	Metals, explosives, anions	Sewer Line southwest of Building AP-7	Evaluated Load Line 11 sewer line adjacent to sewer thrust point or manhole where sewer integrity was potentially suspect. Sewer soil sample was collected at elevations representing the elevation of the sewer system, starting at the elevation equal to the total manhole depth and extending to two ft below the total manhole depth.	None	Metals, explosives
LL11ss-014	0–1	Metals, explosives, anions	Building AP-11	1941-1945, 1951-1957: Utilized for black powder charging operations. 1969-1971: Served as the major assembly and shipping building for MK2A4 primers, and also used to apply lacquer sealing materials.	None	Metals, black powder, lacquers
	1–3	Metals, explosives, anions				
LL11sb-014	11-13	Metals, explosives, anions	Sewer Line along entrance road	Evaluated Load Line 11 sewer line adjacent to sewer thrust point or manhole where sewer integrity was potentially suspect. Sewer soil sample was collected at elevations representing the elevation of the sewer system, starting at the elevation equal to the total manhole depth and extending to two ft below the total manhole depth.	None	Metals, explosives
LL11ss-015	0–1	Metals, explosives, anions	Building AP-11	1941-1945, 1951-1957: Utilized for black powder charging operations. 1969-1971: Served as the major assembly and shipping building for MK2A4 primers, and also used to apply lacquer sealing materials.	None	Metals, black powder, lacquers
	1–3	Metals, explosives, anions				
LL11sb-015	10-12	Metals, explosives, anions	Sewer Line northeast of Building AP-8	Evaluated Load Line 11 sewer line adjacent to sewer thrust point or manhole where sewer integrity was potentially suspect. Sewer soil sample was collected at elevations representing the elevation of the sewer system, starting at the elevation equal to the total manhole depth and extending to two ft below the total manhole depth.	None	Metals, explosives
LL11ss-016	0–1	Metals, explosives, anions	Building AP-11	1941-1945, 1951-1957: Utilized for black powder charging operations. 1969-1971: Served as the major assembly and shipping building for MK2A4 primers, and also used to apply lacquer sealing materials. QC sample (1-3 ft) collected.	None	Metals, black powder, lacquers
	1–3	Full suite, anions				
LL11sb-016	8.5-11.5	Metals, explosives, anions	Sewer line southeast of Building AP-8	Evaluated Load Line 11 sewer line adjacent to sewer thrust point or manhole where sewer integrity was potentially suspect. Sewer soil sample was collected at elevations representing the elevation of the sewer system, starting at the elevation equal to the total manhole depth and extending to two ft below the total manhole depth.	None	Metals, explosives
LL11ss-017	0–1	Metals, explosives, anions	Northwest of Building AP-11	1941-1945, 1951-1957: Utilized for black powder charging operations. 1969-1971: Served as the major assembly and shipping building for MK2A4 primers, and also used to apply lacquer sealing materials.	None	Metals, black powder, lacquers
	1–3	Metals, explosives, anions				
LL11sb-017	4–6	Metals, explosives, anions	Sewer Line south of Building AP-11	Evaluated Load Line 11 sewer line adjacent to sewer thrust point or manhole where sewer integrity was potentially suspect. Sewer soil sample was collected at elevations representing the elevation of the sewer system, starting at the elevation equal to the total manhole depth and extending to two ft below the total manhole depth.	None	Metals, explosives
LL11ss-018	0–1	Metals, explosives, anions	Building AP-10	1941-1945, 1951-1957, and 1969-1971: Utilized as percussion element service magazine prior to primer charging.	None	Metals, explosives
	1–3	Metals, explosives, anions				
LL11sb-018	4–6	Metals, explosives, anions	Sewer line west of Building AP-13	Evaluated Load Line 11 sewer line adjacent to sewer thrust point or manhole where sewer integrity was potentially suspect. Sewer soil sample was collected at elevations representing the elevation of the sewer system, starting at the elevation equal to the total manhole depth and extending to two ft below the total manhole depth.	None	Metals, explosives
LL11sb-019	0–1	Full suite, anions	Sump near Building AP-3	1941-1945, 1951-1957, and 1969-1971: Utilized for black powder screening. Sump located on the southern side of AP-3. Evaluated sump integrity by collecting two samples, zero to two ft interval, and from the six to eight ft interval, which straddled the bottom elevation of the sump. QC sample (0-1 ft) collected.	None	Metals, black powder
	6–8	Metals, explosives, anions				
LL11ss-019	0–1	Metals, explosives, anions	Building AP-20	1941-1945, 1951-1957, and 1969-1971: Served as a quality assurance (QA) primer sensitivity testing facility.	None	Metals, black powder
	1–3	Metals, explosives, anions				
LL11ss-020	0–1	Full suite, anions	Building AP-1	1941-1945, 1951-1957, and 1969-1971: Utilized as black powder service magazine for primer charging.	None	Metals, black powder
	1–3	Metals, explosives, anions				
LL11sb-020	0–1	Metals, explosives, anions	Sump near Building AP-5	1941-1945, 1951-1957, and 1969-1971: Utilized as black powder dry house. One sump was located between AP-5	None	Metals, black powder

Table 4–5. Phase I RI Sampling Locations (continued)

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
	6–8	Metals, explosives, anions		and AP-6. Evaluated sump integrity by collecting two samples, zero to two ft interval, and from the six to eight ft interval, which straddled the bottom elevation of the sump.		
LL11ss-021	0–1	Metals, explosives, anions	Building AP-3	1941-1945, 1951-1957, and 1969-1971: Utilized for black powder screening.	None	Metals, black powder
	1–3	Metals, explosives, anions				
LL11sb-021	0–1	Metals, explosives, anions	Sump near Building AP-6	1941-1945, 1951-1957, and 1969-1971: Utilized as black powder dry house. Two sets of sumps were associated with Building AP-5 and AP-6: one set was located outside the southwest wall of AP-6 and one set was located between AP-5 and AP-6. Evaluated sump integrity by collecting two samples, zero to two ft interval, and from the six to eight ft interval, which straddled the bottom elevation of the sump.	None	Metals, black powder
	6–8	Metals, explosives, anions				
LL11ss-022	0–1	Metals, explosives, anions	Building AP-3	1941-1945, 1951-1957, and 1969-1971: Utilized for black powder screening.	None	Metals, black powder
	1–3	Metals, explosives, anions				
LL11sb-022	0–1	Metals, explosives, anions	Sump near Building AP-8	1941-1945, 1951-1957, and 1969-1971: Utilized for artillery primer loading and served as an administrative building. Two sets of sumps, one on the east side and one on the west side, were associated with this building and were connected to the sewer mains of the facility. Evaluated sump integrity by collecting two samples, zero to two ft interval, and from the six to eight ft interval, which straddled the bottom elevation of the sump.	None	Metals, black powder
	6–8	Metals, explosives, anions				
LL11ss-023	0–1	Metals, explosives, anions	Building AP-4	1941-1945, 1951-1957, and 1969-1971: Utilized as black powder rest house prior to primer charging. QC sample collected.	None	Metals, black powder
	1–3	Metals, explosives, anions				
LL11sb-023	0–1	Metals, explosives, anions	Sump near Building AP-8	1941-1945, 1951-1957, and 1969-1971: Utilized for artillery primer loading and served as an administrative building. Two sets of sumps, one on the east side and one on the west side, were associated with this building and were connected to the sewer mains of the facility. Evaluated sump integrity by collecting two samples, zero to two ft interval, and from the six to eight ft interval, which straddled the bottom elevation of the sump.	None	Metals, black powder
	6–8	Metals, explosives, anions				
LL11ss-024	0–1	Metals, explosives, anions	Buildings AP-5 and AP-6	1941-1945, 1951-1957, and 1969-1971: Utilized as black powder dry house and fan house. Two sets of sumps were associated with Building AP-5 and AP-6: one set was located outside the southwest wall of AP-6 and one set was located between AP-5 and AP-6.	None	Metals, black powder
	1–3	Metals, explosives, anions				
LL11sb-024	7–9	VOCs, SVOCs	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005.	None	Solvents, petroleum
LL11ss-025	0–1	Metals, explosives, anions	Building AP-7	1941-1945, 1951-1957, and 1969-1971: Utilized as black powder rest house prior to primer charging.	None	Metals, black powder
	1–3	Metals, explosives, anions				
LL11sb-025	5–7	VOCs, SVOCs	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
LL11ss-026	0–1	Metals, explosives, anions	North of Building AP-3 within NPA	Characterize an area not previously sampled.	None	Metals, explosives
	1–3	Metals, explosives, anions				
LL11sb-026	4–6	VOCs, SVOCs	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installingLL11mw-005.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
LL11ss-027	0–1	Metals, explosives, anions	North of Buildings AP-11 and AP-17 within NPA	Characterize an area not previously sampled.	None	Metals, explosives
	1–3	Metals, explosives, anions				
LL11sb-027	6–8	VOCs, SVOCs	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005. QC sample collected.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
LL11ss-028	0–1	Metals, explosives, anions	West of Building AP-3 within NPA	Characterize an area not previously sampled.	None	Metals, explosives
	1–3	Metals, explosives, anions				
LL11sb-028	4–6	VOCs, SVOCs	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
LL11ss-029	0–1	Metals, explosives, anions	Southwest of Building AP-4 within NPA	Characterize an area not previously sampled. QC sample (0-1) collected.	None	Metals, explosives
	1–3	Metals, explosives, anions				
LL11sb-029	6–8	VOCs, SVOCs	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil	Petroleum-contaminated soil (Hot	Solvents, petroleum

Table 4–5. Phase I RI Sampling Locations (continued)

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
				boring operations at LL11sb-005 for installing LL11mw-005.	Spot)	
LL11ss-030	0–1	Metals, explosives, anions	Northeast portion of NPA	Characterize an area not previously sampled. QC sample (1-3) collected.	None	Metals, explosives
	1–3	Metals, explosives, anions				
LL11sb-030	8-10	VOCs, SVOCs	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
LL11ss-031	0–1	Metals, explosives, anions	Southeast portion of NPA (Drainage Ditch)	Characterize an area not previously sampled.	None	Metals, explosives
	1–3	Metals, explosives, anions				
LL11sb-031	4–6	Full suite, anions	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
	6–8	Metals, SVOCs, VOCs, TPH-DRO/GRO		Resampling soil boring location LL11sb-031. An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
LL11sb-032	4–6	Full suite, anions	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
LL11sb-033	6–8	VOCs, SVOCs	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
LL11sb-034	2–4	VOCs, SVOCs	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
LL11sb-035	4–6	Full suite, anions	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005. QC sample collected.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
LL11sb-036	4–6	VOCs, SVOCs	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
LL11sb-037	6–8	Full Suite, anions, TPH-DRO/GRO	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
LL11sb-038	6–8	Full Suite, anions, TPH-DRO/GRO	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
LL11sb-039	6–8	Full Suite, anions, TPH-DRO/GRO	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
LL11sb-040	6–8	Full Suite, anions, TPH-DRO/GRO	Hot Spot near LL11mw-005	An area of petroleum-contaminated soil (Hot Spot) approximately 30 ft long by 30 ft wide and 8 ft deep was identified just north of Building AP-17 (Solvent Storage) during the RI. The hot spot was encountered during soil boring operations at LL11sb-005 for installing LL11mw-005.	Petroleum-contaminated soil (Hot Spot)	Solvents, petroleum
LL11sb-041	6–8	Full suite, anions	Sump near Building AP-8	1941-1945, 1951-1957, and 1969-1971: Utilized for artillery primer loading and served as an administrative building. When sump sediment/water samples were collected from the two AP-8 sumps, a sheen was noted on the water. Data from the AP-8 sediment/water samples raised the possibility that VOC/SVOC contaminants might be present in the soil surrounding the sump. Because the original sump soil boring samples had not been analyzed for VOCs/SVOCs, an additional boring was advanced at each of the AP-8 sumps and the soil samples were analyzed for VOCs/SVOCs.	None	Metals, black powder
LL11sb-042	6–8	Full suite, anions	Sump near Building AP-8	1941-1945, 1951-1957, and 1969-1971: Utilized for artillery primer loading and served as an administrative building. When sump sediment/water samples were collected from the two AP-8 sumps, a sheen was noted on the	None	Metals, black powder

Table 4–5. Phase I RI Sampling Locations (continued)

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
				water. Data from the AP-8 sediment/water samples raised the possibility that VOC/SVOC contaminants might be present in the soil surrounding the sump. Because the original sump soil boring samples had not been analyzed for VOCs/SVOCs, an additional boring was advanced at each of the AP-8 sumps and the soil samples were analyzed for VOCs/SVOCs.		
LL11sb-043	6–8	Full suite, anions	Sewer Line south of Building AP-11	Re-collected subsurface soil sample near sewer line boring LL11sb-017, to delineate vertical extent of contamination indicated.	None	Metals, explosives
LL11sb-017	4–6	Metals, explosives, anions	Sewer Line south of Building AP-11	Evaluated Load Line 11 sewer line adjacent to sewer thrust point or manhole where sewer integrity was potentially suspect. Sewer soil sample was collected at elevations representing the elevation of the sewer system, starting at the elevation equal to the total manhole depth and extending to two ft below the total manhole depth.	None	Metals, explosives
LL11sd-013	0–1	Metals, explosives, anions	Drainage Ditch	Drainage ditch, on the south end of the AOC just east of the entrance road**.** QC sample collected.	None	Metals, explosives
LL11sd-014	0–1	Metals, explosives, anions	Drainage Ditch	Drainage ditch north of Building AP-18 (1941-1945, 1951-1957, and 1969-1971: Utilized for storage of percussion elements)	None	Metals, explosives
LL11sd-015	0–1	Metals, explosives, anions	Drainage Ditch	Drainage ditch east of Building AP-18 (1941-1945, 1951-1957, and 1969-1971: Utilized for storage of percussion elements).	None	Metals, explosives
LL11sd-016	0–1	Metals, explosives, anions	East Ditch	Drainage ditch northeast and downgradient of Building AP-13 (Change House), leading to toward AOC boundary. Location was moved east across the road in the ditch line	None	Metals, explosives
LL11sd-017	0–1	Metals, explosives, anions	East Ditch	Drainage ditch (East Ditch) northwest of Building AP-13 (Change House); however, it was moved to the pond influent (due to presence of thick cattails and algae-rich pond water.	None	Metals, explosives
LL11sd-018	0–1	Metals, explosives, anions	East Ditch	Drainage ditch north of Building AP-19 (dining hall).	None	Metals, explosives
LL11sd-019	0–1	Metals, explosives, anions	East Ditch	Drainage ditch northeast and downgradient of Building AP-19 (dining hall), leading toward AOC boundary.	None	Metals, explosives
LL11sd-020	0–1	Metals, explosives, anions	Drainage Ditch	Drainage ditch along northern road, directly across from Building AP-11 (black powder charging operations; assembly)	None	Metals, explosives
LL11sd-021	0–1	Metals, explosives, anions	Drainage Ditch	Drainage ditch in northern portion of NPA, which sample location was moved to an outfall located 30 to 35 ft east of the fence line	None	Metals, explosives
LL11sd-022	0–1	Metals, explosives, anions	Drainage Ditch	Drainage ditch along northern road, northwest of Building AP-20 (quality assurance primer sensitivity testing facility).	None	Metals, black powder
LL11sd-023	0–1	Metals, explosives, anions	Drainage Ditch	Drainage ditch south of Building AP-11 (black powder charging operations; assembly) within the FPA.	None	Metals, black powder
LL11sd-024	0–1	Metals, explosives, anions	West Ditch	Drainage ditch northeast of Building AP-7 (black powder rest house), within the FPA.	None	Metals, black powder
LL11sd-025	0–1	Metals, explosives, anions	West Ditch	Drainage ditch northwest of Building AP-7 (black powder rest house), within the FPA.	None	Metals, black powder
LL11sd-026	0–1	Metals, explosives, anions	Drainage Ditch	Drainage ditch in western portion of FPA.	None	Metals, explosives
LL11sd-027	0–1	Metals, explosives, anions	Drainage Ditch	Drainage ditch within western end of FPA, south of Building AP-3 (black powder screening).	None	Metals, black powder
LL11sd-028	0–1	Metals, explosives, anions	West Ditch (Drainage Ditch East of Building AP-4)	Drainage ditch east/southeast of Building AP-4 (black powder rest house). Location moved approximately 10 ft northwest to a culvert that had an open pool.	None	Metals, black powder
LL11sd-029	0–1	Full suite, anions	Drainage Ditch	Drainage ditch south of Building AP-3 (black powder screening), along western end of FPA. QC sample collected.	None	Metals, black powder
LL11sd-025	0–1	Metals, explosives, anions	West Ditch	Drainage ditch northwest of Building AP-7 (black powder rest house), within the FPA.	None	Metals, black powder
LL11sd-026	0–1	Metals, explosives, anions	Drainage Ditch	Drainage ditch in western portion of FPA.	None	Metals, explosives
LL11sd-027	0–1	Metals, explosives, anions	Drainage Ditch	Drainage ditch within western end of FPA, south of Building AP-3 (black powder screening).	None	Metals, black powder
LL11sd-028	0–1	Metals, explosives, anions	West Ditch (Drainage Ditch East of Building AP-4)	Drainage ditch east/southeast of Building AP-4 (black powder rest house). Location moved approximately 10 ft northwest to a culvert that had an open pool.	None	Metals, black powder
LL11sd-029	0–1	Full suite, anions	Drainage Ditch	Drainage ditch south of Building AP-3 (black powder screening), along western end of FPA. QC sample collected.	None	Metals, black powder
LL11sd-030	0–1	Metals, explosives, anions	West Ditch	Drainage ditch southwest of Building AP-4 (black powder rest house), prior to exiting the AOC.	None	Metals, black powder
LL11sd-031	0–1	Metals, explosives, anions	Drainage Ditch	Drainage ditch along southern area of FPA.	None	Metals, explosives
LL11sd-032	0–1	Full suite, anions	Drainage Ditch North of Building AP-14	Drainage ditch north of Building AP-14 (Change House).	None	Metals, explosives
LL11sd-033	0–1	Metals, explosives, anions	Drainage Ditch West of Building AP-8	Drainage ditch just west of Building AP-8 (1941-1945, 1951-1957, and 1969-1971: Building AP-8 utilized for artillery primer loading and served as an administrative building.)	None	Metals, explosives
LL11sw-012	NA	Full suite, anions	East Ditch	Drainage ditch north of Building AP-13 and southwest of Building AP-19 (dining hall)	None	Metals, explosives
LL11sw-013	NA	Full suite, anions	Drainage Ditch	Drainage ditch south of AP-3 (black powder screening). When sediment sample LL11sd-027 was collected, water	None	Metals, explosives

Table 4–5. Phase I RI Sampling Locations (continued)

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
				was present in the ditch. Therefore, a surface water sample was collected from that ditch rather than from the sewer.		
LL11sw-014	NA	Full suite, anions	Drainage Ditch	Drainage ditch southwest of Buildings AP-5 and AP-6 (black powder dry house and fan house). Due to lack of water, sewer sample LL11sw-014 was collected instead near sediment location LL11sd-028.	None	Metals, black powder
LL11sw-015	NA	Full suite, anions	West Ditch	Drainage ditch southwest of Building AP-4 (black powder rest house) prior to exiting the AOC. Due to lack of water, sewer water Sample LLsw-015 was collected near LL11sd-030	None	Metals, explosives

Note: Interim Removal Action confirmation samples are not included in this table, which are presented in Table 4-2.
Anions include cyanide, sulfide, sulfate, and nitrate.
AOC = Area of concern.
bgs = Below ground surface.
DRO = Diesel range organics.
FPA = Former production area.
ft = Feet.
GRO = Gasoline range organics.
NPA = Non-production area.
QC= Quality control.
RI = Remedial investigation.
SVOC = Semi-volatile organic compound.
TPH = Total petroleum hydrocarbons.
VOC = Volatile organic compound.

Table 4–6. Analytes Detected in Phase I RI Surface Soil Samples

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL11sb-001**	**LL11sb-001**	**LL11sb-003**	**LL11sb-004**	**LL11sb-008**	**LL11sb-009**	**LL11sb-019**	**LL11sb-019**	**LL11sb-020**
Sample ID		**LL11sb-001-0001-FD**	**LL11sb-001-0001-SO**	**LL11sb-003-0001-SO**	**LL11sb-004-0001-SO**	**LL11sb-008-0001-SO**	**LL11sb-009-0001-SO**	**LL11sb-019-0001-FD**	**LL11sb-019-0001-SO**	**LL11sb-020-0001-SO**
Date		**10/31/00**	**10/31/00**	**10/30/00**	**10/31/00**	**10/31/00**	**10/30/00**	**08/21/00**	**08/21/00**	**08/21/00**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed	**Background**	**RVAAP Full-suite**	**RVAAP Full-suite**	**Misc., TAL Metals,**	**Misc., TAL Metals,**	**Misc., TAL Metals,**	**Misc., TAL Metals,**	**RVAAP Full-suite**	**RVAAP Full-suite**	**Misc., TAL Metals,**
Analyte	**Criteria**	**analytes**	**analytes**	**Explosives**	**Explosives**	**Explosives**	**Explosives**	**analytes**	**analytes**	**Explosives**
Metals (mg/kg)										
Aluminum	17700	14000	10600	12000	**18500***	14000	15500	3970	4070	12800
Antimony	0.96	<0.26U	0.45	0.37	0.57	0.32	0.42	0.32	<0.18U	0.25
Arsenic	15.4	13.2	**24.8***	14.5	**18.1***	10.3	**15.5***	8.8	5.9	10.3
Barium	88.4	64.4	50.8	67.4	65.1	66.5	66.2	22.1	24.8	68
Beryllium	0.88	0.45	0.35	0.44	0.48	0.43	0.5	0.31	0.35	0.68
Cadmium	0	<0.14U	<0.13U	<0.13U	<0.13U	<0.14U	<0.14U	**0.21***	**0.17***	**0.21***
Calcium	15800	5090	3490	1740	1140	1770	976	11700	10300	2680
Chromium	17.4	17.1	13.7	15.4	**20.7***	15.9	**18.8***	6.2	6.8	16.7
Cobalt	10.4	7.7	6.5	9.4	7.5	8.9	9	3.9	4.2	8.6
Copper	17.7	16.9	13.6	17.6	**22.7***	9.3	14.6	15.6	14.9	**19.3***
Cyanide	0	<0.53U	<0.49U	<0.35U	<0.52U	<0.52U	<0.48U	<0.36U	<0.44U	<0.3U
Iron	23100	23100	19000	22600	**28600***	18600	**29200***	13600	14400	22200
Lead	26.1	**37.7***	**32.9***	22	17.2	17.7	19.9	**28.8***	21.7	**31.5***
Magnesium	3030	**3360***	2930	2490	**3070***	2540	2770	2910	**3210***	**3300***
Manganese	1450	354	272	666	246	532	413	300	337	366
Mercury	0.036	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.03U	0.03	<0.04U
Nickel	21.1	16.9	15.2	17.2	18.7	13.6	16.5	10.2	11.2	20.8
Potassium	927	**1970***	**1320***	**1600***	**2230***	**1610***	**1540***	684	673	**1790***
Selenium	1.4	<0.43U	<0.42U	<0.42U	<0.45U	<0.42U	<0.43U	<0.59U	<1.5U	<0.35U
Sodium	123	**825***	**700***	**896***	**892***	**878***	**847***	**402***	**397***	**763***
Thallium	0	<0.17U	**0.17***	<0.17U	<0.18U	<0.17U	<0.17U	**2.9***	<0.12U	**0.21***
Vanadium	31.1	25.2	19.7	20.8	29.2	23.9	27.8	8.5	8.6	23.1
Zinc	61.8	**66.3***	52.3	**62.1***	58.9	51.3	**65.1***	54	55.9	**68.5***
Anions (mg/kg)										
Nitrate	None	<1.1U	<1.1U	**1.4***	<1.1U	<1.1U	<1.2U	**1.5***	<1.1U	<1.2U
Sulfide	None	<29U	<28.3U	<29U	**37***	<27.7U	<29.3U	<23U	<26.6U	<31U
Explosives and Propellants (mg/kg)										
Nitrocellulose	None	**0.81***	**0.95***	NR	NR	NR	NR	NR	NR	NR
Nitroguanidine	None	<0.3U	<0.33U	NR	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)										
Benz(a)anthracene	None	**0.1J***	**0.14J***	NR	NR	NR	NR	<0.35U	<0.36U	NR
Benzo(a)pyrene	None	**0.1J***	<0.39U	NR	NR	NR	NR	<0.35U	<0.36U	NR
Benzo(b)fluoranthene	None	<0.39U	<0.39U	NR	NR	NR	NR	<0.35U	<0.36U	NR
Benzo(ghi)perylene	None	<0.39U	<0.39U	NR	NR	NR	NR	<0.35U	<0.36U	NR
Benzo(k)fluoranthene	None	<0.39U	<0.39U	NR	NR	NR	NR	<0.35U	<0.36U	NR
Chrysene	None	**0.11J***	**0.17J***	NR	NR	NR	NR	<0.35U	<0.36U	NR
Fluoranthene	None	**0.24J***	**0.32J***	NR	NR	NR	NR	**0.1J***	<0.36U	NR
Indeno(1,2,3-cd)pyrene	None	<0.39U	<0.39U	NR	NR	NR	NR	<0.35U	<0.36U	NR
Phenanthrene	None	**0.1J***	**0.12J***	NR	NR	NR	NR	<0.35U	<0.36U	NR
Pyrene	None	**0.16J***	**0.31J***	NR	NR	NR	NR	<0.35U	<0.36U	NR
Pesticides/PCBs (mg/kg)										
PCB-1254	None	<0.0096U	<0.0096U	NR	NR	NR	NR	<0.0089U	<0.0089U	NR
gamma-Chlordane	None	<0.0048U	<0.0048U	NR	NR	NR	NR	**0.0018***	<0.0018U	NR
VOCs (mg/kg)										
Acetone	None	<0.006U	<0.006U	NR	NR	NR	NR	<0.005U	<0.005U	NR

Table 4–6. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		FPA	FPA	FPA	FPA	FPA	FPA	FPA	FPA	FPA
Station		**LL11sb-021**	**LL11sb-022**	**LL11sb-023**	**LL11sd-023**	**LL11sd-025**	**LL11sd-026**	**LL11sd-031**	**LL11ss-001**	**LL11ss-001**
Sample ID		**LL11sb-021-0001-SO**	**LL11sb-022-0001-SO**	**LL11sb-023-0001-SO**	**LL11sd-023-0001-SD**	**LL11sd-025-0001-SD**	**LL11sd-026-0001-SD**	**LL11sd-031-0001-SD**	**LL11ss-001-0001-FD**	**LL11ss-001-0001-SO**
Date		**08/21/00**	**08/22/00**	**08/22/00**	**11/15/00**	**11/16/00**	**11/16/00**	**11/16/00**	**11/07/00**	**11/07/00**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed	**Background Criteria**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**
Analyte										
Metals (mg/kg)										
Aluminum	17700	13000	10700	6780	13300	13700	11700	15500	6520	9110
Antimony	0.96	0.28	0.34	<0.19U	0.3	0.6	0.63	0.5	<0.26U	0.29
Arsenic	15.4	9.9	10.2	12.3	12.7	**21***	13.4	**21.1***	10.4	9.9
Barium	88.4	70.8	63.3	53.5	51.8	67.6	59.4	66.9	35.2	48.3
Beryllium	0.88	0.7	0.68	0.52	0.46	0.68	0.49	0.69	0.41	0.52
Cadmium	0	**0.34***	<0.13U	<0.13U	<0.2U	**0.2***	<0.23U	<0.15U	<0.17U	<0.18U
Calcium	15800	6690	1820	6960	830	1290	1810	2030	14300	**53100***
Chromium	17.4	17	14.4	10	17	**17.5***	15.1	**19.9***	8.7	10.3
Cobalt	10.4	8.6	9.6	6.8	3.8	**33.8***	6.3	9.6	5.2	6.3
Copper	17.7	**23.2***	16.7	**18.8***	13.2	12.1	13.4	**18***	13.6	15.7
Cyanide	0	<0.39U	<0.36U	<0.43U	<0.44U	<0.69U	<0.54U	<0.57U	<0.48U	<0.36U
Iron	23100	**23400***	**24400***	19600	**25800***	**25400***	20200	**25400***	16200	16400
Lead	26.1	**70.9***	**28.5***	**33.4***	13	**33.8***	**29.2***	20.7	18.2	17.9
Magnesium	3030	**3720***	2440	2470	2220	2510	2400	**3300***	2220	**3420***
Manganese	1450	378	982	785	63.9	1160	285	294	365	442
Mercury	0.036	<0.04U	<0.04U	<0.03U	<0.04U	**0.05***	<0.06U	<0.04U	<0.04U	<0.04U
Nickel	21.1	21	18.6	14.8	11.5	15.1	14.6	20	10.9	12.2
Potassium	927	**1930***	**1400***	**945***	831	**1320***	**1130***	**1830***	926	**1330***
Selenium	1.4	<2U	<0.33U	<0.31U	1.1	1	0.68	0.55	<2.1U	<0.92U
Sodium	123	**804***	**668***	**528***	<97.7U	**721***	**702***	**796***	**456***	**599***
Thallium	0	**0.26***	**0.13***	**0.14***	**0.21***	**0.21***	<0.21U	**0.21***	<0.17U	<0.18U
Vanadium	31.1	23.3	21.6	13.1	29.1	28	21.8	30.7	12	14.7
Zinc	61.8	**94.6***	54.5	58.4	36.6	**71.2***	**90.6***	60.8	51	52.4
Anions (mg/kg)										
Nitrate	None	<1.2U	<1.1U	<1.1U	<1.3U	<0.69U	<0.77U	**0.92***	**3***	**3.2***
Sulfide	None	<26.9U	<28.6U	<25U	**76***	**45.3***	<29.5U	**42.8***	**133***	**244***
Explosives and Propellants (mg/kg)										
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	**0.74***	**0.89***
Nitroguanidine	None	NR	NR	NR	NR	NR	NR	NR	<0.29U	**0.077J***
SVOCs (mg/kg)										
Benz(a)anthracene	None	NR	NR	NR	NR	NR	**0.17J***	**0.078J***	NR	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	**0.15J***	**0.07J***	NR	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	**0.16J***	<0.38U	NR	NR
Benzo(ghi)perylene	None	NR	NR	NR	NR	NR	<0.37U	<0.38U	NR	NR
Benzo(k)fluoranthene	None	NR	NR	NR	NR	NR	**0.15J***	<0.38U	NR	NR
Chrysene	None	NR	NR	NR	NR	NR	**0.17J***	**0.086J***	NR	NR
Fluoranthene	None	NR	NR	NR	NR	NR	**0.33J***	**0.14J***	NR	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	NR	NR	<0.37U	<0.38U	NR	NR
Phenanthrene	None	NR	NR	NR	NR	NR	**0.12J***	<0.38U	NR	NR
Pyrene	None	NR	NR	NR	NR	NR	**0.22J***	<0.38U	NR	NR
Pesticides/PCBs (mg/kg)										
PCB-1254	None	NR	NR	NR	NR	NR	NR	NR	<0.0092U	<0.0095U
gamma-Chlordane	None	NR	NR	NR	NR	NR	NR	NR	<0.0046U	<0.0047U
VOCs (mg/kg)										
Acetone	None	NR	NR	NR	NR	NR	NR	NR	<0.006U	<0.006U

Table 4–6. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL11ss-002**	**LL11ss-003**	**LL11ss-004**	**LL11ss-004**	**LL11ss-005**	**LL11ss-006**	**LL11ss-008**	**LL11ss-009**	**LL11ss-010**
Sample ID		**LL11ss-002-0001-SO**	**LL11ss-003-0001-SO**	**LL11ss-004-0001-FD**	**LL11ss-004-0001-SO**	**LL11ss-005-0001-SO**	**LL11ss-006-0001-SO**	**LL11ss-008-0001-SO**	**LL11ss-009-0001-SO**	**LL11ss-010-0001-FD**
Date		**11/06/00**	**11/07/00**	**11/07/00**	**11/07/00**	**11/17/00**	**11/17/00**	**11/07/00**	**11/08/00**	**11/13/00**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed		**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**Misc., TAL Metals, Explosives**
Analyte	**Background Criteria**									
Metals (mg/kg)										
Aluminum	17700	9270	9700	8530	7840	13300	15900	9660	9260	12200
Antimony	0.96	<0.26U	0.51	<0.28U	0.54	0.3	0.85	0.35	<0.27U	<0.29U
Arsenic	15.4	13.2	14.3	14.2	**20.2***	**24***	11.4	**17.9***	5.3	8.4
Barium	88.4	56	**98.6***	41.7	48.5	62.4	62.6	59.9	55.9	**91.1***
Beryllium	0.88	0.66	0.58	0.46	0.45	0.78	0.6	0.57	0.61	0.63
Cadmium	0	<0.17U	**0.35***	<0.18U	<0.19U	**0.23***	**0.17***	<0.18U	**0.22***	**0.32***
Calcium	15800	**19800***	3200	1410	1940	1530	2620	2090	860	**56100***
Chromium	17.4	13.6	12.8	11.6	10.9	17.2	**18.7***	14	11.5	13.6
Cobalt	10.4	6.4	8.2	7.2	7.4	9.8	7.9	7.8	8.8	10.4
Copper	17.7	17.7	**35.5***	**23***	**20.7***	**20.5***	11.1	17.1	15.2	12
Cyanide	0	**0.58***	<0.35U	<0.39U	<0.52U	<0.46U	<0.6U	**0.68***	<0.55U	<0.56U
Iron	23100	**23200***	21700	20300	18300	**26700***	**24900***	22300	17600	16000
Lead	26.1	15.2	**63.4***	**34.4***	**34.6***	5.6	5.3	**58.1***	6.4	20.5
Magnesium	3030	**4570***	2230	2290	2070	**3090***	2950	2150	1960	2560
Manganese	1450	576	800	313	501	286	481	569	843	1240
Mercury	0.036	<0.04U	**0.08***	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	**0.04***	**0.06***
Nickel	21.1	12.8	14.8	16.7	14.5	**23.2***	14.6	15.1	15.6	13.6
Potassium	927	**1050***	**948***	**1060***	**988***	**1840***	**1540***	**1300***	**1020***	**1290***
Selenium	1.4	<0.44U	<0.46U	<0.47U	<0.43U	<0.36U	**1.4***	<0.9U	<0.45U	<0.41U
Sodium	123	**591***	**632***	**623***	**612***	**879***	**829***	**656***	**719***	**789***
Thallium	0	<0.18U	<0.19U	<0.19U	<0.17U	<0.14U	**0.22***	<0.18U	<0.18U	<0.19U
Vanadium	31.1	14.7	18.9	15	14.2	21.2	**31.4***	19.7	17.4	21.9
Zinc	61.8	48.9	**92.7***	**85.3***	66.4*	59.9	51.9	**88***	59.4	**68***
Anions (mg/kg)										
Nitrate	None	<0.94U	**1.3***	<1U	<1.2U	<1.1U	<0.92U	<1.1U	<1.1U	**1.5***
Sulfide	None	**154***	<29U	**81.5***	**52.1***	<29U	<30.2U	**35***	<27.8U	**45.4***
Explosives and Propellants (mg/kg)										
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	**1.1***	NR
Nitroguanidine	None	NR	NR	NR	NR	NR	NR	NR	<0.29U	NR
SVOCs (mg/kg)										
Benz(a)anthracene	None	NR	NR	NR	NR	NR	NR	NR	<0.39U	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	NR	NR	<0.39U	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	<0.39U	NR
Benzo(ghi)perylene	None	NR	NR	NR	NR	NR	NR	NR	<0.39U	NR
Benzo(k)fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	<0.39U	NR
Chrysene	None	NR	NR	NR	NR	NR	NR	NR	<0.39U	NR
Fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	<0.39U	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	NR	NR	NR	NR	<0.39U	NR
Phenanthrene	None	NR	NR	NR	NR	NR	NR	NR	<0.39U	NR
Pyrene	None	NR	NR	NR	NR	NR	NR	NR	<0.39U	NR
Pesticides/PCBs (mg/kg)										
PCB-1254	None	NR	NR	NR	NR	NR	NR	NR	<0.0092U	<0.0095U
gamma-Chlordane	None	NR	NR	NR	NR	NR	NR	NR	<0.0046U	<0.0047U
VOCs (mg/kg)										
Acetone	None	NR	NR	NR	NR	NR	NR	NR	<0.006U	<0.006U

Table 4–6. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL11ss-011**	**LL11ss-012**	**LL11ss-013**	**LL11ss-014**	**LL11ss-015**	**LL11ss-016**	**LL11ss-017**	**LL11ss-018**	**LL11ss-019**
Sample ID		**LL11ss-011-0001-SO**	**LL11ss-012-0001-SO**	**LL11ss-013-0001-SO**	**LL11ss-014-0001-SO**	**LL11ss-015-0001-SO**	**LL11ss-016-0001-SO**	**LL11ss-017-0001-SO**	**LL11ss-018-0001-SO**	**LL11ss-019-0001-SO**
Date		**11/17/00**	**11/17/00**	**11/08/00**	**11/06/00**	**11/08/00**	**11/13/00**	**11/08/00**	**11/09/00**	**11/10/00**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed	**Background Criteria**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**
Analyte										
Metals (mg/kg)										
Aluminum	17700	11400	7870	14500	7410	7900	8780	10700	13500	11900
Antimony	0.96	0.5	0.34	<0.24U	0.27	0.32	0.27	<0.29U	0.55	0.56
Arsenic	15.4	13.1	**24.2***	12.1	9.1	6.3	12.2	11.5	10.6	11.5
Barium	88.4	33.6	36.1	**107***	82.6	52.9	46.7	59.9	**101***	54
Beryllium	0.88	0.47	0.49	**1.1***	0.83	0.54	0.49	0.65	**1***	0.61
Cadmium	0	<0.15U	<0.14U	**0.37***	**0.73***	**1.3***	**0.32***	**0.25***	**0.16***	**0.2***
Calcium	15800	167	1470	**23700***	**64400***	2030	1040	2140	**27500***	2010
Chromium	17.4	13	11.4	11.4	12.9	12.4	11.4	16.1	14	14.5
Cobalt	10.4	5.3	8	5	4	9.2	8.7	**11.2***	6.9	**10.8***
Copper	17.7	15.7	**18.9***	12.7	**41.2***	**45.7***	16.5	**19.5***	10.7	11.8
Cyanide	0	<0.53U	<0.42U	<0.53U	**1.6***	<0.52U	<0.55U	<0.52U	<0.53U	<0.56U
Iron	23100	19600	20600	18100	13100	20400	16700	**26800***	19100	18400
Lead	26.1	6.6	9.8	**28.2***	**78.3***	**43***	**97.1***	5.5	17.8	19.8
Magnesium	3030	1940	2410	**4280***	**5390***	2090	1720	**3520***	**4800***	2480
Manganese	1450	158	354	**1500***	642	544	507	390	**1540***	536
Mercury	0.036	<0.04U	<0.04U	**0.34***	**0.07***	**0.05***	0.04*	<0.04U	<0.04U	<0.04U
Nickel	21.1	12.7	18.5	11.2	13.3	17.6	11.8	**26.8***	10.1	13.4
Potassium	927	**949***	**1240***	**1560***	**959***	**981***	**1060***	**1270***	**1110***	**1010***
Selenium	1.4	0.5	0.62	0.89	<0.87U	<0.44U	<0.32U	<0.49U	0.45	<0.47U
Sodium	123	**604***	**770***	**858***	663*	**734***	**647***	**888***	**178***	**840***
Thallium	0	<0.15U	**0.15***	<0.16U	<0.17U	<0.18U	<0.18U	<0.2U	<0.18U	<0.19U
Vanadium	31.1	20.2	13.5	15.2	8.9	14.9	16.8	17.8	20.2	21.2
Zinc	61.8	43.4	52.2	45.5	**107***	**105***	58.4	71.5*	38.9	50.5
Anions (mg/kg)										
Nitrate	None	**8.1***	**4.1***	<1U	<0.99U	<1.1U	<1U	<1.2U	<1.1U	<1.2U
Sulfide	None	<28.5U	<27.4U	**40.5***	**226***	**29.9***	**36.8***	**42.6***	**105***	**30.7***
Explosives and Propellants (mg/kg)										
Nitrocellulose	None	NR	**1.1***	NR	NR	NR	NR	NR	NR	NR
Nitroguanidine	None	NR	<0.28U	NR	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)										
Benz(a)anthracene	None	NR	<0.36U	NR	NR	NR	NR	NR	NR	NR
Benzo(a)pyrene	None	NR	<0.36U	NR	NR	NR	NR	NR	NR	NR
Benzo(b)fluoranthene	None	NR	<0.36U	NR	NR	NR	NR	NR	NR	NR
Benzo(ghi)perylene	None	NR	<0.36U	NR	NR	NR	NR	NR	NR	NR
Benzo(k)fluoranthene	None	NR	<0.36U	NR	NR	NR	NR	NR	NR	NR
Chrysene	None	NR	<0.36U	NR	NR	NR	NR	NR	NR	NR
Fluoranthene	None	NR	<0.36U	NR	NR	NR	NR	NR	NR	NR
Indeno(1,2,3-cd)pyrene	None	NR	<0.36U	NR	NR	NR	NR	NR	NR	NR
Phenanthrene	None	NR	<0.36U	NR	NR	NR	NR	NR	NR	NR
Pyrene	None	NR	<0.36U	NR	NR	NR	NR	NR	NR	NR
Pesticides/PCBs (mg/kg)										
PCB-1254	None	NR	<0.0089U	NR	NR	NR	NR	NR	NR	NR
gamma-Chlordane	None	NR	<0.00089U	NR	NR	NR	NR	NR	NR	NR
VOCs (mg/kg)										
Acetone	None	NR	<0.006U	NR	NR	NR	NR	NR	NR	NR

Table 4–6. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**NPA**	**NPA**
Station		**LL11ss-020**	**LL11ss-021**	**LL11ss-022**	**LL11ss-023**	**LL11ss-023**	**LL11ss-024**	**LL11ss-025**	**LL11sb-002**	**LL11sb-005**
Sample ID		**LL11ss-020-0001-SO**	**LL11ss-021-0001-SO**	**LL11ss-022-0001-SO**	**LL11ss-023-0002-FD**	**LL11ss-023-0001-SO**	**LL11ss-024-0001-SO**	**LL11ss-025-0001-SO**	**LL11sb-002-0001-SO**	**LL11sb-005-0001-SO**
Date		**11/10/00**	**11/09/00**	**11/09/00**	**11/09/00**	**11/09/00**	**11/09/00**	**11/09/00**	**10/30/00**	**10/31/00**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed	**Background Criteria**	**RVAAP Full-suite analytes**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**
Analyte										
Metals (mg/kg)										
Aluminum	17700	7800	6880	11300	14900	7880	14100	9570	8870	13800
Antimony	0.96	0.4	<0.28U	0.41	0.73	0.36	0.61	0.54	0.32	<0.25U
Arsenic	15.4	13.9	10.3	**30.2***	14.8	11.1	**16***	12.6	12.1	9.4
Barium	88.4	39	44.6	45	**128***	33.9	79.8	52.5	48	69.8
Beryllium	0.88	0.5	0.39	0.53	0.78	0.44	0.68	0.54	0.35	0.45
Cadmium	0	**0.4***	<0.14U	<0.16U	<0.15U	<0.14U	<0.16U	<0.16U	<0.14U	<0.14U
Calcium	15800	1200	14900	999	1330	1200	2320	1400	3000	1580
Chromium	17.4	10.4	9.1	14.1	**19.1***	10.4	**19.4***	12.3	14.2	16.7
Cobalt	10.4	6.6	5.9	5.7	**10.5***	6.1	8.5	8	7.2	8.4
Copper	17.7	**20.7***	19.4*	**19.4***	15.2	**19.8***	**21.4***	14.2	14.5	16.2
Cyanide	0	<0.41U	<0.46U	<0.52U	<0.46U	<0.42U	<0.43U	<0.53U	<0.43U	<0.55U
Iron	23100	17600	15100	20100	**23300***	18800	**25900***	18400	18800	22500
Lead	26.1	**33.1***	28.1*	17.1	16.1	21.6	**28***	20.1	21.2	20.1
Magnesium	3030	1970	2800	2230	**3250***	2160	**3410***	2150	2290	2680
Manganese	1450	483	383	134	691	334	296	471	395	484
Mercury	0.036	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U
Nickel	21.1	17	12	13.5	**22.1***	15	**21.2***	14.4	15.5	18.2
Potassium	927	868	743	**945***	**2130***	**1210***	**1730***	**939***	**1200***	**1980***
Selenium	1.4	<0.46U	<0.35U	<0.41U	<0.37U	<0.35U	<0.39U	0.61	<0.42U	<0.41U
Sodium	123	**593***	<70.5U	<81.4U	99.5	<69.2U	87.3	<78.9U	**745***	**901***
Thallium	0	<0.18U	<0.19U	<0.2U	<0.18U	<0.16U	<0.2U	<0.17U	<0.17U	<0.16U
Vanadium	31.1	13.2	12.7	21.6	24.9	13.9	24.4	17.3	16.2	24.6
Zinc	61.8	**79.9***	**72.8***	60.8	59.7	59.9	**67.1***	53.6	56.8	**71.7***
Anions (mg/kg)										
Nitrate	None	<1U	**2.3***	<1.2U	<1.2U	<1U	<1.2U	**2.1***	<1.1U	<1.1U
Sulfide	None	**30.2***	**52.3***	**41.8***	**36.5***	**56.8***	**43.1***	**46.9***	<28.5U	31.1*
Explosives and Propellants (mg/kg)										
Nitrocellulose	None	1*	NR	NR	NR	NR	NR	NR	NR	**0.89***
Nitroguanidine	None	<0.28U	NR	NR	NR	NR	NR	NR	NR	<0.3U
SVOCs (mg/kg)										
Benz(a)anthracene	None	<0.37U	NR	NR	NR	NR	NR	NR	NR	**0.071J***
Benzo(a)pyrene	None	<0.37U	NR	NR	NR	NR	NR	NR	NR	<0.39U
Benzo(b)fluoranthene	None	<0.37U	NR	NR	NR	NR	NR	NR	NR	<0.39U
Benzo(ghi)perylene	None	<0.37U	NR	NR	NR	NR	NR	NR	NR	<0.39U
Benzo(k)fluoranthene	None	<0.37U	NR	NR	NR	NR	NR	NR	NR	<0.39U
Chrysene	None	<0.37U	NR	NR	NR	NR	NR	NR	NR	**0.083J***
Fluoranthene	None	<0.37U	NR	NR	NR	NR	NR	NR	NR	**0.14J***
Indeno(1,2,3-cd)pyrene	None	<0.37U	NR	NR	NR	NR	NR	NR	NR	<0.39U
Phenanthrene	None	<0.37U	NR	NR	NR	NR	NR	NR	NR	<0.39U
Pyrene	None	<0.37U	NR	NR	NR	NR	NR	NR	NR	<0.39U
Pesticides/PCBs (mg/kg)										
PCB-1254	None	**0.11***	NR	NR	NR	NR	NR	NR	NR	<0.0098U
gamma-Chlordane	None	<0.00094U	NR	NR	NR	NR	NR	NR	NR	<0.0049U
VOCs (mg/kg)										
Acetone	None	NR	<0.006U	NR	<0.006U	NR	<0.006U	NR	<0.006U	NR

Table 4–6. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11sb-006**	**LL11sb-007**	**LL11sb-010**	**LL11sd-014**	**LL11sd-015**	**LL11sd-016**	**LL11sd-020**	**LL11sd-022**	**LL11sd-029**
Sample ID		**LL11sb-006-0001-SO**	**LL11sb-007-0001-SO**	**LL11sb-010-0001-SO**	**LL11sd-014-0001-SD**	**LL11sd-015-0001-SD**	**LL11sd-016-0001-SD**	**LL11sd-020-0001-SD**	**LL11sd-022-0001-SD**	**LL11sd-029-0001-FD**
Date		**10/31/00**	**10/31/00**	**10/31/00**	**11/14/00**	**11/14/00**	**11/14/00**	**11/15/00**	**11/15/00**	**11/16/00**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed	**Background Criteria**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**
Analyte										
Metals (mg/kg)										
Aluminum	17700	8570	11500	13400	12500	8640	11800	6170	10100	15400
Antimony	0.96	0.41	<0.26U	<0.27U	<0.28U	<0.29U	0.77	<0.25U	<0.25U	<0.22U
Arsenic	15.4	**17.8***	11.4	6.7	12.7	9.7	14.1	11.4	12.5	9.3
Barium	88.4	45.1	51.6	64.6	**98.1***	48.5	74.5	37.7	46.7	86.3
Beryllium	0.88	0.39	0.42	0.36	0.68	0.52	0.71	0.41	0.53	0.84
Cadmium	0	<0.15U	<0.13U	<0.15U	<0.2U	<0.22U	<0.2U	<0.19U	<0.16U	<0.17U
Calcium	15800	13500	1140	802	1940	1790	**18100***	1780	1240	3510
Chromium	17.4	11.9	13.9	13.1	14.6	12.3	17.2	10.5	15.3	**20.9***
Cobalt	10.4	7.6	**11***	6.2	**13.9***	8.1	**11.8***	6.2	5.6	**11.1***
Copper	17.7	**21***	**19.1***	5.8	11.3	15	**19.6***	**18.2***	14.3	**20.9***
Cyanide	0	<0.53U	<0.41U	<0.58U	<0.43U	<0.65U	<0.35U	<0.58U	<0.46U	<0.44U
Iron	23100	21600	**23400***	14300	19500	18600	**23900***	17400	21100	**26900***
Lead	26.1	20	15.3	13.3	16.2	18.3	20.3	**27.2***	10.8	14
Magnesium	3030	**3520***	2260	1580	2220	2050	**6390***	1740	2190	**4440***
Manganese	1450	373	664	237	**1930***	302	356	266	210	367
Mercury	0.036	<0.04U	<0.04U	<0.04U	**0.05***	<0.04U	<0.04U	**0.08***	<0.04U	<0.04U
Nickel	21.1	17.3	17.3	8.5	14.7	15.3	**24.7***	13.3	14.1	**27.5***
Potassium	927	**1610***	**1560***	**1210***	**1120***	**971***	**1870***	**934***	**1040***	**2530***
Selenium	1.4	<0.39U	<0.43U	<0.46U	0.59	0.69	<0.5U	0.64	0.68	<0.43U
Sodium	123	**922***	**905***	**990***	**807***	**553***	**736***	<92.9U	<81.5U	**864***
Thallium	0	<0.16U	<0.17U	<0.18U	<0.19U	<0.19U	<0.2U	<0.17U	**0.23***	<0.15U
Vanadium	31.1	16.1	19.9	22.8	24.4	16.9	21.4	12.2	19.9	26.4
Zinc	61.8	**98.4***	59.7	40.8	53	**73.3***	**63.4***	**68.1***	55.8	**62.3***
Anions (mg/kg)										
Nitrate	None	<1U	**1.2***	<1.2U	**3***	<0.57U	**0.69***	<1.1U	**1.3***	<0.6U
Sulfide	None	<27.3U	<29.6U	<31U	**79.7***	**58***	**68.2***	**48***	**51.5***	**37.4***
Explosives and Propellants (mg/kg)										
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	NR	**0.97***
Nitroguanidine	None	NR	NR	NR	NR	NR	NR	NR	NR	<0.3U
SVOCs (mg/kg)										
Benz(a)anthracene	None	NR	NR	NR	NR	NR	NR	NR	NR	<0.4U
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	NR	NR	NR	<0.4U
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	NR	<0.4U
Benzo(ghi)perylene	None	NR	NR	NR	NR	NR	NR	NR	NR	<0.4U
Benzo(k)fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	NR	<0.4U
Chrysene	None	NR	NR	NR	NR	NR	NR	NR	NR	<0.4U
Fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	NR	<0.4U
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	NR	NR	NR	NR	NR	<0.4U
Phenanthrene	None	NR	NR	NR	NR	NR	NR	NR	NR	<0.4U
Pyrene	None	NR	NR	NR	NR	NR	NR	NR	NR	<0.4U
Pesticides/PCBs (mg/kg)										
PCB-1254	None	NR	NR	NR	NR	NR	NR	NR	NR	<0.01U
gamma-Chlordane	None	NR	NR	NR	NR	NR	NR	NR	NR	<0.001U
VOCs (mg/kg)										
Acetone	None	NR	NR	NR	NR	NR	NR	NR	NR	<0.006U

Table 4–6. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11sd-029**	**LL11ss-026**	**LL11ss-027**	**LL11ss-028**	**LL11ss-029**	**LL11ss-029**	**LL11ss-030**	**LL11ss-031**
Sample ID		**LL11sd-029-0001-SD**	**LL11ss-026-0001-SO**	**LL11ss-027-0001-SO**	**LL11ss-028-0001-SO**	**LL11ss-029-0001-FD**	**LL11ss-029-0001-SO**	**LL11ss-030-0001-SO**	**LL11ss-031-0001-SO**
Date		**11/16/00**	**11/10/00**	**11/10/00**	**11/10/00**	**11/14/00**	**11/14/00**	**11/14/00**	**11/10/00**
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**
Parameters Analyzed **Analyte**	**Background Criteria**	**RVAAP Full-suite analytes**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives, VOCs**	**Misc., TAL Metals, Explosives, VOCs**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**
					Metals (mg/kg)				
Aluminum	17700	11000	9070	9340	14400	11600	11700	14400	10000
Antimony	0.96	0.43	0.34	<0.27U	<0.3U	0.63	0.39	<0.29U	0.36
Arsenic	15.4	**18.2***	6.6	**18.8***	9.5	11.3	11.5	11.5	**17.9***
Barium	88.4	61	62.4	28.4	55.2	71.9	71.5	58.3	87.7
Beryllium	0.88	0.64	0.48	0.53	0.52	0.64	0.63	0.53	0.74
Cadmium	0	<0.16U	**0.2***	**0.19***	**0.23***	<0.2U	<0.2U	<0.19U	**0.38***
Calcium	15800	5670	790	292	215	520	543	363	1370
Chromium	17.4	16.4	11.1	10.6	16.7	13.8	13.7	**19***	12.2
Cobalt	10.4	9.4	**10.5***	7.8	6.4	**14***	**10.7***	7	7.2
Copper	17.7	17.7	6.7	**19.5***	8.6	9.1	8.9	11.6	8.7
Cyanide	0	<0.4U	<0.59U	<0.57U	<0.53U	<0.37U	<0.53U	**0.54***	<0.49U
Iron	23100	22200	14800	19100	20800	20200	18500	**27300***	17400
Lead	26.1	15.6	16.2	13.7	18.5	22.6	23.2	15.4	22.4
Magnesium	3030	**3510***	1540	1750	2160	1850	1820	2800	1630
Manganese	1450	285	822	300	270	**2080***	**1520***	288	901
Mercury	0.036	<0.04U	<0.04U	<0.04U	<0.04U	**0.05***	**0.05***	<0.04U	**0.05***
Nickel	21.1	**22***	10.5	15.3	12.4	12.8	12.1	15.9	13.1
Potassium	927	**1580***	585	**1020***	**1000***	755	798	**1430***	752
Selenium	1.4	0.62	<0.48U	<0.46U	<0.5U	0.85	0.77	0.77	<0.51U
Sodium	123	**746***	**684***	**637***	**934***	**704***	**775***	**647***	**706***
Thallium	0	**0.16***	<0.19U	<0.18U	<0.2U	**0.24***	<0.21U	<0.19U	<0.2U
Vanadium	31.1	20.1	19.7	14.3	28.4	25.5	24.6	26	19.9
Zinc	61.8	60.5	39.5	58.8	46.6	**79.6***	**74.3***	50.9	60.1
					Anions (mg/kg)				
Nitrate	None	<0.58U	<1.2U	<1.1U	<1.2U	<0.53U	**0.67***	**0.64***	<1.3U
Sulfide	None	<26U	**42.6***	**52.7***	**48.6***	**42.1***	<31.8U	**85.5***	**54.7***
					Explosives and Propellants (mg/kg)				
Nitrocellulose	None	**0.91***	NR	NR	NR	**1.2***	**1.2***	NR	NR
Nitroguanidine	None	<0.29U	NR	NR	NR	<0.33U	<0.32U	NR	NR
					SVOCs (mg/kg)				
Benz(a)anthracene	None	<0.4U	NR	NR	NR	NR	NR	NR	NR
Benzo(a)pyrene	None	<0.4U	NR	NR	NR	NR	NR	NR	NR
Benzo(b)fluoranthene	None	<0.4U	NR	NR	NR	NR	NR	NR	NR
Benzo(ghi)perylene	None	<0.4U	NR	NR	NR	NR	NR	NR	NR
Benzo(k)fluoranthene	None	<0.4U	NR	NR	NR	NR	NR	NR	NR
Chrysene	None	<0.4U	NR	NR	NR	NR	NR	NR	NR
Fluoranthene	None	<0.4U	NR	NR	NR	NR	NR	NR	NR
Indeno(1,2,3-cd)pyrene	None	<0.4U	NR	NR	NR	NR	NR	NR	NR
Phenanthrene	None	<0.4U	NR	NR	NR	NR	NR	NR	NR
Pyrene	None	<0.4U	NR	NR	NR	NR	NR	NR	NR
					Pesticides/PCBs (mg/kg)				
PCB-1254	None	<0.01U	NR	NR	NR	NR	NR	NR	NR
gamma-Chlordane	None	<0.001U	NR	NR	NR	NR	NR	NR	NR

Table 4–6. Analytes Detected in Phase I RI Surface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11sd-029**	**LL11ss-026**	**LL11ss-027**	**LL11ss-028**	**LL11ss-029**	**LL11ss-029**	**LL11ss-030**	**LL11ss-031**
Sample ID		**LL11sd-029-0001-SD**	**LL11ss-026-0001-SO**	**LL11ss-027-0001-SO**	**LL11ss-028-0001-SO**	**LL11ss-029-0001-FD**	**LL11ss-029-0001-SO**	**LL11ss-030-0001-SO**	**LL11ss-031-0001-SO**
Date		**11/16/00**	**11/10/00**	**11/10/00**	**11/10/00**	**11/14/00**	**11/14/00**	**11/14/00**	**11/10/00**
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**
Parameters Analyzed **Analyte**	**Background Criteria**	**RVAAP Full-suite analytes**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives, VOCs**	**Misc., TAL Metals, Explosives, VOCs**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**
VOCs (mg/kg)									
Acetone	None	<0.006U	NR	NR	NR	<0.006U	<0.006U	NR	NR

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

Table 4–7. Analytes Detected in Phase I RI Subsurface Soil Samples

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL11sb-001**	**LL11sb-003**	**LL11sb-004**	**LL11sb-008**	**LL11sb-008**	**LL11sb-009**	**LL11sb-011**	**LL11sb-012**	**LL11sb-012**
Sample ID		**LL11sb-001-0002-SO**	**LL11sb-003-0002-SO**	**LL11sb-004-0002-SO**	**LL11sb-008-0002-FD**	**LL11sb-008-0002-SO**	**LL11sb-009-0002-SO**	**LL11sb-011-0001-SO**	**LL11sb-012-0001-FD**	**LL11sb-012-0001-SO**
Date		**11/03/00**	**11/09/00**	**11/08/00**	**11/08/00**	**11/08/00**	**11/13/00**	**08/21/00**	**08/22/00**	**08/22/00**
Depth (ft)		**18.0 - 20.0**	**20.0 - 40.0**	**10.0 - 12.0**	**12.0 - 13.0**	**12.0 - 13.0**	**4.0 - 6.0**	**4.0 - 6.0**	**8.0 - 10.0**	**8.0 - 10.0**
Parameters Analyzed		**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**
Analyte	**Background Criteria**									
Metals (mg/kg)										
Aluminum	19500	8130	8650	6670	8300	7450	11600	10300	12000	11900
Antimony	0.96	<0.3U	<0.29U	<0.27U	<0.26U	<0.26U	0.74	<0.21U	0.58	<0.2U
Arsenic	19.8	**28***	**24.5***	7.2	9.3	9.5	**22.9***	15.7	12.6	11.3
Barium	124	35.2	64.7	26.9	42.5	30.2	68.8	54.4	58.5	58.8
Beryllium	0.88	0.44	0.61	0.41	0.47	0.45	0.72	0.72	0.84	0.61
Cadmium	0	<0.21U	<0.16U	<0.18U	**0.22***	<0.17U	<0.16U	<0.14U	<0.14U	**0.16***
Calcium	35500	8080	993	9050	17900	6990	1130	4460	5990	23500
Chromium	27.2	12.6	12.4	11.5	15.8	13.5	16.2	14.4	15.8	16
Cobalt	23.2	8.2	12.7	7.1	10.1	8.9	8	9.2	9.9	9.4
Copper	32.3	19.1	20.2	17.4	18.9	21.4	17.2	18.5	20.6	18.3
Cyanide	0	<0.34U	<0.55U	<0.32U	<0.37U	<0.48U	<0.3U	<0.6U	<0.42U	<0.5U
Iron	35200	22700	22500	19000	21700	22900	24100	22700	21800	23200
Lead	19.1	8.3	13.7	6.5	7.5	**47.5***	13.8	14.6	**20.4***	15.8
Magnesium	8790	4850	2370	4420	4960	4260	3360	3840	4040	5400
Manganese	3030	232	456	320	353	271	324	296	206	435
Mercury	0.044	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U
Nickel	60.7	19.7	19.2	17.5	23.3	20	21.2	23.3	21.8	21.5
Potassium	3350	1650	1020	1580	1510	1210	1130	1550	1870	1920
Selenium	1.5	**<0.5U**	0.39	<0.46U	<0.44U	<0.44U	<0.4U	<1.8U	<1.7U	<1.7U
Sodium	145	**693***	<77.8U	**684***	**672***	**725***	**840***	**789***	**731***	**716***
Thallium	0.91	<0.2U	<0.19U	<0.18U	<0.18U	<0.17U	<0.2U	0.2	0.23	0.14
Vanadium	37.6	13.8	14.8	11.7	14.1	12.8	18.7	17.3	21.7	21.3
Zinc	93.3	53.7	49.5	58	53.8	56.5	56.9	54.8	57.7	58
Anions (mg/kg)										
Nitrate	None	<1.3U	<1U	<1.1U	<1.1U	<1.1U	<1.2U	<1.1U	<1.1U	<1.2U
Sulfate	None	<63.6U	<49.8U	<54.7U	<56.7U	<55.8U	<59U	<58.2U	<57.5U	<59.8U
Sulfide	None	**36.5***	**44.2***	46.9*	<27.4U	<27U	**46.6***	<29.7U	<27U	<28.5U
Miscellaneous (mg/kg)										
TPH-DRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
TPH-GRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Explosives/Propellants (mg/kg)										
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)										
Benz(a)anthracene	None	NR	NR	NR	NR	NR	NR	NR	<0.4U	<0.41U
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	NR	NR	<0.4U	<0.41U
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	<0.4U	<0.41U
Chrysene	None	NR	NR	NR	NR	NR	NR	NR	<0.4U	<0.41U
Fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	<0.4U	<0.41U
Phenanthrene	None	NR	NR	NR	NR	NR	NR	NR	<0.4U	<0.41U
Pyrene	None	NR	NR	NR	NR	NR	NR	NR	<0.4U	<0.41U
Pesticides/PCBs (mg/kg)										
PCB-1254	None	NR	NR	NR	NR	NR	NR	NR	<0.01U	<0.01U
VOCs (mg/kg)										
Acetone	None	NR	NR	NR	NR	NR	NR	NR	<0.006U	<0.006U
Carbon tetrachloride	None	NR	NR	NR	NR	NR	NR	NR	<0.006U	<0.006U
Toluene	None	NR	NR	NR	NR	NR	NR	NR	<0.006U	<0.006U

Table 4–7. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL11sb-017**	**LL11sb-018**	**LL11sb-019**	**LL11sb-020**	**LL11sb-021**	**LL11sb-022**	**LL11sb-023**	**LL11sb-041**	**LL11sb-042**
Sample ID		**LL11sb-017-0001-SO**	**LL11sb-018-0001-SO**	**LL11sb-019-0002-SO**	**LL11sb-020-0002-SO**	**LL11sb-021-0002-SO**	**LL11sb-022-0002-SO**	**LL11sb-023-0002-SO**	**LL11sb-041-0001-SO**	**LL11sb-042-0001-SO**
Date		**08/22/00**	**08/22/00**	**08/21/00**	**08/21/00**	**08/21/00**	**08/22/00**	**08/22/00**	**03/13/01**	**03/13/01**
Depth (ft)		**4.0 - 6.0**	**4.0 - 6.0**	**6.0 - 8.0**	**6.0 - 8.0**	**6.0 - 8.0**	**6.0 - 8.0**	**6.0 - 8.0**	**6.0 - 8.0**	**6.0 - 8.0**
Parameters Analyzed		**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**
Analyte	**Background Criteria**									
Metals (mg/kg)										
Aluminum	19500	6120	11800	13100	13700	13500	7330	9910	6020	11900
Antimony	0.96	0.24	<0.2U	<0.2U	<0.2U	<0.21U	0.33	0.21	<0.29U	<0.27U
Arsenic	19.8	13.4	16.5	11.8	11.4	15.3	**25.8***	10.7	11.2	**20.6***
Barium	124	24.1	64.1	60	73.2	69.6	49.4	63.4	23.5	69.2
Beryllium	0.88	0.48	0.86	0.74	0.73	0.75	0.59	0.64	<0.38U	0.74
Cadmium	0	<0.15U	<0.14U	**0.24***	**0.25***	**0.16***	<0.14U	<0.14U	<0.19U	<0.18U
Calcium	35500	820	11300	27600	32600	16200	984	2930	844	7850
Chromium	27.2	8.9	15.4	18.9	19.2	19	11.1	12.9	9.8	16
Cobalt	23.2	7.1	8.7	10.6	13.3	10.6	7.4	7.8	6.3	7.9
Copper	32.3	19.9	18.7	20.6	20.8	20.8	21	14.6	21.1	16.3
Cyanide	0	<0.27U	<0.33U	<0.35U	<0.42U	<0.3U	<0.27U	<0.23U	<0.23U	<0.24U
Iron	35200	19200	23000	25500	24500	27300	24700	19200	20600	21300
Lead	19.1	13.7	**19.2***	15.2	15.7	16.2	**22.1***	**65.1***	9.1	11.8
Magnesium	8790	1660	3810	6770	8270	6300	2250	2370	1810	4630
Manganese	3030	346	527	359	545	313	330	507	145	578
Mercury	0.044	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.042U	<0.04U
Nickel	60.7	14.4	22.7	27.5	28.6	27.2	18	16.5	16	22.1
Potassium	3350	690	1920	2860	3090	2970	900	1160	679	1480
Selenium	1.5	<1.9U	<1.7U	<0.33U	<1.6U	<1.7U	<0.31U	<1.7U	<0.47U	<0.44U
Sodium	145	**611***	**884***	**817***	**805***	**837***	**619***	**623***	**712***	**923***
Thallium	0.91	<0.15U	<0.13U	0.17	0.17	0.21	<0.13U	<0.14U	<0.2U	0.19
Vanadium	37.6	11.7	19	21.9	23	22.9	14	18.8	11.8	18.1
Zinc	93.3	54.5	60.2	62.4	57.7	59.9	52.7	54.6	53.3	55.3
Anions (mg/kg)										
Nitrate	None	<1.3U	<1.1U	<1.1U	<1.2U	<1.2U	<1.1U	<1.2U	**0.15***	**0.14***
Sulfate	None	<63.6U	<57.5U	<56.3U	<58.6U	<59.8U	<57.6U	<59.8U	**23***	**44.2***
Sulfide	None	<30.2U	<29.3U	<28.6U	<29U	<25.9U	<29.2U	**44.7***	<9.3U	<8.4U
Miscellaneous (mg/kg)										
TPH-DRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
TPH-GRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Explosives/Propellants (mg/kg)										
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	**1.9***	**1.6***
SVOCs (mg/kg)										
Benz(a)anthracene	None	NR	NR	NR	NR	NR	NR	NR	<0.42U	<0.4U
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	NR	NR	<0.42U	<0.4U
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	<0.42U	<0.4U
Chrysene	None	NR	NR	NR	NR	NR	NR	NR	<0.42U	<0.4U
Fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	<0.42U	<0.4U
Phenanthrene	None	NR	NR	NR	NR	NR	NR	NR	<0.42U	<0.4U
Pyrene	None	NR	NR	NR	NR	NR	NR	NR	<0.42U	<0.4U
Pesticides/PCBs (mg/kg)										
PCB-1254	None	NR	NR	NR	NR	NR	NR	NR	<0.011U	<0.01U
VOCs (mg/kg)										
Acetone	None	NR	NR	NR	NR	NR	NR	NR	<0.006U	<0.006U
Carbon tetrachloride	None	NR	NR	NR	NR	NR	NR	NR	<0.006U	<0.006U
Toluene	None	NR	NR	NR	NR	NR	NR	NR	<0.006U	<0.006U

Table 4–7. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL11sb-043**	**LL11ss-001**	**LL11ss-002**	**LL11ss-003**	**LL11ss-004**	**LL11ss-007**	**LL11ss-008**	**LL11ss-009**	**LL11ss-010**
Sample ID		**LL11sb-043-0001-SO**	**LL11ss-001-0002-SO**	**LL11ss-002-0002-SO**	**LL11ss-003-0002-SO**	**LL11ss-004-0002-SO**	**LL11ss-007-0002-SO**	**LL11ss-008-0002-SO**	**LL11ss-009-0002-SO**	**LL11ss-010-0002-SO**
Date		**03/13/01**	**11/07/00**	**11/06/00**	**11/06/00**	**11/07/00**	**11/13/00**	**11/07/00**	**11/08/00**	**11/13/00**
Depth (ft)		**6.0 - 8.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**
Parameters Analyzed		**RVAAP Full-suite analytes**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**
Analyte	**Background Criteria**									
Metals (mg/kg)										
Aluminum	19500	8910	11600	7190	9190	9540	11700	9810	8510	13200
Antimony	0.96	<0.29U	0.69	0.28	0.51	0.92	0.37	0.37	<0.26U	<0.29U
Arsenic	19.8	**22.4***	19.5	**20***	**22.6***	15.9	12.3	13.7	6.3	11.8
Barium	124	42.3	53.8	47.4	65.9	52.3	75.5	58.2	42.9	76.7
Beryllium	0.88	0.49	0.52	0.51	0.61	0.53	0.72	0.65	0.53	0.71
Cadmium	0	<0.2U	<0.18U	<0.18U	<0.2U	<0.19U	<0.16U	<0.17U	**0.2***	<0.16U
Calcium	35500	1260	8060	1390	2260	1680	2600	2020	848	1720
Chromium	27.2	13.4	13.6	10.4	13.7	13.3	14.9	13.3	11.6	15.4
Cobalt	23.2	8	7.5	8.8	10.9	9.9	9.4	7.8	8	10.2
Copper	32.3	23.6	17.2	22.7	27.6	16.7	11	14.8	16.5	10
Cyanide	0	<0.23U	<0.4U	<0.45U	<0.43U	**0.79***	**0.29***	<0.46U	<0.37U	<0.52U
Iron	35200	25000	20800	22000	23200	22600	19100	23400	17400	18900
Lead	19.1	12.7	**20.1***	13.4	**32.9***	16.8	16.4	18.2	8.1	18.8
Magnesium	8790	2550	3580	2160	2420	2480	2550	2150	1860	2090
Manganese	3030	231	382	325	395	413	895	594	737	935
Mercury	0.044	<0.043U	<0.04U	<0.04U	0.04	<0.04U	0.04	<0.04U	<0.04U	**0.05***
Nickel	60.7	19.5	14.4	19.2	18.9	17.9	16	15.9	15.1	14
Potassium	3350	802	1320	814	990	1060	1320	1200	1070	1060
Selenium	1.5	<0.5U	<0.47U	<0.43U	<0.89U	<0.48U	0.56	<0.89U	<0.43U	0.66
Sodium	145	**909***	**791***	**534***	**668***	**588***	**751***	**632***	**712***	**776***
Thallium	0.91	<0.19U	<0.19U	<0.17U	<0.18U	<0.19U	<0.19U	<0.18U	0.2	<0.19U
Vanadium	37.6	15.1	20	12.3	16.6	17.2	21.3	20.2	16.5	26.4
Zinc	93.3	61.6	51.9	63.3	74.4	54	54.1	63.6	56	50.6
Anions (mg/kg)										
Nitrate	None	**0.15***	**2***	<1.1U	<1U	<1.2U	**1.4***	<1.1U	<1.1U	**1.1***
Sulfate	None	**22.8***	<59.4U	<56.7U	<51U	<59.7U	<58.8U	<56.4U	<53.3U	<50.9U
Sulfide	None	<9.4U	<27.3U	<27.9U	**34.5***	**71.5***	**63.8***	**35.2***	**34.5***	**54.7***
Miscellaneous (mg/kg)										
TPH-DRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
TPH-GRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Explosives/Propellants (mg/kg)										
Nitrocellulose	None	**2***	NR	NR	NR	NR	NR	NR	NR	**1.3***
SVOCs (mg/kg)										
Benz(a)anthracene	None	<0.43U	NR	NR	NR	NR	NR	NR	NR	<0.4U
Benzo(a)pyrene	None	<0.43U	NR	NR	NR	NR	NR	NR	NR	<0.4U
Benzo(b)fluoranthene	None	<0.43U	NR	NR	NR	NR	NR	NR	NR	<0.4U
Chrysene	None	<0.43U	NR	NR	NR	NR	NR	NR	NR	<0.4U
Fluoranthene	None	<0.43U	NR	NR	NR	NR	NR	NR	NR	<0.4U
Phenanthrene	None	<0.43U	NR	NR	NR	NR	NR	NR	NR	<0.4U
Pyrene	None	<0.43U	NR	NR	NR	NR	NR	NR	NR	<0.4U
Pesticides/PCBs (mg/kg)										
PCB-1254	None	<0.011U	NR	NR	NR	NR	NR	NR	NR	**0.033***
VOCs (mg/kg)										
Acetone	None	<0.006U	NR	NR	NR	NR	NR	NR	NR	<0.006U
Carbon tetrachloride	None	<0.006U	NR	NR	NR	NR	NR	NR	NR	<0.006U
Toluene	None	<0.006U	NR	NR	NR	NR	NR	NR	NR	<0.006U

Table 4–7. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL11ss-013**	**LL11ss-014**	**LL11ss-015**	**LL11ss-016**	**LL11ss-016**	**LL11ss-017**	**LL11ss-018**	**LL11ss-019**	**LL11ss-020**
Sample ID		**LL11ss-013-0002-SO**	**LL11ss-014-0002-SO**	**LL11ss-015-0002-SO**	**LL11ss-016-0002-FD**	**LL11ss-016-0002-SO**	**LL11ss-017-0002-SO**	**LL11ss-018-0002-SO**	**LL11ss-019-0002-SO**	**LL11ss-020-0002-SO**
Date		**11/08/00**	**11/07/00**	**11/08/00**	**11/13/00**	**11/13/00**	**11/08/00**	**11/09/00**	**11/10/00**	**11/10/00**
Depth (ft)		**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**
Parameters Analyzed		**RVAAP Full-suite analytes**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**
Analyte	**Background Criteria**									
Metals (mg/kg)										
Aluminum	19500	5350	14000	9290	11400	11700	9480	14600	12700	9840
Antimony	0.96	<0.26U	0.49	<0.26U	0.47	0.42	<0.26U	<0.3U	0.44	<0.29U
Arsenic	19.8	4.3	10.9	9.2	9.6	14.7	9.3	13.7	8.1	15.3
Barium	124	39.5	80.7	63.4	41.9	39.4	42.7	48.5	58.1	44.7
Beryllium	0.88	0.36	0.8	0.68	0.53	0.54	0.6	0.55	0.68	0.5
Cadmium	0	**0.24***	<0.18U	**0.29***	<0.15U	<0.14U	**0.17***	<0.16U	**0.17***	**0.27***
Calcium	35500	891	10100	1600	850	710	1730	1840	597	1620
Chromium	27.2	7.7	15.8	14.4	14.2	13.7	14.1	19	14.4	13.3
Cobalt	23.2	4.5	8.2	10.2	6.9	6.9	9.6	6.4	11	7.9
Copper	32.3	14.1	20.4	24.5	18.4	17.6	19.6	20	11	13.8
Cyanide	0	<0.33U	<0.48U	<0.4U	<0.43U	<0.55U	<0.39U	<0.52U	<0.45U	<0.48U
Iron	35200	14200	21400	23100	20800	20300	23900	26500	18800	21500
Lead	19.1	4.8	**23.8***	14.1	**19.7***	**22.2***	5.4	12.9	15.9	**25.9***
Magnesium	8790	1210	3370	2430	2310	2270	2960	3040	2020	2210
Manganese	3030	245	788	332	292	303	338	178	638	337
Mercury	0.044	<0.04U	0.04	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U
Nickel	60.7	10.2	16.2	22.7	14.3	13.9	23	16.1	12.7	15
Potassium	3350	595	1390	1310	942	1030	1450	1570	975	704
Selenium	1.5	<0.44U	<0.48U	<0.44U	0.43	0.5	<0.44U	<0.4U	<0.5U	<0.48U
Sodium	145	**478***	**793***	**885***	**634***	**622***	**868***	90.9	**835***	**631***
Thallium	0.91	<0.18U	<0.19U	<0.17U	<0.19U	<0.19U	0.21	<0.2U	<0.2U	0.23
Vanadium	37.6	10.3	23	15.9	20.9	20.9	16.1	24.3	21.6	17.1
Zinc	93.3	58.2	65.3	66.4	51.4	46.5	65.2	47.6	44.1	52.2
Anions (mg/kg)										
Nitrate	None	<0.94U	<1.2U	<1.1U	<1.2U	**13.6***	**1.4***	<1.1U	<1.2U	<1.2U
Sulfate	None	<47.1U	<59.4U	<51.4U	<57.7U	<56.5U	<53.8U	<56.7U	<55.5U	<60.4U
Sulfide	None	<27.5U	**125***	**44.6***	<27.5U	<25.8U	**74***	**49.7***	**52.9***	**31.8***
Miscellaneous (mg/kg)										
TPH-DRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
TPH-GRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Explosives/Propellants (mg/kg)										
Nitrocellulose	None	**0.87***	NR	NR	**1***	**0.98***	NR	NR	NR	NR
SVOCs (mg/kg)										
Benz(a)anthracene	None	<0.37U	NR	NR	<0.39U	<0.39U	NR	NR	NR	NR
Benzo(a)pyrene	None	<0.37U	NR	NR	<0.39U	<0.39U	NR	NR	NR	NR
Benzo(b)fluoranthene	None	<0.37U	NR	NR	<0.39U	<0.39U	NR	NR	NR	NR
Chrysene	None	<0.37U	NR	NR	<0.39U	<0.39U	NR	NR	NR	NR
Fluoranthene	None	<0.37U	NR	NR	<0.39U	<0.39U	NR	NR	NR	NR
Phenanthrene	None	<0.37U	NR	NR	<0.39U	<0.39U	NR	NR	NR	NR
Pyrene	None	<0.37U	NR	NR	<0.39U	<0.39U	NR	NR	NR	NR
Pesticides/PCBs (mg/kg)										
PCB-1254	None	**0.042***	NR	NR	**0.45***	**0.79***	NR	NR	NR	NR
VOCs (mg/kg)										
Acetone	None	<0.006U	NR	NR	<0.006U	<0.006U	NR	NR	NR	NR
Carbon tetrachloride	None	<0.006U	NR	NR	<0.006U	<0.006U	NR	NR	NR	NR
Toluene	None	<0.006U	NR	NR	<0.006U	<0.006U	NR	NR	NR	NR

Table 4–7. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11ss-021**	**LL11ss-022**	**LL11ss-023**	**LL11ss-024**	**LL11ss-025**	**LL11sb-002**	**LL11sb-005**	**LL11sb-006**	**LL11sb-007**
Sample ID		**LL11ss-021-0002-SO**	**LL11ss-022-0002-SO**	**LL11ss-023-0002-SO**	**LL11ss-024-0002-SO**	**LL11ss-025-0002-SO**	**LL11sb-002-0002-SO**	**LL11sb-005-0002-SO**	**LL11sb-006-0002-SO**	**LL11sb-007-0002-SO**
Date		**11/09/00**	**11/09/00**	**11/09/00**	**11/09/00**	**11/09/00**	**11/10/00**	**11/09/00**	**11/13/00**	**11/07/00**
Depth (ft)		**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**6.0 - 8.0**	**6.0 - 8.0**	**2.0 - 4.0**	**14.0 - 16.0**
Parameters Analyzed		**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**
Analyte	**Background Criteria**									
Metals (mg/kg)										
Aluminum	19500	11100	9840	16400	15000	11900	8990	4720	6140	7980
Antimony	0.96	0.4	0.33	0.5	0.33	0.39	<0.27U	<0.29U	0.31	0.4
Arsenic	19.8	13.6	16.4	11.8	12.8	12	18.9	12	18.5	**21.8***
Barium	124	47.1	46.3	88.8	65	38.9	39.2	20.6	26.1	23
Beryllium	0.88	0.49	0.62	0.81	0.68	0.56	0.55	<0.32U	0.42	0.39
Cadmium	0	<0.14U	<0.16U	<0.15U	<0.16U	<0.15U	**0.24***	<0.16U	<0.15U	<0.18U
Calcium	35500	1710	610	1650	2060	977	6710	143	7020	9150
Chromium	27.2	15.1	13	19.8	20	15.3	16.1	7.2	11.1	14.2
Cobalt	23.2	7.5	8.5	9.5	9.6	14.7	8.8	4	6.9	9.1
Copper	32.3	16.2	18.3	14	17.4	17.5	19.4	13.7	18.7	19.5
Cyanide	0	<0.45U	<0.47U	<0.46U	<0.35U	<0.46U	<0.5U	<0.47U	<0.31U	<0.35U
Iron	35200	20100	20800	24200	23600	21300	22500	12200	18500	24400
Lead	19.1	13.5	15.3	14.4	23.1*	12.6	12.5	8.9	10.8	10.3
Magnesium	8790	2750	2210	3070	3160	2480	3470	1040	3970	5750
Manganese	3030	257	228	763	188	493	297	186	269	366
Mercury	0.044	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U
Nickel	60.7	15.4	14.8	18.6	18.5	18	22	8.6	15.4	21.3
Potassium	3350	979	722	2210	1410	1470	1570	716	1210	1510
Selenium	1.5	<0.36U	0.48	<0.38U	0.42	<0.39U	<0.45U	<0.4U	<0.38U	<0.46U
Sodium	145	<71.6U	<79.1U	94.7	86.8	<77.4U	**858***	<80.4U	**671***	**452***
Thallium	0.91	<0.19U	<0.19U	<0.19U	<0.18U	<0.17U	<0.18U	<0.2U	<0.19U	<0.18U
Vanadium	37.6	20.5	18.4	28.5	29	21.6	15.3	8.9	11.2	12.7
Zinc	93.3	51.6	46	65.1	51.7	44.1	58.8	42.4	51.3	49.9
Anions (mg/kg)										
Nitrate	None	**1.4***	<0.96U	<1.2U	<1.2U	<1.2U	**1.5***	<1.2U	<0.96U	<1.1U
Sulfate	None	<58.5U	<47.8U	<59.5U	<59.8U	<57.8U	<48.4U	<59.1U	<48.2U	<54.8U
Sulfide	None	**37.1***	**28.7***	**161***	**52.3***	**44.4***	**39.9***	**52.5***	**46.9***	**29.9***
Miscellaneous (mg/kg)										
TPH-DRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
TPH-GRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Explosives/Propellants (mg/kg)										
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)										
Benz(a)anthracene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Chrysene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Phenanthrene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pyrene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pesticides/PCBs (mg/kg)										
PCB-1254	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
VOCs (mg/kg)										
Acetone	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon tetrachloride	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Toluene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 4–7. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11sb-010**	**LL11sb-024**	**LL11sb-025**	**LL11sb-026**	**LL11sb-027**	**LL11sb-027**	**LL11sb-028**	**LL11sb-029**	**LL11sb-030**
Sample ID		**LL11sb-010-0002-SO**	**LL11sb-024-0001-SO**	**LL11sb-025-0001-SO**	**LL11sb-026-0001-SO**	**LL11sb-027-0001-FD**	**LL11sb-027-0001-SO**	**LL11sb-028-0001-SO**	**LL11sb-029-0001-SO**	**LL11sb-030-0001-SO**
Date		**11/07/00**	**11/16/00**	**11/17/00**	**11/16/00**	**11/16/00**	**11/16/00**	**11/16/00**	**11/16/00**	**11/17/00**
Depth (ft)		**14.0 - 16.0**	**7.0 - 9.0**	**5.0 - 7.0**	**4.0 - 6.0**	**6.0 - 8.0**	**6.0 - 8.0**	**4.0 - 6.0**	**6.0 - 8.0**	**8.0 - 10.0**
Parameters Analyzed		**Misc., TAL Metals, Explosives**	**SVOCs, VOCs**	**SVOCs, VOCs**	**SVOCs, VOCs**	**SVOCs, VOCs**	**SVOCs, VOCs**	**SVOCs, VOCs**	**SVOCs, VOCs**	**SVOCs, VOCs**
Analyte	**Background Criteria**									
Metals (mg/kg)										
Aluminum	19500	5750	NR	NR	NR	NR	NR	NR	NR	NR
Antimony	0.96	0.35	NR	NR	NR	NR	NR	NR	NR	NR
Arsenic	19.8	14.7	NR	NR	NR	NR	NR	NR	NR	NR
Barium	124	17.5	NR	NR	NR	NR	NR	NR	NR	NR
Beryllium	0.88	<0.34U	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium	0	<0.17U	NR	NR	NR	NR	NR	NR	NR	NR
Calcium	35500	6920	NR	NR	NR	NR	NR	NR	NR	NR
Chromium	27.2	9.4	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt	23.2	6	NR	NR	NR	NR	NR	NR	NR	NR
Copper	32.3	22.8	NR	NR	NR	NR	NR	NR	NR	NR
Cyanide	0	<0.3U	NR	NR	NR	NR	NR	NR	NR	NR
Iron	35200	16800	NR	NR	NR	NR	NR	NR	NR	NR
Lead	19.1	8.1	NR	NR	NR	NR	NR	NR	NR	NR
Magnesium	8790	3850	NR	NR	NR	NR	NR	NR	NR	NR
Manganese	3030	346	NR	NR	NR	NR	NR	NR	NR	NR
Mercury	0.044	<0.04U	NR	NR	NR	NR	NR	NR	NR	NR
Nickel	60.7	14.8	NR	NR	NR	NR	NR	NR	NR	NR
Potassium	3350	1310	NR	NR	NR	NR	NR	NR	NR	NR
Selenium	1.5	<0.41U	NR	NR	NR	NR	NR	NR	NR	NR
Sodium	145	**456***	NR	NR	NR	NR	NR	NR	NR	NR
Thallium	0.91	<0.16U	NR	NR	NR	NR	NR	NR	NR	NR
Vanadium	37.6	10	NR	NR	NR	NR	NR	NR	NR	NR
Zinc	93.3	41.3	NR	NR	NR	NR	NR	NR	NR	NR
Anions (mg/kg)										
Nitrate	None	<0.97U	NR	NR	NR	NR	NR	NR	NR	NR
Sulfate	None	<48.5U	NR	NR	NR	NR	NR	NR	NR	NR
Sulfide	None	<27.6U	NR	NR	NR	NR	NR	NR	NR	NR
Miscellaneous (mg/kg)										
TPH-DRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
TPH-GRO	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Explosives/Propellants (mg/kg)										
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)										
Benz(a)anthracene	None	NR	<0.39U	<0.38U	<0.38U	<0.39U	<0.38U	<0.39U	<0.38U	<0.38U
Benzo(a)pyrene	None	NR	<0.39U	<0.38U	<0.38U	<0.39U	<0.38U	<0.39U	<0.38U	<0.38U
Benzo(b)fluoranthene	None	NR	<0.39U	<0.38U	<0.38U	<0.39U	<0.38U	<0.39U	<0.38U	<0.38U
Chrysene	None	NR	<0.39U	<0.38U	<0.38U	<0.39U	<0.38U	<0.39U	<0.38U	<0.38U
Fluoranthene	None	NR	<0.39U	<0.38U	<0.38U	<0.39U	<0.38U	<0.39U	<0.38U	<0.38U
Phenanthrene	None	NR	<0.39U	<0.38U	<0.38U	<0.39U	<0.38U	<0.39U	<0.38U	<0.38U
Pyrene	None	NR	<0.39U	<0.38U	<0.38U	<0.39U	<0.38U	<0.39U	<0.38U	<0.38U
Pesticides/PCBs (mg/kg)										
PCB-1254	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
VOCs (mg/kg)										
Acetone	None	NR	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U
Carbon tetrachloride	None	NR	<0.006U	<0.006U	**0.001J***	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U
Toluene	None	NR	<0.006U	<0.006U	<0.006U	**0.002J***	<0.006U	<0.006U	<0.006U	<0.006U

Table 4–7. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11sb-035**	**LL11sb-035**	**LL11sb-037**	**LL11sb-038**	**LL11sb-039**	**LL11sb-040**	**LL11ss-026**	**LL11ss-027**	**LL11ss-028**
Sample ID		**LL11sb-035-0001-FD**	**LL11sb-035-0001-SO**	**LL11sb-037-0001-SO**	**LL11sb-038-0001-SO**	**LL11sb-039-0001-SO**	**LL11sb-040-0001-SO**	**LL11ss-026-0002-SO**	**LL11ss-027-0002-SO**	**LL11ss-028-0002-SO**
Date		**11/17/00**	**11/17/00**	**03/13/01**	**03/13/01**	**03/13/01**	**03/13/01**	**11/10/00**	**11/10/00**	**11/10/00**
Depth (ft)		**4.0 - 6.0**	**4.0 - 6.0**	**6.0 - 8.0**	**6.0 - 8.0**	**6.0 - 8.0**	**6.0 - 8.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**
Parameters Analyzed **Analyte**	**Background Criteria**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Misc., Explosives, Pesticides/PCBs, SVOCs, VOCs**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**
Metals (mg/kg)										
Aluminum	19500	7410	7490	6990	7170	7460	8690	14000	7250	13900
Antimony	0.96	0.4	0.35	<0.29U	<0.27U	<0.27U	<0.28U	0.41	<0.28U	<0.29U
Arsenic	19.8	13.5	11.5	15.4	9.8	**22.3***	**23.4***	10.6	18.4	**20.1***
Barium	124	30.5	28.9	27	25.3	28.8	34.7	49.6	19.7	48.3
Beryllium	0.88	0.49	0.43	<0.37U	<0.38U	0.44	0.48	0.6	0.47	0.66
Cadmium	0	<0.15U	<0.14U	<0.19U	<0.19U	<0.18U	<0.19U	**0.26***	**0.18***	**0.27***
Calcium	35500	173	186	297	192	206	247	898	112	319
Chromium	27.2	9.5	8.5	9.4	9.1	11.6	13.4	17	9.2	18.1
Cobalt	23.2	7.2	6	5.3	5.8	8	8.6	6.2	8	8.5
Copper	32.3	22.2	18.2	16.4	19.5	21.2	21.9	17.6	21.8	17.8
Cyanide	0	<0.59U	<0.54U	<0.25U	<0.18U	<0.24U	<0.22U	<0.43U	<0.45U	<0.54U
Iron	35200	20100	15600	16200	17800	22100	24700	23000	20000	25800
Lead	19.1	7	5.3	8.8	11.5	11.3	10.9	17.6	13	13.3
Magnesium	8790	1680	1360	1350	1480	2160	2500	2440	1770	2680
Manganese	3030	248	265	250	245	277	323	306	300	229
Mercury	0.044	<0.04U	<0.04U	<0.042U	<0.041U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U
Nickel	60.7	14	11.4	10.9	11.6	18.6	21.5	14.9	16.4	19.4
Potassium	3350	888	941	695	707	1110	1340	1400	680	1530
Selenium	1.5	0.64	0.61	<0.47U	0.54	<0.45U	<0.47U	<0.48U	<0.47U	<0.49U
Sodium	145	**724***	**562***	**552***	**631***	**873***	**970***	**691***	**618***	**961***
Thallium	0.91	0.16	0.14	<0.19U	<0.18U	<0.18U	<0.19U	<0.19U	<0.19U	<0.2U
Vanadium	37.6	12.9	13	13.5	13.3	13.2	14.8	26.6	10.9	25
Zinc	93.3	59.2	50.8	47.4	47.7	57.5	63.9	44.5	57.7	55.2
Anions (mg/kg)										
Nitrate	None	<1.2U	<1.1U	<0.083U	<0.08U	**0.41***	**0.54***	<1.2U	<1.1U	<1.2U
Sulfate	None	<61.6U	<54.5U	**36.3***	**40.3***	**27.3***	**22.7***	<57.9U	<57.4U	<59.9U
Sulfide	None	<28.3U	<29.9U	<9.2U	<8.3U	<9.1U	<8.6U	**30.5***	**30.5***	<29.3U
Miscellaneous (mg/kg)										
TPH-DRO	None	NR	NR	<5.1U	<5U	<5U	<5U	NR	NR	NR
TPH-GRO	None	NR	NR	<0.063U	<0.062U	<0.06U	<0.061U	NR	NR	NR
Explosives/Propellants (mg/kg)										
Nitrocellulose	None	**1.1***	**0.87***	**2***	**1.8***	**2***	**1.8***	NR	NR	NR
SVOCs (mg/kg)										
Benz(a)anthracene	None	<0.41U	<0.4U	<0.41U	<0.4U	<0.4U	<0.4U	NR	NR	NR
Benzo(a)pyrene	None	<0.41U	<0.4U	<0.41U	<0.4U	<0.4U	<0.4U	NR	NR	NR
Benzo(b)fluoranthene	None	<0.41U	<0.4U	<0.41U	<0.4U	<0.4U	<0.4U	NR	NR	NR
Chrysene	None	<0.41U	<0.4U	<0.41U	<0.4U	<0.4U	<0.4U	NR	NR	NR
Fluoranthene	None	<0.41U	<0.4U	<0.41U	<0.4U	<0.4U	<0.4U	NR	NR	NR
Phenanthrene	None	<0.41U	<0.4U	<0.41U	<0.4U	<0.4U	<0.4U	NR	NR	NR
Pyrene	None	<0.41U	<0.4U	<0.41U	<0.4U	<0.4U	<0.4U	NR	NR	NR
Pesticides/PCBs (mg/kg)										
PCB-1254	None	<0.01U	<0.01U	<0.01U	<0.01U	<0.01U	<0.01U	NR	NR	NR
VOCs (mg/kg)										
Acetone	None	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	NR	NR	NR
Carbon tetrachloride	None	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	NR	NR	NR
Toluene	None	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	<0.006U	NR	NR	NR

Table 4–7. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate	**Background Criteria**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11ss-029**	**LL11ss-030**	**LL11ss-030**	**LL11ss-031**
Sample ID		**LL11ss-029-0002-SO**	**LL11ss-030-0002-FD**	**LL11ss-030-0002-SO**	**LL11ss-031-0002-SO**
Date		**11/14/00**	**11/14/00**	**11/14/00**	**11/10/00**
Depth (ft)		**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**
Parameters Analyzed		**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**
Analyte					
Metals (mg/kg)					
Aluminum	19500	13200	13700	19000	8560
Antimony	0.96	0.56	0.92	0.49	<0.29U
Arsenic	19.8	19.3	15.7	13.2	**21.7***
Barium	124	60.6	60.9	84.2	56.6
Beryllium	0.88	0.6	0.66	**0.89***	0.64
Cadmium	0	<0.18U	<0.19U	<0.19U	**0.26***
Calcium	35500	548	642	872	2090
Chromium	27.2	17.5	18.7	24.7	13.3
Cobalt	23.2	10.6	7.7	9.8	8.4
Copper	32.3	19.8	17	19.9	16.5
Cyanide	0	<0.47U	<0.52U	**1***	<0.56U
Iron	35200	25500	26900	30700	22300
Lead	19.1	14.5	14.9	15.1	**21.6***
Magnesium	8790	2690	3400	4340	2190
Manganese	3030	313	159	191	527
Mercury	0.044	<0.04U	<0.04U	<0.04U	<0.04U
Nickel	60.7	17.4	21.3	25.8	17.5
Potassium	3350	1210	1370	2520	1110
Selenium	1.5	1	<0.48U	0.52	<0.48U
Sodium	145	**706***	**517***	**793***	**734***
Thallium	0.91	0.22	0.21	0.21	<0.19U
Vanadium	37.6	27.3	23.3	31.5	17.3
Zinc	93.3	44.5	50	61.1	55
Anions (mg/kg)					
Nitrate	None	<0.59U	<0.57U	<0.53U	<1.2U
Sulfate	None	<58.9U	<57.1U	<52.7U	<57.8U
Sulfide	None	**76.2***	**81.8***	**81.8***	**33.3***
Miscellaneous (mg/kg)					
TPH-DRO	None	NR	NR	NR	NR
TPH-GRO	None	NR	NR	NR	NR
Explosives/Propellants (mg/kg)					
Nitrocellulose	None	NR	NR	NR	NR
SVOCs (mg/kg)					
Benz(a)anthracene	None	NR	NR	NR	NR
Benzo(a)pyrene	None	NR	NR	NR	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR
Chrysene	None	NR	NR	NR	NR
Fluoranthene	None	NR	NR	NR	NR
Phenanthrene	None	NR	NR	NR	NR
Pyrene	None	NR	NR	NR	NR
Pesticides/PCBs (mg/kg)					
PCB-1254	None	NR	NR	NR	NR

Table 4–7. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11ss-029**	**LL11ss-030**	**LL11ss-030**	**LL11ss-031**
Sample ID		**LL11ss-029-0002-SO**	**LL11ss-030-0002-FD**	**LL11ss-030-0002-SO**	**LL11ss-031-0002-SO**
Date		**11/14/00**	**11/14/00**	**11/14/00**	**11/10/00**
Depth (ft)		**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**
Parameters Analyzed					
Analyte	**Background Criteria**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**
			VOCs (mg/kg)		
Acetone	None	NR	NR	NR	NR
Carbon tetrachloride	None	NR	NR	NR	NR
Toluene	None	NR	NR	NR	NR

FPA = Former Production Area.
ft = Feet.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
PCB = Polychlorinated biphenyl.
NPA= Non-production area.
NR = Not reported/not analyzed.
RI = Remedial investigation.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
TAL = Target analyte list.
TPH-GRO/DRO = Total petroleum hydrocarbons-gasoline range organics/diesel range organics.
U = Not detected.
VOC = Volatile organic compound.
*** = Result exceeds background criteria or no background criteria was available.**
< = Less than.

Table 4–8. Analytes Detected in Phase I RI Surface Water Samples

Aggregate		**East Ditch EU**	**East Ditch EU**	**West Ditch EU**	**West Ditch EU**	**West Ditch EU**	**West Ditch EU**
Station		**LL11sw-012**	**LL11sw-012**	**LL11sw-014**	**LL11sw-014**	**LL11sw-015**	**LL11sw-015**
Sample ID		**LL11sw-012-0001-FD**	**LL11sw-012-0001-SW**	**LL11sw-014-0001-SW**	**LL11sw-014-0001b-SW**	**LL11sw-015-0001-SW**	**LL11sw-015-0001b-SW**
Date		**11/17/00**	**11/17/00**	**11/20/00**	**02/07/01**	**11/20/00**	**02/07/01**
Parameters Analyzed **Analyte**	**Background Criteria**	**RVAAP Full-suite analytes + Nitrate, Sulfate, and Sulfide**	**RVAAP Full-suite analytes + Nitrate, Sulfate, and Sulfide**	**RVAAP Full-suite analytes + Nitrate, Sulfate, and Sulfide**	**Explosives**	**RVAAP Full-suite analytes + Nitrate, Sulfate, and Sulfide**	**TAL Metals, Explosives**
Metals (mg/L)							
Antimony	0	<0.003U	<0.003U	<0.003U	NR	**0.0059***	NR
Barium	0.0475	0.0252	0.0258	0.0416	NR	0.0235	NR
Calcium	41.4	**75***	**76.8***	**85.4***	NR	**67.2***	NR
Iron	2.56	<0.05U	<0.05U	<0.05U	NR	0.0587	NR
Magnesium	10.8	**24.7***	**25.4***	**21***	NR	**15.5***	NR
Manganese	0.391	0.0139	0.0149	0.0181	NR	0.15	NR
Potassium	3.17	1.88	1.92	1.67	NR	1.24	NR
Sodium	21.3	13.5	13.7	14.7	NR	9.05	NR
Zinc	0.042	<0.01U	<0.01U	0.0115	NR	0.0155	NR
Anions (mg/L)							
Sulfate	None	**46.7***	**46.2***	**50.6***	NR	**32***	NR
SVOCs (mg/L)							
Bis(2-ethylhexyl)phthalate	None	<0.01U	<0.01U	<0.01U	NR	**0.012***	NR
VOCs (mg/L)							
Trichloroethene	None	**0.0006***	**0.002***	<0.0005U	NR	<0.0005U	NR

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

Table 4–9. Analytes Detected in Phase I RI Sediment Samples

Aggregate		**East Ditch EU**	**East Ditch EU**	**Sewer Outfall EU**	**West Ditch EU**	**West Ditch EU**
Station		**LL11sd-017**	**LL11sd-017**	**LL11sd-021**	**LL11sd-024**	**LL11sd-030**
Sample ID		**LL11sd-017-0001-FD**	**LL11sd-017-0001-SD**	**LL11sd-021-0001-SD**	**LL11sd-024-0001-SD**	**LL11sd-030-0001-SD**
Date		**11/15/00**	**11/15/00**	**11/16/00**	**11/16/00**	**11/16/00**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed		**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**
Analyte	**Background Criteria**					
Metals (mg/kg)						
Aluminum	13900	10300	10700	4300	**15400***	**21400***
Antimony	0	**0.42***	<0.4U	<0.34U	**0.9***	<0.88U
Arsenic	19.5	11.9	**21.1***	12.8	19.5	11.9
Barium	123	89.3	90.6	48	111	**159***
Beryllium	0.38	**0.61***	**0.69***	<0.51U	**1***	<1.3U
Cadmium	0	<0.26U	<0.27U	<0.26U	<0.24U	<0.65U
Calcium	5510	2630	2730	2960	2520	**6490***
Chromium	18.1	14	15.5	7.1	**21***	**26.2***
Cobalt	9.1	**9.5***	**9.5***	5.3	**14.1***	**11.5***
Copper	27.6	15.3	15.9	13.4	21.4	**32.7***
Iron	28200	20700	23300	12100	27800	24900
Lead	27.4	26.8	**39.8***	19.3	19.7	**47.6***
Magnesium	2760	2110	2160	1340	**3630***	**4260***
Manganese	1950	**1980***	**2020***	1760	530	311
Nickel	17.7	13.4	14	11.1	**27.7***	**31.1***
Potassium	1950	1020	1110	521	**2010***	**2240***
Selenium	1.7	**1.9***	<0.67U	<0.64U	0.66	<1.6U
Sodium	112	<129U	<133U	**396***	**1060***	**1450***
Thallium	0.89	<0.26U	<0.27U	<0.22U	<0.22U	<0.59U
Vanadium	26.1	19.9	22.2	8.9	**30.8***	**35.6***
Zinc	532	63.4	64.3	47.2	79.5	202
Anions						
Sulfate	None	**76.4***	**252***	**248***	<83.6U	**4220***
Sulfide	None	**137***	**210***	**540***	**43.4***	**431***
Explosives (mg/kg)						
Nitrocellulose	None	**1.9***	**1.8***	NR	NR	NR
Pesticides/PCBs (mg/kg)						
PCB-1254	None	**0.037***	**0.056***	NR	NR	NR
VOCs (mg/kg)						
Acetone	None	**0.028***	**0.03***	NR	NR	NR

EU = Exposure unit.
ft = Feet.
ID = Identification.
mg/kg = Milligrams per kilogram.
NR = Not reported/not analyzed.
PCB = Polychlorinated biphenyl.
RI = Remedial Investigation
RVAAP = Ravenna Army Ammunition Plant.
TAL = Target analyte list.
U = Not detected.
*** = Result exceeds background criteria or no background criteria was available.**
< = Less than.

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Table 4–10. Human Health COPCs per the Phase I RI

Surface Soil (0-1 ft bgs)	Subsurface Soil (>1 ft bgs)	Sediment	Surface Water	Groundwater
Aluminum Arsenic Manganese Vanadium Benzo(a)pyrene	Aluminum Arsenic Barium Thallium Aroclor-1254 Benzo(a)pyrene	Aluminum Arsenic Manganese Vanadium Benzo(a)pyrene	Antimony Manganese Bis(2-ethylhexyl) phthalate	Arsenic Bis(2-ethylhexyl) phthalate Trichloroethene

Source: *Report for the Remedial Investigation at Load Line 11 (AOC 44)* (MKM 2005a).

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

bgs = Below ground surface.

ft = Feet.

RI = Remedial Investigation.

Table 4–11. Summary of Ecological Risk Calculation Results per the Phase I RI

Terrestrial Plants and Soil Invertebrates	Benthic Invertebrates	Aquatic Organisms	Terrestrial Wildlife: Insectivores/Herbivores	Terrestrial Wildlife: Carnivores and Piscivores
No COPCs retained	No COPCs retained	No COPCs retained	Arsenic Aroclor-1254 Lead Chromium Zinc	Aroclor-1254

Source: *Report for the Remedial Investigation at Load Line 11 (AOC 44)* (MKM 2005a).

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

COPC = Chemical of potential concern.

RI = Remedial investigation.

Table 4–12. Chemicals Detected at Concentrations above Screening Criteria in Previous Investigations

Surface Soil	Subsurface Soil	Sediment	Surface Water
Aluminum Arsenic Chromium Cobalt Manganese Thallium Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Indeno(1,2,3-cd)pyrene	Aluminum Arsenic Barium Cobalt Thallium PCB-1254 Benzo(a)pyrene	Aluminum Arsenic Barium Chromium Manganese	Antimony Manganese Bis(2-ethylhexyl)phthalate Trichloroethene

Note: This table was generated using data from the *Report for the Remedial Investigation at Load Line 11 (AOC 44)* (MKM 2005a).

PCB = Polychlorinated biphenyl.

Table 4–13. PBA08 RI Surface Soil Samples and Rationales

PBA08 RI Station	Targeted Area	Purpose	Analyses Performed				
			Metals	**Explosives**	**VOCs**	**Pesticides/ PCBs**	**SVOC**
LL11ss-070	Adjacent to Earthen Barricade associated with Building AP-18 (Percussion Elements Storage)	Characterize an area not previously sampled.	Y	Y	N	PCBs	PAH
LL11ss-071	Building AP-9 (Shipping Building)	Characterize an area not previously sampled.	Y	Y	N	PCBs	PAH
LL11ss-074	Building AP-14 (Change House)	Delineate previously identified contamination.	Y	Y	N	PCBs	PAH
LL11ss-076	LL11ss-022; Drainage ditch near Buildings AP-1 and AP-3.	Delineate previously identified contamination.	Y	Y	N	PCBs	PAH
		QA/QC	Y	Y	N	PCBs	PAH
			Y	Y	N	PCBs	PAH
LL11ss-077	Drainage ditch exiting AOC in north-west portion of NPA	Characterize an area not previously sampled.	Y	Y	N	PCBs	PAH
LL11ss-078	Drainage ditch in north-central portion of NPA across road from Building AP-10 (downgradient of LL11sb-006)	Delineate previously identified contamination.	Y	Y	N	PCBs	PAH
LL11ss-079	Northern portion of NPA, upgradient of FPA	Characterize an area not previously sampled. Analyzed for RVAAP full-suite analytes.	Y	Y	Y	Y	Y
LL11ss-080	Downgradient of IRA excavation area in north-east portion of NPA	Characterize an area not previously sampled.	Y	Y	N	PCBs	PAH
LL11ss-081	Confluence of drainage ditches in northeastern portion of NPA	Characterize an area not previously sampled.	Y	Y	N	PCBs	PAH

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

Table 4–14. Analytes Detected in PBA08 RI Discrete Surface Soil Samples

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL11sb-060**	**LL11sb-061**	**LL11sb-062**	**LL11sb-062**	**LL11sb-064**	**LL11ss-071**	**LL11ss-072**	**LL11ss-073**	**LL11ss-074**
Sample ID		**LL11sb-060-5551-SO**	**LL11sb-061-5555-SO**	**LL11sb-062-6189-FD**	**LL11sb-062-5559-SO**	**LL11sb-064-5569-SO**	**LL11ss-071-5597-SO**	**LL11ss-072-5598-SO**	**LL11ss-073-5599-SO**	**LL11ss-074-5600-SO**
Date		**03/18/10**	**03/17/10**	**03/18/10**	**03/18/10**	**03/18/10**	**04/12/10**	**04/12/10**	**04/12/10**	**04/12/10**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed [a]		**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**Chromium Speciation**	**Chromium Speciation**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**
Analyte	**Background Criteria [b]**									
Metals (mg/kg)										
Aluminum	17700	14800	8150	11300	11200	789	11100	NR	NR	9340
Antimony	0.96	0.099J	0.081J	0.12J	0.1J	0.08J	0.1J	NR	NR	0.12J
Arsenic	15.4	13.3J	12.1J	10.2J	10.6J	2.7J	11.2	NR	NR	11.1
Barium	88.4	57.5J	45.5J	66.1J	73.8J	14.6J	57.7	NR	NR	44
Beryllium	0.88	0.65	0.49	0.55	0.58	0.13	0.56	NR	NR	0.48
Cadmium	0	**0.21J***	**0.068J***	0.26J*	0.24J*	**0.053J***	**0.13J***	NR	NR	**0.17J***
Calcium	15800	2000	2300J	2220	2030	1690J	1450	NR	NR	2630
Chromium	17.4	**18***	12.1	13.5	13.5	3.5	14.9	10.1	17.1	12.9
Chromium, hexavalent		NR	NR	NR	NR	NR	NR	**0.44J***	<1U	NR
Cobalt	10.4	8.3J	9.4	**10.5J***	**13J***	2.2	10.4	NR	NR	8.5
Copper	17.7	16.6	17.5	12.6	11	2.7	16.2J	NR	NR	16.4J
Iron	23100	**30100***	**23900***	20600	22300	11400	**23500***	NR	NR	21800
Lead	26.1	20.5J	15.3J	23.4J	21.4J	3.9J	17	NR	NR	17.5
Magnesium	3030	2270	2880J	2210	2140	121J	2670	NR	NR	2600
Manganese	1450	257	263	887	1320	174	525	NR	NR	302
Mercury	0.036	**0.077J***	<0.12U	**0.041J***	0.035J	<0.11U	0.031J	NR	NR	0.018J
Nickel	21.1	19	19.6	15.7	15.4	4.5	18.9	NR	NR	18
Potassium	927	852J	**1100***	804J	658J	232	803	NR	NR	748
Selenium	1.4	1.1J	0.72J	0.94J	0.9J	0.25J	0.83J	NR	NR	0.84J
Silver	0	<0.04UJ	**0.023J***	<0.033UJ	<0.036UJ	**0.0046J***	<0.028UJ	NR	NR	<0.027UJ
Sodium	123	44.5J	63.6J	35.9J	34.8J	21.9J	34.5J	NR	NR	36.2J
Thallium	0	**0.19J***	**0.15J***	**0.16J***	**0.17J***	<0.22U	0.16J*	NR	NR	**0.15J***
Vanadium	31.1	25	14.8	19.7	20.8	2.9	19.9	NR	NR	17.2
Zinc	61.8	**128***	52.6J	55.7	49.9	20.9J	52.8J	NR	NR	54.9J
Explosives (mg/kg)										
HMX	None	<0.24UJ	<0.24U	<0.25U	<0.24U	<0.24U	<0.26U	NR	NR	<0.24U
PETN	None	<0.49U	**0.049J***	<0.5U	<0.48U	<0.48U	<0.52U	NR	NR	<0.48U
Tetryl	None	<0.24U	**0.02J***	<0.25U	<0.24U	<0.24U	<0.26U	NR	NR	<0.24U
SVOCs (mg/kg)										
Acenaphthene	None	**0.033***	**0.081***	<0.009U	<0.0088U	<0.0074U	<0.0082U	NR	NR	<0.0078U
Acenaphthylene	None	**0.012***	<0.008U	<0.009U	<0.0088U	<0.0074U	<0.0082U	NR	NR	<0.0078U
Anthracene	None	**0.049***	**0.16***	<0.009U	<0.0088U	<0.0074U	<0.0082U	NR	NR	<0.0078U
Benz(a)anthracene	None	**0.37***	**0.35***	<0.009U	<0.0088U	**0.0089***	<0.0082U	NR	NR	<0.0078U
Benzo(a)pyrene	None	**0.45***	**0.31***	**0.0099***	**0.0091***	<0.0074U	<0.0082U	NR	NR	<0.0078U
Benzo(b)fluoranthene	None	**0.56***	**0.42***	<0.009U	<0.0088U	**0.014***	<0.0082U	NR	NR	**0.011***
Benzo(ghi)perylene	None	**0.32***	**0.23***	<0.009U	<0.0088U	**0.012***	<0.0082U	NR	NR	<0.0078U
Benzo(k)fluoranthene	None	**0.37***	**0.17***	<0.009U	<0.0088U	<0.0074U	<0.0082U	NR	NR	<0.0078U
Chrysene	None	**0.47***	**0.31***	<0.009U	<0.0088U	**0.014***	<0.0082U	NR	NR	<0.0078U
Dibenz(a,h)anthracene	None	**0.076***	**0.072***	<0.009U	<0.0088U	**0.022***	<0.0082U	NR	NR	<0.0078U
Fluoranthene	None	**1***	**0.9***	**0.017***	**0.014***	**0.017***	**0.0093***	NR	NR	**0.013***
Fluorene	None	**0.025***	**0.079***	<0.009U	<0.0088U	<0.0074U	<0.0082U	NR	NR	<0.0078U

Table 4–14. Analytes Detected in PBA08 RI Discrete Surface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL11sb-060**	**LL11sb-061**	**LL11sb-062**	**LL11sb-062**	**LL11sb-064**	**LL11ss-071**	**LL11ss-072**	**LL11ss-073**	**LL11ss-074**
Sample ID		**LL11sb-060-5551-SO**	**LL11sb-061-5555-SO**	**LL11sb-062-6189-FD**	**LL11sb-062-5559-SO**	**LL11sb-064-5569-SO**	**LL11ss-071-5597-SO**	**LL11ss-072-5598-SO**	**LL11ss-073-5599-SO**	**LL11ss-074-5600-SO**
Date		**03/18/10**	**03/17/10**	**03/18/10**	**03/18/10**	**03/18/10**	**04/12/10**	**04/12/10**	**04/12/10**	**04/12/10**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed [a] **Analyte**	**Background Criteria** [b]	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**Chromium Speciation**	**Chromium Speciation**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**
SVOCs (mg/kg), continued										
Indeno(1,2,3-cd)pyrene	None	**0.27***	**0.2***	<0.009U	<0.0088U	**0.021***	<0.0082U	NR	NR	<0.0078U
Naphthalene	None	**0.01***	**0.017***	<0.009U	**0.0089***	<0.0074U	<0.0082U	NR	NR	<0.0078U
Phenanthrene	None	**0.37***	**0.62***	**0.011***	<0.0088U	**0.012***	<0.0082U	NR	NR	<0.0078U
Pyrene	None	**0.83***	**0.69***	**0.014***	**0.012***	**0.013***	<0.0082U	NR	NR	**0.011***
PCBs (mg/kg)										
PCB-1254	None	<0.046U	**0.42***	<0.045U	<0.043U	**0.02J***	<0.041U	NR	NR	**0.02J***

Table 4–14. Analytes Detected in PBA08 RI Discrete Surface Soil Samples (continued)

Aggregate	**Background Criteria [b]**	**FPA**	**FPA**	**FPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11ss-075**	**LL11ss-076**	**LL11ss-076**	**LL11sb-063**	**LL11sb-065**	**LL11sb-066**	**LL11sb-067**	**LL11sb-068**	**LL11sb-069**
Sample ID		**LL11ss-075-5601-SO**	**LL11ss-076-6183-FD**	**LL11ss-076-5602-SO**	**LL11sb-063-5563-SO**	**LL11sb-065-5573-SO**	**LL11sb-066-5577-SO**	**LL11sb-067-5581-SO**	**LL11sb-068-5585-SO**	**LL11sb-069-5589-SO**
Date		**04/12/10**	**04/12/10**	**04/12/10**	**03/22/10**	**03/22/10**	**03/22/10**	**03/18/10**	**03/18/10**	**03/22/10**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed [a]		**Chromium Speciation**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**
Analyte										
Metals (mg/kg)										
Aluminum	17700	NR	13500	13000	8570J	12900J	10200	8740	8920	6960
Antimony	0.96	NR	0.15J	0.26J	0.1J	0.087J	<0.7UJ	0.099J	0.091J	<0.7UJ
Arsenic	15.4	NR	**18.7***	**26.4***	9.3J	10.3J	9.6	10.1J	12.3J	7.6
Barium	88.4	NR	46.1	44.2	64.5	45.5	69.5J	57.7J	55.9J	50.4J
Beryllium	0.88	NR	0.5	0.45	0.65	0.41	0.48	0.49	0.5	0.51
Cadmium	0	NR	**0.08J***	**0.071J***	**0.24J***	**0.073J***	**0.13J***	**0.14J***	**0.15J***	**0.29***
Calcium	15800	NR	1120	1030	8480	446	180J	2250J	1260J	1870J
Chromium	17.4	15.4	16.6	15.4	11.3	14.4	11.9	11.8	11.6	9.3
Chromium, hexavalent		**0.71J***	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt	10.4	NR	6.1	6	7.3	6.4	9.5	8.2	9.1	5.4
Copper	17.7	NR	**18J***	**17.9J***	14	10.7	6.3	11.9	14	10.4
Iron	23100	NR	**31900***	**26200***	17100	21200	19700	19700	20900	15100
Lead	26.1	NR	14.7	14.2	**27.2***	11.6	17	16.9J	14.8J	16.3
Magnesium	3030	NR	2430	2490	**3060J***	2210J	1430	2380J	2250J	1570
Manganese	1450	NR	171	136	748	243	1100	543	608	247
Mercury	0.036	NR	0.034J	**0.039J***	**0.041J***	**0.043J***	**0.053J***	<0.12U	0.023J	**0.054J***
Nickel	21.1	NR	16.2	16.3	14.7	12.9	9	15.6	17.9	12.8
Potassium	927	NR	662	675	721	635	512	660	709	549
Selenium	1.4	NR	0.88J	0.81J	1.1J	0.89J	1	0.72J	0.75J	1
Silver	0	NR	<0.024UJ	<0.024UJ	**0.025J***	<0.017UJ	**0.05J***	**0.024J***	<0.025UJ	**0.036J***
Sodium	123	NR	33.2J	36J	74.3J	30.4J	30.3J	39.4J	39.2J	33J
Thallium	0	NR	**0.16J***	**0.16J***	**0.13J***	**0.13J***	**0.18J***	**0.14J***	**0.16J***	**0.1J***
Vanadium	31.1	NR	24.4	24	15	24.4	22.3	16.3	16.1	15.1
Zinc	61.8	NR	40.8J	38.8J	**64.3***	46.1	38.7	46.9J	56J	**67.6***
Explosives (mg/kg)										
HMX	None	NR	<0.25U	<0.24U	<0.26U	<0.26U	<0.25U	<0.24U	<0.25U	<0.24U
PETN	None	NR	<0.5U	<0.48U	<0.51U	<0.51U	<0.5U	**0.036J***	<0.5U	<0.48U
Tetryl	None	NR	<0.25U	<0.24U	<0.26U	<0.26U	<0.25U	<0.24U	<0.25U	<0.24U
SVOCs (mg/kg)										
Acenaphthene	None	NR	<0.0083U	<0.0085U	<0.0098U	<0.0086U	<0.0093U	**0.065***	<0.061U	<0.0094U
Acenaphthylene	None	NR	<0.0083U	<0.0085U	<0.0098U	<0.0086U	<0.0093U	<0.008U	<0.061U	<0.0094U
Anthracene	None	NR	<0.0083U	<0.0085U	**0.011***	<0.0086U	<0.0093U	**0.13***	<0.061U	<0.0094U
Benz(a)anthracene	None	NR	**0.018***	**0.0096***	**0.048***	<0.0086U	<0.0093U	**0.32***	**0.015J***	**0.046***
Benzo(a)pyrene	None	NR	**0.022***	**0.011***	**0.049***	<0.0086U	<0.0093U	**0.28***	**0.014J***	**0.05***
Benzo(b)fluoranthene	None	NR	**0.025***	**0.016***	**0.085***	<0.0086U	<0.0093U	**0.41***	**0.022J***	**0.081***
Benzo(ghi)perylene	None	NR	**0.019***	<0.0085U	**0.041***	<0.0086U	<0.0093U	**0.21***	**0.014J***	**0.034***
Benzo(k)fluoranthene	None	NR	<0.0083U	<0.0085U	**0.036***	<0.0086U	<0.0093U	**0.13***	**0.0094J***	**0.037***
Chrysene	None	NR	**0.017***	**0.0097***	**0.054***	<0.0086U	<0.0093U	**0.28***	**0.016J***	**0.056***
Dibenz(a,h)anthracene	None	NR	<0.0083U	<0.0085U	<0.0098U	<0.0086U	<0.0093U	**0.069***	<0.061U	<0.0094U
Fluoranthene	None	NR	**0.03***	**0.016***	**0.1***	<0.0086U	**0.011***	**0.78***	**0.034J***	**0.12***
Fluorene	None	NR	<0.0083U	<0.0085U	<0.0098U	<0.0086U	<0.0093U	**0.049***	<0.061U	<0.0094U

Table 4–14. Analytes Detected in PBA08 RI Discrete Surface Soil Samples (continued)

Aggregate		**FPA**	**FPA**	**FPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11ss-075**	**LL11ss-076**	**LL11ss-076**	**LL11sb-063**	**LL11sb-065**	**LL11sb-066**	**LL11sb-067**	**LL11sb-068**	**LL11sb-069**
Sample ID		**LL11ss-075-5601-SO**	**LL11ss-076-6183-FD**	**LL11ss-076-5602-SO**	**LL11sb-063-5563-SO**	**LL11sb-065-5573-SO**	**LL11sb-066-5577-SO**	**LL11sb-067-5581-SO**	**LL11sb-068-5585-SO**	**LL11sb-069-5589-SO**
Date		**04/12/10**	**04/12/10**	**04/12/10**	**03/22/10**	**03/22/10**	**03/22/10**	**03/18/10**	**03/18/10**	**03/22/10**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed [a]		**Chromium Speciation**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**
Analyte	**Background Criteria [b]**									
SVOCs (mg/kg), continued										
Indeno(1,2,3-cd)pyrene	None	NR	**0.015***	<0.0085U	**0.028***	<0.0086U	<0.0093U	**0.19***	**0.011J***	**0.03***
Naphthalene	None	NR	<0.0083U	<0.0085U	**0.01***	<0.0086U	<0.0093U	**0.0094***	<0.061U	<0.0094U
Phenanthrene	None	NR	**0.015***	<0.0085U	**0.046***	<0.0086U	<0.0093U	**0.52***	**0.017J***	**0.058***
Pyrene	None	NR	**0.022***	**0.013***	**0.096***	<0.0086U	**0.01***	**0.59***	**0.025J***	**0.11***
PCBs (mg/kg)										
PCB-1254	None	NR	<0.041U	<0.042U	<0.049U	<0.043U	<0.046UJ	<0.039U	<0.041U	<0.046UJ

Table 4–14. Analytes Detected in PBA08 RI Discrete Surface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11ss-070**	**LL11ss-077**	**LL11ss-078**	**LL11ss-079**	**LL11ss-080**	**LL11ss-081**
Sample ID		**LL11ss-070-5596-SO**	**LL11ss-077-5603-SO**	**LL11ss-078-5604-SO**	**LL11ss-079-5605-SO**	**LL11ss-080-5606-SO**	**LL11ss-081-5607-SO**
Date		**04/12/10**	**04/12/10**	**04/12/10**	**04/12/10**	**04/12/10**	**04/12/10**
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**
Parameters Analyzed [a]		**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**
Analyte	**Background Criteria** [b]						
Aluminum	17700	7900	12400	9350	8070	11100	11400
Antimony	0.96	0.74J	<0.62UJ	0.16J	0.084J	<0.72UJ	0.12J
Arsenic	15.4	**40.4***	10.2	10.8	9.7	10.4	6.5
Barium	88.4	65.8	57.6	60.1	26.8	85.6	**128***
Beryllium	0.88	0.59	0.36	0.55	0.36	0.76	0.69
Cadmium	0	**0.17J***	**0.057J***	**0.92***	**0.092J***	**0.34***	**0.45***
Calcium	15800	10100	859	2650	<113UJ	1770	2800
Chromium	17.4	12.1	14.5	13.4	9.5	12.8	15.4
Chromium, hexavalent		NR	NR	NR	NR	NR	NR
Cobalt	10.4	**12.7***	8.4	8.4	5.9	9.2	7.6
Copper	17.7	**19.6J***	15.5J	17.3J	11.2J	10.2J	**18.1J***
Iron	23100	**26300***	20100	21700	16200	20600	16500
Lead	26.1	**29.5***	9.9	23.4	12.6	17.8	**33.9***
Magnesium	3030	2750	2230	2560	1430	2060	2650
Manganese	1450	1030	393	337	239	506	445
Mercury	0.036	**0.044J***	<0.12U	0.031J	0.02J	**0.037J***	**0.04J***
Nickel	21.1	**26.2***	16.7	19.4	11.2	16.8	20.4
Potassium	927	588	**967***	912	437	788	908
Selenium	1.4	0.91J	0.78J	0.94J	0.7J	0.88J	1.2J
Silver	0	<0.029UJ	**0.032J***	**0.035J***	<0.021UJ	**0.053J***	**0.06J***
Sodium	123	85.9J	35.2J	40.6J	22.5J	38.5J	48.2J
Thallium	0	**0.15J***	**0.21J***	**0.16J***	**0.11J***	**0.16J***	**0.21J***
Vanadium	31.1	14.4	16.5	17	13.7	21.4	19.1
Zinc	61.8	57.8J	45.6J	**478J***	40.4J	**78.6J***	**117J***
HMX	None	<0.24U	<0.24U	<0.25U	<0.24U	<0.26U	**0.013J***
PETN	None	<0.48U	<0.48U	<0.5U	<0.48U	<0.51U	<0.5U
Tetryl	None	<0.24U	<0.24U	<0.25U	<0.24U	<0.26U	<0.25U
Acenaphthene	None	<0.0079U	<0.0083U	<0.0082U	<0.059U	<0.0096U	**0.012***
Acenaphthylene	None	<0.0079U	<0.0083U	<0.0082U	<0.059U	<0.0096U	<0.011U
Anthracene	None	<0.0079U	<0.0083U	**0.016***	<0.059U	<0.0096U	**0.018***
Benz(a)anthracene	None	**0.042***	<0.0083U	**0.056***	**0.013J***	<0.0096U	**0.089***
Benzo(a)pyrene	None	**0.053***	<0.0083U	**0.052***	**0.017J***	<0.0096U	**0.11***
Benzo(b)fluoranthene	None	**0.12***	<0.0083U	**0.068***	<0.059U	<0.0096U	**0.15***
Benzo(ghi)perylene	None	**0.047***	<0.0083U	**0.039***	**0.013J***	<0.0096U	**0.066***
Benzo(k)fluoranthene	None	**0.062***	<0.0083U	**0.036***	<0.059U	<0.0096U	**0.077***
Chrysene	None	**0.076***	<0.0083U	**0.059***	**0.018J***	<0.0096U	**0.11***
Dibenz(a,h)anthracene	None	<0.0079U	<0.0083U	<0.0082U	<0.059U	<0.0096U	<0.011U
Fluoranthene	None	**0.075***	<0.0083U	**0.14***	**0.028J***	**0.02***	**0.26***
Fluorene	None	<0.0079U	<0.0083U	<0.0082U	<0.059U	<0.0096U	<0.011U

Table 4–14. Analytes Detected in PBA08 RI Discrete Surface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11ss-070**	**LL11ss-077**	**LL11ss-078**	**LL11ss-079**	**LL11ss-080**	**LL11ss-081**
Sample ID		**LL11ss-070-5596-SO**	**LL11ss-077-5603-SO**	**LL11ss-078-5604-SO**	**LL11ss-079-5605-SO**	**LL11ss-080-5606-SO**	**LL11ss-081-5607-SO**
Date		**04/12/10**	**04/12/10**	**04/12/10**	**04/12/10**	**04/12/10**	**04/12/10**
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**
Parameters Analyzed [a]		**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**
Analyte	**Background Criteria [b]**						
SVOCs (mg/kg), continued							
Indeno(1,2,3-cd)pyrene	None	**0.037***	<0.0083U	0.033*	<0.059U	<0.0096U	**0.067***
Naphthalene	None	<0.0079U	<0.0083U	<0.0082U	<0.059U	<0.0096U	<0.011U
Phenanthrene	None	**0.025***	<0.0083U	**0.069***	**0.012J***	<0.0096U	**0.11***
Pyrene	None	**0.061***	<0.0083U	**0.1***	**0.023J***	**0.016***	**0.19***
PCBs (mg/kg)							
PCB-1254	None	<0.039U	<0.041U	**0.035J***	<0.039U	<0.047U	<0.056U

[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.
FPA = Former production area.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
NPA = Non-production area.
NR = Not reported/not analyzed.
PBA08 RI = Performance-Based Acquisition 2008 Remedial Investigation.
PCB = Polychlorinated biphenyl.
PETN = Pentaerythritol tetranitrate.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
TAL = Target analyte list.
U = Non-detectable concentration.
* = Result exceeds background criteria or no background criteria was available.
< = Less than.

Table 4–15. Chromium Speciation Samples under PBA08 RI

PBA08 RI Location	Rationale for Sample Selection
LL11ss-072	Discrete sample collected to assess chromium speciation. Previous chromium result represents elevated chromium concentration (LL11sb-004 at 20.7 mg/kg)
LL11ss-073	Discrete sample collected to assess chromium speciation. Previous chromium result represents near background chromium concentration (LL11sd-025 at 17.5 mg/kg)
LL11ss-075	Discrete sample collected to assess chromium speciation. Previous chromium result represents elevated chromium concentration (LL11cs-011 at 28.4 mg/kg)

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

Table 4–16. Subsurface Soil Rationale and Analyses

PBA08 RI Location	Comments/Rationale	Sample Type	Depth (ft bgs)	Analyses Performed				
				Metals	Explosives	VOCs	Pesticides/ PCBs	SVOC
LL11sb-060	Confirm presence of contamination in previously sampled area (LL11sb-001)	Discrete	0-1	Y	Y	N	PCBs	PAH
		Discrete	1-4	Y	Y	N	PCBs	PAH
		Discrete	4-7	Y	Y	N	PCBs	PAH
		NA	7-13	Y	Y	N	N	N
LL11sb-061	Further investigation of previously identified contamination (LL11ss-003 and LL11ss-005, Building AP-8)	Discrete	0-1	Y	Y	N	PCBs	PAH
		Discrete	1-4	Y	Y	N	PCBs	PAH
		Discrete	4-7	Y	Y	N	PCBs	PAH
		NA	7-13	N	N	N	N	N
LL11sb-062	Delineate vertical and lateral extent of previously identified contamination (LL11sb-004 and LL11sb-017	Discrete	0-1	Y	Y	N	PCBs	PAH
		Discrete	1-4	Y	Y	N	PCBs	PAH
		Discrete	4-7	Y	Y	N	PCBs	PAH
		NA	7-13	N	N	N	N	N
	QA/QC	Discrete	0-1	Y	Y	N	PCBs	PAH
	QA/QC	Discrete	0-1	Y	Y	N	PCBs	PAH
LL11sb-085	Geotechnical. Water encountered at 6.5 ft bgs. South of Building AP-11	Discrete	2-3.9	N	N	N	N	N
		Discrete	4-5.5	N	N	N	N	N
LL11sb-063	Confirm presence of contamination in previously sampled area (LL11ss-024; LL11cs-018, LL11cs-019); Geoprobe could not access location safely over steep ditch slopes; hand auger refusal at 5 ft bgs	Discrete	0-1	Y	Y	N	PCBs	PAH
		Discrete	1-4	Y	Y	N	PCBs	PAH
		Discrete	4-5	Y	Y	N	PCBs	PAH
		NS	7-13	N	N	N	N	N
LL11sb-064	Confirm presence of contamination in previously sampled area (LL11ss-012 and LL11ss-013; Building AP-11 QA/QC	Discrete	0-1	Y	Y	N	PCBs	PAH
	QA/QC	Discrete	1-4	Y	Y	N	PCBs	PAH
	QA/QC	Discrete	4-7	Y	Y	N	PCBs	PAH
		Discrete[b]	7-13	Y	Y	N	PCBs	PAH
		Discrete	7-13	Y	Y	N	PCBs	PAH
		Discrete	7-13	Y	Y	N	PCBs	PAH
LL11sb-065	Confirm presence of contamination in previously sampled area (LL11ss-029)	Discrete	0-1	Y	Y	N	PCBs	PAH
		Discrete	1-4	Y	Y	N	PCBs	PAH
		Discrete	4-7	Y	Y	N	PCBs	PAH
		Discrete[a]	7-13	Y	Y	N	PCBs	PAH

Table 4–16. Subsurface Soil Rationale and Analyses (continued)

PBA08 RI Location	Comments/Rationale	Sample Type	Depth ft (bgs)	Analyses Performed				
				Metals	Explosives	VOCs	Pesticides/ PCBs	SVOC
LL11sb-066	Delineate vertical extent of previously identified contamination (LL11ss-028)	Discrete	0-1	Y	Y	N	PCBs	PAH
		Discrete	1-4	Y	Y	N	PCBs	PAH
		Discrete	4-7	Y	Y	N	PCBs	PAH
		NA	7-13	N	N	N	N	N
LL11sb-067	Confirm presence of contamination in previously sampled area (LL11cs-045)	Discrete	0-1	Y	Y	N	PCBs	PAH
		Discrete	1-4	Y	Y	N	PCBs	PAH
		Discrete	4-7	Y	Y	N	PCBs	PAH
		NA	7-13	N	N	N	N	N
	QA/QC	Discrete	1-4	Y	Y	N	PCBs	PAH
	QA/QC	Discrete	1-4	Y	Y	N	PCBs	PAH
LL11sb-068	Delineate previously identified contamination (LL11cs-050, LL11sb-040, and LL11sb-039). 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
LL11sb-069	Confirm presence of contamination in previously sampled area (LL11ss-031, drainage ditch); Geoprobe could not access location safely over steep ditch slopes; hand auger refusal at 5 ft bgs	Discrete	0-1	Y	Y	N	PCBs	PAH
		Discrete	1-4	Y	Y	N	PCBs	PAH
		Discrete	4-5	Y	Y	N	PCBs	PAH
		NS	7-13	N	N	N	N	N

[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 results of the 4–7 ft sample interval.

NS = Not sampled due to refusal.

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.

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Table 4–17. Analytes Detected in PBA08 RI Subsurface Soil Samples

Aggregate		**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**	**FPA**
Station		**LL11sb-060**	**LL11sb-060**	**LL11sb-061**	**LL11sb-061**	**LL11sb-062**	**LL11sb-062**	**LL11sb-064**	**LL11sb-064**	**LL11sb-064**
Sample ID		**LL11sb-060-5552-SO**	**LL11sb-060-5553-SO**	**LL11sb-061-5556-SO**	**LL11sb-061-5557-SO**	**LL11sb-062-5560-SO**	**LL11sb-062-5561-SO**	**LL11sb-064-5570-SO**	**LL11sb-064-5571-SO**	**LL11sb-064-6188-FD**
Date		**03/18/10**	**03/18/10**	**03/17/10**	**03/17/10**	**03/18/10**	**03/18/10**	**03/18/10**	**03/18/10**	**03/18/10**
Depth (ft)		**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, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**
Analyte	**Background Criteria**[b]									
Metals (mg/kg)										
Aluminum	19500	13100	6110	6950	6650	16200	6550	5340	5130	6110
Antimony	0.96	0.084J	0.093J	0.084J	0.079J	<0.63R	0.077J	0.083J	0.077J	<0.62UJ
Arsenic	19.8	15.9J	16.8J	15.1J	15.4	11.7J	18.2J	12.5J	13.9	11.5J
Barium	124	103J	56.4	31.9J	30	65.9J	30.8	28.8J	25.1	26.4J
Beryllium	0.88	0.84	0.28J	0.39	0.34	0.69	0.34J	0.32	0.26	0.3
Cadmium	0	**0.074J***	**0.077J***	**0.044J***	**0.053J***	<0.065UJ	**0.061J***	**0.068J***	**0.064J***	<0.054UJ
Calcium	35500	1600	1140	1870J	7710	1070	3970	6320J	6760	5080J
Chromium	27.2	16.6	9	10.7	10.6	19	10.3	8.5	8.4	9.5
Cobalt	23.2	**27.1J***	8	7.7	8.5	11.5J	8.6	7.1	7.1	7.4
Copper	32.3	22.1	23.9J	18.6	18.5	20.4	18J	16.8	18.4	16.7
Iron	35200	29000	21600	22400	22600	27000	22600	19800	19500	18600
Lead	19.1	15.8J	15.3	14.9J	12.2	16.5J	11.4	10.4J	10	8.8J
Magnesium	8790	3260	2140J	2600J	3820	3900	3040J	3010J	3440	3740J
Manganese	3030	788	593	260	355	256	361	382	325	279
Mercury	0.044	<0.12U	<0.12U	<0.12U	<0.12U	0.026J	<0.12U	<0.11U	<0.12U	<0.12U
Nickel	60.7	30.4	17.7J	18	19.1	28.8	19.2J	16.7	16.8	17
Potassium	3350	1050J	574	848	953	1290J	807	895	815	1000
Selenium	1.5	1.4J	0.73J	0.65J	0.72	0.84J	0.64J	0.5J	0.59J	0.81J
Silver	0	<0.035UJ	**0.019J***	**0.019J***	**0.021J***	<0.018UJ	**0.017J***	**0.017J***	**0.019J***	<0.018UJ
Sodium	145	63.2J	34.3J	64.2J	56.6J	48.5J	41.7J	46.5J	34.8J	61.3J
Thallium	0.91	0.19J	0.12J	0.14J	0.13J	0.18J	0.12J	0.11J	0.11J	0.11J
Vanadium	37.6	22.2	10.4	12.3	11.9	22.3	11.4	10.2	9.5	10.4
Zinc	93.3	62.5	56	52.3J	55.3	57.6	53	55.2J	51	47.7J
SVOCs (mg/kg)										
Benz(a)anthracene	None	<0.0081U	<0.0079U	<0.0077U	<0.0077U	<0.0084U	<0.0077U	<0.0077U	<0.008U	<0.0083U
Benzo(a)pyrene	None	<0.0081U	<0.0079U	<0.0077U	<0.0077U	<0.0084U	<0.0077U	<0.0077U	<0.008U	<0.0083U
Benzo(b)fluoranthene	None	<0.0081U	<0.0079U	<0.0077U	<0.0077U	<0.0084U	<0.0077U	<0.0077U	<0.008U	<0.0083U
Benzo(ghi)perylene	None	<0.0081U	<0.0079U	<0.0077U	<0.0077U	<0.0084U	<0.0077U	<0.0077U	<0.008U	<0.0083U
Bis(2-ethylhexyl)phthalate	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Chrysene	None	<0.0081U	<0.0079U	<0.0077U	<0.0077U	<0.0084U	<0.0077U	<0.0077U	<0.008U	<0.0083U
Di-n-butyl phthalate	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Fluoranthene	None	<0.0081U	<0.0079U	<0.0077U	<0.0077U	<0.0084U	<0.0077U	<0.0077U	<0.008U	<0.0083U
Phenanthrene	None	<0.0081U	<0.0079U	<0.0077U	<0.0077U	<0.0084U	<0.0077U	<0.0077U	<0.008U	<0.0083U
Pyrene	None	<0.0081U	<0.0079U	<0.0077U	<0.0077U	<0.0084U	<0.0077U	<0.0077U	<0.008U	<0.0083U

Table 4–17. Analytes Detected in PBA08 RI Subsurface Soil Samples (continued)

Aggregate		**FPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11sb-064**	**LL11sb-063**	**LL11sb-063**	**LL11sb-065**	**LL11sb-065**	**LL11sb-065**	**LL11sb-066**	**LL11sb-066**	**LL11sb-067**
Sample ID		**LL11sb-064-5572-SO**	**LL11sb-063-5564-SO**	**LL11sb-063-5565-SO**	**LL11sb-065-5574-SO**	**LL11sb-065-5575-SO**	**LL11sb-065-5576-SO**	**LL11sb-066-5578-SO**	**LL11sb-066-5579-SO**	**LL11sb-067-6186-FD**
Date		**03/18/10**	**03/22/10**	**03/22/10**	**03/22/10**	**03/22/10**	**03/22/10**	**03/22/10**	**03/22/10**	**03/18/10**
Depth (ft)		**7.0 - 13.0**	**1.0 - 4.0**	**4.0 - 5.0**	**1.0 - 4.0**	**4.0 - 7.0**	**7.0 - 13.0**	**1.0 - 4.0**	**4.0 - 7.0**	**1.0 - 4.0**
Parameters Analyzed [a]		**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**
Analyte	**Background Criteria** [b]									
Metals (mg/kg)										
Aluminum	19500	4760	8900J	8210J	10500	7280	6880	9320	6720	11700
Antimony	0.96	<0.63UJ	<0.61UJ	<0.63UJ	0.092J	0.087J	0.078J	0.086J	0.077J	0.12J
Arsenic	19.8	11.5J	12J	15.5J	15.5	**24.7J***	14.1	16.6	15.1J	15.5J
Barium	124	23.9	45.2	34.9	88.9J	32.4	25.4	70J	39.2	48.3J
Beryllium	0.88	0.25	0.45	0.43	0.63	0.46	0.41	0.53	0.41	0.5
Cadmium	0	**0.065J***	**0.088J***	<0.049UJ	**0.13J***	**0.051J***	**0.039J***	**0.054J***	**0.059J***	**0.082J***
Calcium	35500	5850J	20400	6000	1340J	1140	4420	790J	1190	1720J
Chromium	27.2	7.4	13.6	12.4	14.7	11.5	10.5	13.8	11.4	15
Cobalt	23.2	6.4	9.5	9.4	16.8	9.1	8.7	9.4	9.4	5.2
Copper	32.3	16.7	17	17.7	21.2	24.5	15.5J	19.7	18.5	18.4
Iron	35200	17300	23500	25000	25800	26100	20600	24600	21200	27800
Lead	19.1	9.7J	11.4	10.8	14.3	12.5	10.2J	13.7	10.9	8.6J
Magnesium	8790	3460J	4710J	4250J	3210	2540J	3530J	2670	2540J	2220J
Manganese	3030	282	408	375	867	243	367	388	478	132
Mercury	0.044	<0.13U	<0.12U	<0.13U	<0.12U	0.025J	<0.12U	**0.045J***	<0.12U	0.031J
Nickel	60.7	14.8	22.3	21.3	33.2	22.1	19.6J	23.3	24.3	13.6
Potassium	3350	748	1250	1110	1080	838	1370	901	801	585
Selenium	1.5	0.55J	0.8J	1.1J	1.5	0.84J	1	1.4	0.8J	0.91J
Silver	0	**0.017J***	<0.015UJ	<0.02UJ	<0.013UJ	**0.014J***	<0.021UJ	<0.015UJ	**0.011J***	<0.01UJ
Sodium	145	53J	62.2J	65.8J	51.2J	40.3J	52.5J	39.7J	41.6J	38.9J
Thallium	0.91	0.1J	0.15J	0.11J	0.19J	0.13J	0.11J	0.14J	0.13J	0.26
Vanadium	37.6	8.7	15.3	12.7	19.8	14.1	12.1	15.3	12.1	23
Zinc	93.3	46.9J	60.2	54.7	51.9	54.3	52.2	54.8	54.9	39.6J
SVOCs (mg/kg)										
Benz(a)anthracene	None	<0.0084U	<0.0082U	<0.0085U	<0.008U	<0.0078U	<0.0077U	<0.0079U	<0.0079U	<0.008U
Benzo(a)pyrene	None	<0.0084U	<0.0082U	<0.0085U	<0.008U	<0.0078U	<0.0077U	<0.0079U	<0.0079U	<0.008U
Benzo(b)fluoranthene	None	<0.0084U	<0.0082U	<0.0085U	<0.008U	<0.0078U	**0.022***	<0.0079U	<0.0079U	<0.008U
Benzo(ghi)perylene	None	<0.0084U	<0.0082U	<0.0085U	<0.008U	<0.0078U	<0.0077U	<0.0079U	<0.0079U	<0.008U
Bis(2-ethylhexyl)phthalate	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Chrysene	None	<0.0084U	<0.0082U	<0.0085U	<0.008U	<0.0078U	<0.0077U	<0.0079U	<0.0079U	<0.008U
Di-n-butyl phthalate	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Fluoranthene	None	<0.0084U	<0.0082U	<0.0085U	<0.008U	<0.0078U	<0.0077U	<0.0079U	<0.0079U	**0.0098***
Phenanthrene	None	<0.0084U	<0.0082U	<0.0085U	<0.008U	<0.0078U	**0.01***	<0.0079U	<0.0079U	<0.008U
Pyrene	None	<0.0084U	<0.0082U	<0.0085U	<0.008U	<0.0078U	**0.0094***	<0.0079U	<0.0079U	<0.008U

Table 4–17. Analytes Detected in PBA08 RI Subsurface Soil Samples (continued)

Aggregate		**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**	**NPA**
Station		**LL11sb-067**	**LL11sb-067**	**LL11sb-068**	**LL11sb-068**	**LL11sb-068**	**LL11sb-069**	**LL11sb-069**
Sample ID		**LL11sb-067-5582-SO**	**LL11sb-067-5583-SO**	**LL11sb-068-5586-SO**	**LL11sb-068-6187-FD**	**LL11sb-068-5587-SO**	**LL11sb-069-5590-SO**	**LL11sb-069-5591-SO**
Date		**03/18/10**	**03/18/10**	**03/18/10**	**03/18/10**	**03/18/10**	**03/22/10**	**03/22/10**
Depth (ft)		**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 - 5.0**
Parameters Analyzed [a]		**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs**
Analyte	**Background Criteria** [b]							
Metals (mg/kg)								
Aluminum	19500	11700	6730	12700	7580	6670	6840	6750
Antimony	0.96	0.081J	0.082J	0.11J	0.076J	0.082J	<0.6UJ	<0.6UJ
Arsenic	19.8	12.5J	14.4	9.7J	9.5J	9	13.8	13.9
Barium	124	46.7J	38.4	48.3J	26J	23.9	21.6J	48.3J
Beryllium	0.88	0.5	0.35	0.42	0.29	0.25	0.35	0.36
Cadmium	0	**0.066J***	**0.051J***	**0.063J***	<0.036UJ	0.037J*	**0.058J***	**0.06J***
Calcium	35500	915J	205J	1230J	459J	426	1650J	8520J
Chromium	27.2	14.8	9.6	14.9	8.5	8.1	10.9	13
Cobalt	23.2	10.6	7.5	7.4	4.5	4.6	7	9.8
Copper	32.3	19.1	21.5	12.2	12.1	10.9	18.6	16.6
Iron	35200	24600	22500	22200	14700	14500	22000	21700
Lead	19.1	11.6J	10.7	12.9J	8J	8.2	10.2	10.2
Magnesium	8790	2890J	2010	2770J	1440J	1390	2640	4130
Manganese	3030	352	286	375	194	189	325	516
Mercury	0.044	<0.12U	<0.12U	0.036J	<0.12U	<0.12U	<0.12U	**0.068J***
Nickel	60.7	21.4	16.7	15.9	10.5	9.8	19.9	21.1
Potassium	3350	891	581	670	528	449	1070	1200
Selenium	1.5	0.87J	0.66	0.65J	0.5J	0.56J	0.98	0.96
Silver	0	**0.0076J***	**0.0059J***	**0.019J***	<0.0063UJ	**0.01J***	<0.024UJ	<0.022UJ
Sodium	145	44.6J	31.4J	41.6J	28.4J	27.4J	47.6J	52.4J
Thallium	0.91	0.15J	0.12J	0.16J	0.11J	0.097J	0.1J	0.11J
Vanadium	37.6	18.4	11.4	24.7	12.6	12.2	11.9	11.5
Zinc	93.3	52.2J	55.8	42.9J	36J	32.5	56.3	53
SVOCs (mg/kg)								
Benz(a)anthracene	None	<0.008U	<0.0079U	**0.011J***	<0.059U	<0.059U	<0.008U	<0.008U
Benzo(a)pyrene	None	<0.008U	<0.0079U	**0.011J***	<0.059U	<0.059U	<0.008U	<0.008U
Benzo(b)fluoranthene	None	<0.008U	<0.0079U	**0.016J***	<0.059U	<0.059U	<0.008U	**0.0085***
Benzo(ghi)perylene	None	<0.008U	<0.0079U	<0.061U	<0.059U	<0.059U	<0.008U	**0.01***
Bis(2-ethylhexyl)phthalate	None	NR	NR	**0.024J***	<0.39U	<0.39UJ	NR	NR
Chrysene	None	<0.008U	<0.0079U	**0.01J***	<0.059U	<0.059U	<0.008U	**0.0082***
Di-n-butyl phthalate	None	NR	NR	**0.019J***	**0.019J***	<0.39UJ	NR	NR
Fluoranthene	None	<0.008U	<0.0079U	**0.025J***	<0.059U	<0.059U	<0.008U	<0.008U
Phenanthrene	None	<0.008U	<0.0079U	**0.013J***	<0.059U	<0.059U	<0.008U	<0.008U
Pyrene	None	<0.008U	<0.0079U	**0.019J***	<0.059U	<0.059U	<0.008U	<0.008U

[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.
FPA = Former production area.
ft = Feet.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
NPA = Non-production area.
NR = Not reported/not analyzed.
PAH = Polycyclic aromatic hydrocarbon.
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.
PCB = Polychlorinated biphenyl.
PETN = Pentaerythritol tetranitrate.
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 4–18. 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
LL11sd-082	Sand Creek near Newton Falls Road	Assess potential off-AOC migration of contamination; sample collected in Sand Creek north of the AOC.	Composite	0–0.5	Y	Y	N	PCBs	PAH
LL11sw-082			Discrete	N/A	Y	Y	Y	Y	Y
LL11sd-083	LL11sd-017 (drainage ditch within FPA)	Confirm presence of contamination in previously sampled area; sediment sample analyzed for RVAAP full-suite analytes.	Composite	0–0.5	Y	Y	Y	Y	Y
LL11sw-083			Discrete	N/A	Y	Y	Y	Y	Y
LL11sd-084	LL11sd-030 (drainage ditch west of FPA)	Delineate lateral extent of previously identified contamination.	Composite	0–0.5	Y	Y	N	PCBs	PAH
LL11sw-084			Discrete	N/A	Y	Y	Y	Y	Y
LL11sd-096	LL11sd-030 and LL11sd-084 (drainage ditch west of FPA)	Recollect sediment near LLsd-084 for RVAAP full-suite analytes in August 2012. No surface water present.	Composite	0–0.5	Y	Y	Y	Y	Y

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

Table 4–19. Analytes Detected in PBA08 RI Surface Water Samples

Aggregate		**East Ditch EU**	**Off AOC**	**West Ditch EU**
Sample location		**LL11sw-083**	**LL11sw-082**	**LL11sw-084**
Sample ID		**LL11sw-083-5609-SW**	**LL11sw-082-5608-SW**	**LL11sw-084-5610-SW**
Date		**02/25/10**	**02/24/10**	**02/25/10**
Parameters Analyzed [a] **Analyte**	**Background Criteria [b]**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**
Metals (mg/L)				
Aluminum	3.37	0.674	0.58	2.72
Antimony	0	<0.005U	<0.005U	**0.00036J***
Arsenic	0.0032	0.00058J	0.00066J	**0.0043J***
Barium	0.0475	0.0136	0.0179	**0.0576***
Beryllium	0	<0.001U	<0.001U	**0.00011J***
Cadmium	0	<0.002U	**0.00004J***	**0.00024J***
Calcium	41.4	33.1	18.6	**61.9***
Chromium	0	**0.00078J***	**0.00079J***	**0.0033J***
Cobalt	0	**0.00017J***	**0.00026J***	**0.0019J***
Copper	0.0079	0.0014J	0.0024J	0.0062
Iron	2.56	0.637	0.864	**5.83***
Lead	0	**0.00044J***	**0.00043J***	**0.0062***
Magnesium	10.8	5.59	4.5	**12.8***
Manganese	0.391	0.0161	0.21	**0.559***
Nickel	0	**0.00091J***	**0.0012J***	**0.0039J***
Potassium	3.17	1.21	1.3	1.92
Selenium	0	**0.00026J***	<0.005U	**0.00073J***
Sodium	21.3	1.86	4.79	6.26
Vanadium	0	**0.0011J***	**0.00086J***	**0.0051J***
SVOCs (mg/L)				
Benz(a)anthracene		<0.01U	<0.01U	**0.00035J***
Benzo(a)pyrene		<0.01U	<0.01U	**0.00033J***
Benzo(b)fluoranthene		<0.01UJ	<0.01U	**0.00041J***
Benzo(ghi)perylene		<0.01U	<0.01U	**0.00024J***
Benzo(k)fluoranthene		<0.01U	<0.01U	**0.00024J***
Chrysene		<0.01U	<0.01U	**0.00035J***
Fluoranthene		<0.01U	<0.01U	**0.00073J***
Indeno(1,2,3-cd)pyrene		<0.01U	<0.01U	**0.00021J***
Phenanthrene		<0.01U	<0.01U	**0.00022J***
Pyrene		<0.01U	<0.01U	**0.00057J***
Pesticides (mg/L)				
beta-BHC	None	**0.00001J***	<0.00005U	**9.6E-6J***
gamma-Chlordane	None	**0.00002J***	<0.00005U	<0.00005U

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

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

AOC = Area of concern

BHC = Hexachlorocyclohexane.

EU = Exposure unit.

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.

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

Table 4–20. Analytes Detected in PBA08 RI Sediment Samples

Aggregate		**East Ditch EU**	**Off AOC**	**West Ditch EU**	**West Ditch EU**
Sample location		**LL11sd-083**	**LL11sd-082**	**LL11sd-084**	**LL11sd-096**
Sample ID		**LL11sd-083-5594-SD**	**LL11sd-082-5593-SD**	**LL11sd-084-5595-SD**	**LL11sd-096-5874-SD**
Date		**02/25/10**	**02/24/10**	**02/25/10**	**08/09/12**
Depth (ft)		**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**
Parameters Analyzed[a]					
Analyte	**Background Criteria[b]**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs, VOCs**	**TAL Metals, Explosives, SVOCs, VOCs**	**RVAAP Full-suite analytes**
			Metals (mg/kg)		
Aluminum	13900	**15100***	4070	10100	**15000***
Antimony	0	**0.13J***	<0.65R	<0.78R	**0.14J***
Arsenic	19.5	**19.7***	9.3	7.9	10
Barium	123	98.2	16.7	64	84
Beryllium	0.38	**1***	0.22	**0.61***	**0.91***
Cadmium	0	<0.13UJ	<0.056UJ	<0.42U	**0.51***
Calcium	5510	3190J	1490J	3100J	3800
Chromium	18.1	**18.6***	5.7	12.2	17
Cobalt	9.1	**17.4***	4.3	7.1	**9.4***
Copper	27.6	**31.4***	15.8	14.6	18
Iron	28200	**39300***	13500	17100	23000
Lead	27.4	25.7	8.4	22	27
Magnesium	2760	**3660***	1540	1820	2700
Manganese	1950	665	317	164	270
Mercury	0.059	<0.15U	<0.13U	0.049J	**0.1J***
Nickel	17.7	**32.6***	10.5	15.6	**21***
Potassium	1950	1230J	390J	685J	1100
Selenium	1.7	**3.2***	0.48J	1.4	1.7
Silver	0	<0.022UJ	<0.027UJ	<0.062UJ	**0.072J***
Sodium	112	68.1J	33.2J	36J	35J
Thallium	0.89	0.14J	<0.26U	0.13J	0.21J
Vanadium	26.1	21.4	6.5	17.8	25
Zinc	532	77.6	27.5	80.9	120
			Propellants (mg/kg)		
Nitrocellulose	None	<7.5U	NR	NR	**1.4J***
			SVOCs (mg/kg)		
2-Methylnaphthalene	None	**0.013J***	**0.0097J***	<0.51U	<0.0045U
Acenaphthene	None	<0.075U	<0.065U	<0.078U	**0.013***
Anthracene	None	**0.025J***	<0.065U	<0.078U	**0.02***
Benz(a)anthracene	None	**0.11***	**0.014J***	**0.019J***	**0.077***
Benzenemethanol	None	<0.5U	<0.43U	<0.51U	**0.054J***
Benzo(a)pyrene	None	**0.098***	**0.012J***	**0.021J***	**0.09***
Benzo(b)fluoranthene	None	**0.13***	**0.017J***	**0.038J***	**0.14***
Benzo(ghi)perylene	None	**0.064J***	**0.011J***	**0.017J***	**0.068***
Benzo(k)fluoranthene	None	**0.056J***	**0.0089J***	**0.011J***	**0.066***
Chrysene	None	**0.096***	**0.014J***	**0.023J***	**0.099***
Dibenz(a,h)anthracene	None	**0.017J***	<0.065U	<0.078U	**0.016***
Fluoranthene	None	**0.23***	**0.025J***	**0.043J***	**0.21***
Fluorene	None	**0.012J***	<0.065U	<0.078U	<0.0045U
Indeno(1,2,3-cd)pyrene	None	**0.056J***	<0.065U	**0.015J***	**0.061***
Naphthalene	None	**0.01J***	<0.065U	<0.078U	<0.0045U
Phenanthrene	None	**0.1***	**0.017J***	**0.016J***	**0.098***
Pyrene	None	**0.18***	**0.019J***	**0.033J***	**0.16***

Table 4–20. Analytes Detected in PBA08RI Sediment Samples (continued)

Aggregate		**East Ditch EU**	**Off AOC**	**West Ditch EU**	**West Ditch EU**
Sample location		**LL11sd-083**	**LL11sd-082**	**LL11sd-084**	**LL11sd-096**
Sample ID		**LL11sd-083-5594-SD**	**LL11sd-082-5593-SD**	**LL11sd-084-5595-SD**	**LL11sd-096-5874-SD**
Date		**02/25/10**	**02/24/10**	**02/25/10**	**08/09/12**
Depth (ft)		**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**
Parameters Analyzed[a] **Analyte**	**Background Criteria**[b]	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs, VOCs**	**TAL Metals, Explosives, SVOCs, VOCs**	**RVAAP Full-suite analytes**
VOCs (mg/kg)					
Carbon disulfide		<0.0075U	**0.00063J***	<0.0078UJ	<0.00068UJ
Toluene		<0.0075U	**0.0004J***	<0.0078UJ	<0.00068UJ

[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.
EU = Exposure unit.
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.
VOC = Volatile organic compound.
* = Result exceeds background criteria or no background criteria was available.
< = Less than

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Table 4–21. Changes from the PBA08 SAP

Location	Affected Sample	Date Sampled	Change/Rationale
LL11sb-060	LL11SB-060-5551-SO	3/18/2010	Relocated to the southwest to the bottom of the ditch
	LL11SB-060-5552-SO	3/18/2010	
	LL11SB-060-5553-SO	3/18/2010	
	LL11SB-060-5554-SO	3/18/2010	
LL11sb-063	LL11SB-063-5567-SO	3/18/2010	Geotechnical boring renamed LL11sb-085 due to the duplicate usage of LL11sb-063 in Work Plan. (Note: SDG AOC 190549 indicates geotechnical sample was collected at LL11sb-063)
	LL11SB-063-5568-SO		
	LL11SB-085-5567-SO		
	LL11SB-085-5568-SO		
LL11sb-063	LL11SB-063-5563-SO	3/22/2010	Sample could not be hand augered because location was in asphalt, so the 0-1 ft bgs sample was collected by the Geoprobe
LL11sb-067	LL11SB-067-6186-FD	3/18/2010	A twin boring had to be drilled to collect volume for QA/QC samples
	LL11SB-067-6190-QA	3/18/2010	
LL11sb-068	LL11SB-068-5586-SO	3/18/2010	A twin boring had to be drilled to collect adequate volume for samples collected from the 1-4 ft bgs and 4-7 ft bgs
	LL11SB-068-5587-SO	3/18/2010	
	LL11SB-068-6187-FD	3/18/2010	
	LL11SB-068-6191-QA	3/18/2010	
LL11sb-069	LL11SB-069-5589-SO	3/22/2010	Relocated to the southwest to the bottom of a ditch
	LL11SB-069-5590-SO	3/22/2010	
	LL11SB-069-5591-SO	3/22/2010	
LL11ss-076	LL11SS-076-5602-SO	4/12/2010	Relocated to the southwest to the bottom of a ditch
	LL11SS-076-6183-FD	4/12/2010	
	LL11SS-076-6182-QA	4/12/2010	
LL11ss-078	LL11SS-078-5604-SO	4/12/2010	Relocated to the northwest to the bottom of a ditch
LL11ss-080	LL11SS-080-5606-SO	4/12/2010	Relocated to the north to the bottom of a ditch
LL11ss-081	LL11SS-081-5607-SO	4/12/2010	Relocated to the east to the bottom of a ditch
LL11sd-082	LL11SD-082-5593-SD	2/24/2010	Relocated downstream so samples could be collected safely
LL11sw-082	LL11SW-082-5608-SW	2/24/2010	
LL11sd-083	LL11SD-083-5594-SD	2/25/2010	Relocated to the east to the bottom of a ditch
LL11sw-083	LL11SW-083-5609-SW	2/25/2010	
LL11sb-085	See note above for LL11sb-063.		
LLsd-096	LL11sd-096-5874-SD	8/9/2012	Recollected near LL11sd-084 for RVAAP full-suite analytes

bgs = Below ground surface.
Ft = Feet.
PBA08 SAP = Performance-Based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1.
N/A = Not applicable.
QA/QC = Quality assurance/quality control.

Table 4–22. 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 4–23. Recommended Dietary Allowances/Reference Daily Intake Values

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

[a] Dietary reference intakes vary by gender and age, values present are for life stage group: Males 19-30 years.

[b] Adequate intake value.

mg/d = Milligram per day.
RDA= Recommended dietary allowance.
RDI= Reference daily intake.
µg/d = Micrograms per day.
USDA = U.S. Department of Agriculture.
Source= Values were obtained from http://fnic.nal.usda.gov charts.

Table 4–24. SRC Screening Summary for FPA 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**	**47/ 47**	**789**	**23800**	**11400**	**17700**	**Yes**	**Exceeds background**
Antimony	7440-36-0	35/ 47	0.08	0.63	0.306	0.96	No	Below background
Arsenic	**7440-38-2**	**47/ 47**	**2.7**	**30.2**	**13.2**	**15.4**	**Yes**	**Exceeds background**
Barium	**7440-39-3**	**47/ 47**	**14.6**	**107**	**61**	**88.4**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**47/ 47**	**0.13**	**1.1**	**0.587**	**0.88**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**26/ 47**	**0.053**	**1.3**	**0.215**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	47/ 47	830	64400	6500	15800	No	Essential Nutrient
Chromium	**7440-47-3**	**47/ 47**	**3.5**	**28.4**	**14.6**	**17.4**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**47/ 47**	**2.2**	**33.8**	**8.54**	**10.4**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**47/ 47**	**2.7**	**45.7**	**18**	**17.7**	**Yes**	**Exceeds background**
Cyanide	**57-12-5**	**3/ 34**	**0.58**	**1.6**	**0.301**	**0**	**Yes**	**Exceeds background**
Iron	7439-89-6	47/ 47	11400	38300	21600	23100	No	Essential Nutrient
Lead	**7439-92-1**	**47/ 47**	**3.9**	**102**	**29.6**	**26.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	47/ 47	121	5390	2790	3030	No	Essential Nutrient
Manganese	**7439-96-5**	**47/ 47**	**63.9**	**1540**	**511**	**1450**	**Yes**	**Exceeds background**
Mercury	**7439-97-6**	**17/ 47**	**0.018**	**0.34**	**0.0397**	**0.036**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**47/ 47**	**4.5**	**33.2**	**16.4**	**21.1**	**Yes**	**Exceeds background**
Potassium	7440-09-7	47/ 47	232	2910	1260	927	No	Essential Nutrient
Selenium	7782-49-2	19/ 47	0.25	1.3	0.48	1.4	No	Below background
Silver	7440-22-4	2/ 47	0.0046	0.023	0.181	0	No	<5% Detected
Sodium	7440-23-5	42/ 47	21.9	943	471	123	No	Essential Nutrient
Thallium	**7440-28-0**	**16/ 47**	**0.13**	**0.26**	**0.124**	**0**	**Yes**	**Exceeds background**
Vanadium	**7440-62-2**	**47/ 47**	**2.9**	**38.8**	**20.1**	**31.1**	**Yes**	**Exceeds background**
Zinc	**7440-66-6**	**47/ 47**	**20.9**	**465**	**77.3**	**61.8**	**Yes**	**Exceeds background**
Anions								
Nitrate	**14797-55-8**	**7/ 34**	**0.92**	**3.2**	**0.834**	**None**	**Yes**	**Exceeds background**
Sulfide	**18496-25-8**	**22/ 34**	**29.9**	**244**	**49.3**	**None**	**Yes**	**Exceeds background**
Explosives and Propellants								
Nitrocellulose	**9004-70-0**	**4/ 4**	**0.89**	**1.1**	**0.985**	**None**	**Yes**	**Detected organic**
Nitroguanidine	**556-88-7**	**1/ 4**	**0.077**	**0.077**	**0.132**	**None**	**Yes**	**Detected organic**

Table 4–24. SRC Screening Summary for FPA 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
				Explosives and Propellants (continued)				
PETN	**78-11-5**	**1/ 7**	**0.049**	**0.049**	**0.216**	**None**	**Yes**	**Detected organic**
Tetryl	**479-45-8**	**1/ 41**	**0.02**	**0.02**	**0.101**	**None**	**Yes**	**Detected organic**
				SVOCs				
Acenaphthene	**83-32-9**	**2/ 14**	**0.033**	**0.081**	**0.114**	**None**	**Yes**	**Detected organic**
Acenaphthylene	**208-96-8**	**1/ 14**	**0.012**	**0.012**	**0.107**	**None**	**Yes**	**Detected organic**
Anthracene	**120-12-7**	**2/ 14**	**0.049**	**0.16**	**0.121**	**None**	**Yes**	**Detected organic**
Benz(a)anthracene	**56-55-3**	**7/ 14**	**0.0089**	**0.37**	**0.147**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**7/ 14**	**0.0091**	**0.45**	**0.151**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**6/ 14**	**0.011**	**0.56**	**0.188**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**4/ 14**	**0.012**	**0.32**	**0.145**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**2/ 14**	**0.17**	**0.37**	**0.145**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**8/ 14**	**0.0097**	**0.47**	**0.153**	**None**	**Yes**	**Detected organic**
Dibenz(a,h)anthracene	**53-70-3**	**3/ 14**	**0.022**	**0.076**	**0.118**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**11/ 14**	**0.0093**	**1**	**0.277**	**None**	**Yes**	**Detected organic**
Fluorene	**86-73-7**	**2/ 14**	**0.025**	**0.079**	**0.114**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**4/ 14**	**0.021**	**0.27**	**0.142**	**None**	**Yes**	**Detected organic**
Naphthalene	**91-20-3**	**3/ 14**	**0.0089**	**0.017**	**0.108**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**5/ 14**	**0.012**	**0.62**	**0.172**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**8/ 14**	**0.011**	**0.83**	**0.255**	**None**	**Yes**	**Detected organic**
				Pesticides/PCBs				
PCB-1254	**11097-69-1**	**4/ 12**	**0.02**	**0.42**	**0.0562**	**None**	**Yes**	**Detected organic**
				VOCs				
Acetone	**67-64-1**	**1/8**	**0.011**	**0.011**	**0.0112**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b). Site-related contaminant screening tables include all available and appropriate data as presented in Section 4.5.4.

CAS = Chemical Abstract Service.
FPA = Former production area.
mg/kg = Milligrams per kilogram.
PCB = Polychlorinated biphenyl.
PETN = Pentaerythritol tetranitrate.
SRC = Site-related contaminant.
SVOC= Semi-volatile organic compound
VOC = Volatile organic compound.
Bold indicates analyte identified as an SRC.

Table 4–25. SRC Screening Summary for NPA 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	30/ 30	6170	14400	10300	17700	No	Below background
Antimony	7440-36-0	15/ 30	0.084	0.77	0.246	0.96	No	Below background
Arsenic	**7440-38-2**	**29/ 30**	**6.5**	**40.4**	**12**	**15.4**	**Yes**	**Exceeds background**
Barium	**7440-39-3**	**30/ 30**	**26.8**	**128**	**61.3**	**88.4**	**Yes**	**Exceeds background**
Beryllium	7440-41-7	30/ 30	0.35	0.76	0.528	0.88	No	Below background
Cadmium	**7440-43-9**	**17/ 30**	**0.057**	**0.92**	**0.191**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	29/ 30	180	18100	2970	15800	No	Essential Nutrient
Chromium	**7440-47-3**	**30/ 30**	**9.3**	**19**	**13.3**	**17.4**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**30/ 30**	**5.4**	**13.9**	**8.46**	**10.4**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**30/ 30**	**5.8**	**21**	**13.5**	**17.7**	**Yes**	**Exceeds background**
Cyanide	**57-12-5**	**1/ 17**	**0.54**	**0.54**	**0.269**	**0**	**Yes**	**Exceeds background**
Iron	7439-89-6	30/ 30	14300	27300	19900	23100	No	Essential Nutrient
Lead	**7439-92-1**	**29/ 30**	**9.9**	**33.9**	**18.1**	**26.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	30/ 30	1430	6390	2340	3030	No	Essential Nutrient
Manganese	**7439-96-5**	**30/ 30**	**210**	**1930**	**550**	**1450**	**Yes**	**Exceeds background**
Mercury	**7439-97-6**	**14/ 30**	**0.02**	**0.08**	**0.034**	**0.036**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**30/ 30**	**8.5**	**26.2**	**15.5**	**21.1**	**Yes**	**Exceeds background**
Potassium	7440-09-7	30/ 30	437	1980	991	927	No	Essential Nutrient
Selenium	7782-49-2	20/ 30	0.59	1.2	0.626	1.4	No	Below background
Silver	**7440-22-4**	**8/ 30**	**0.024**	**0.06**	**0.139**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	28/ 30	22.5	990	432	123	No	Essential Nutrient
Thallium	**7440-28-0**	**14/ 30**	**0.1**	**0.23**	**0.124**	**0**	**Yes**	**Exceeds background**
Vanadium	7440-62-2	30/ 30	12.2	28.4	19.3	31.1	No	Below background
Zinc	**7440-66-6**	**30/ 30**	**38.7**	**478**	**78.2**	**61.8**	**Yes**	**Exceeds background**
Anions								
Nitrate	**14797-55-8**	**6/ 17**	**0.64**	**3**	**0.778**	**None**	**Yes**	**Exceeds background**
Sulfide	**18496-25-8**	**11/ 17**	**31.1**	**85.5**	**41.6**	**None**	**Yes**	**Exceeds background**
Explosives and Propellants								
HMX	**2691-41-0**	**1/ 29**	**0.013**	**0.013**	**0.12**	**None**	**Yes**	**Detected organic**
Nitrocellulose	**9004-70-0**	**3/ 5**	**0.89**	**1.2**	**1.8**	**None**	**Yes**	**Detected organic**

Table 4–25. SRC Screening Summary for NPA 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
Explosives and Propellants (continued)								
PETN	**78-11-5**	**1/ 12**	**0.036**	**0.036**	**0.23**	**None**	**Yes**	**Detected organic**
SVOCs								
Acenaphthene	**83-32-9**	**2/ 14**	**0.012**	**0.065**	**0.0405**	**None**	**Yes**	**Detected organic**
Anthracene	**120-12-7**	**4/ 14**	**0.011**	**0.13**	**0.0469**	**None**	**Yes**	**Detected organic**
Benz(a)anthracene	**56-55-3**	**9/ 14**	**0.013**	**0.32**	**0.0656**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**8/ 14**	**0.014**	**0.28**	**0.0741**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**7/ 14**	**0.022**	**0.41**	**0.0985**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**8/ 14**	**0.013**	**0.21**	**0.0626**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**7/ 14**	**0.0094**	**0.13**	**0.0593**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**9/ 14**	**0.016**	**0.28**	**0.0693**	**None**	**Yes**	**Detected organic**
Dibenz(a,h)anthracene	**53-70-3**	**1/ 14**	**0.069**	**0.069**	**0.0404**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**11/ 14**	**0.011**	**0.78**	**0.137**	**None**	**Yes**	**Detected organic**
Fluorene	**86-73-7**	**1/ 14**	**0.049**	**0.049**	**0.0389**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**7/ 14**	**0.011**	**0.19**	**0.0599**	**None**	**Yes**	**Detected organic**
Naphthalene	**91-20-3**	**2/ 14**	**0.0094**	**0.01**	**0.0365**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**8/ 14**	**0.012**	**0.52**	**0.0907**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**10/ 14**	**0.01**	**0.59**	**0.116**	**None**	**Yes**	**Detected organic**
Pesticides/PCBs								
PCB-1254	**11097-69-1**	**1/ 14**	**0.035**	**0.035**	**0.0206**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b). SRC screening tables include all available and appropriate data as presented in Section 4.5.4.

CAS = Chemical Abstract Service.

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

mg/kg = Milligrams per kilogram.

NPA = Non-production area.

PCB = Polychlorinated biphenyl.

SRC = Site-related contaminant.

SVOC = Semi-volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–26. SRC Screening Summary for FPA 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	30/ 30	6170	14400	10300	17700	No	Below background
Antimony	7440-36-0	15/ 30	0.084	0.77	0.246	0.96	No	Below background
Arsenic	**7440-38-2**	**29/ 30**	**6.5**	**40.4**	**12**	**15.4**	**Yes**	**Exceeds background**
Barium	7440-39-3	30/ 30	26.8	128	61.3	88.4	Yes	Exceeds background
Beryllium	7440-41-7	30/ 30	0.35	0.76	0.528	0.88	No	Below background
Cadmium	**7440-43-9**	**17/ 30**	**0.057**	**0.92**	**0.191**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	29/ 30	180	18100	2970	15800	No	Essential Nutrient
Chromium	**7440-47-3**	**30/ 30**	**9.3**	**19**	**13.3**	**17.4**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**30/ 30**	**5.4**	**13.9**	**8.46**	**10.4**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**30/ 30**	**5.8**	**21**	**13.5**	**17.7**	**Yes**	**Exceeds background**
Cyanide	**57-12-5**	**1/ 17**	**0.54**	**0.54**	**0.269**	**0**	**Yes**	**Exceeds background**
Iron	7439-89-6	30/ 30	14300	27300	19900	23100	No	Essential Nutrient
Lead	**7439-92-1**	**29/ 30**	**9.9**	**33.9**	**18.1**	**26.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	30/ 30	1430	6390	2340	3030	No	Essential Nutrient
Manganese	**7439-96-5**	**30/ 30**	**210**	**1930**	**550**	**1450**	**Yes**	**Exceeds background**
Mercury	**7439-97-6**	**14/ 30**	**0.02**	**0.08**	**0.034**	**0.036**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**30/ 30**	**8.5**	**26.2**	**15.5**	**21.1**	**Yes**	**Exceeds background**
Potassium	7440-09-7	30/ 30	437	1980	991	927	No	Essential Nutrient
Selenium	7782-49-2	20/ 30	0.59	1.2	0.626	1.4	No	Below background
Silver	**7440-22-4**	**8/ 30**	**0.024**	**0.06**	**0.139**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	28/ 30	22.5	990	432	123	No	Essential Nutrient
Thallium	**7440-28-0**	**14/ 30**	**0.1**	**0.23**	**0.124**	**0**	**Yes**	**Exceeds background**
Vanadium	7440-62-2	30/ 30	12.2	28.4	19.3	31.1	No	Below background
Zinc	**7440-66-6**	**30/ 30**	**38.7**	**478**	**78.2**	**61.8**	**Yes**	**Exceeds background**
Anions								
Nitrate	**14797-55-8**	**6/ 17**	**0.64**	**3**	**0.778**	**None**	**Yes**	**Exceeds background**
Sulfide	**18496-25-8**	**11/ 17**	**31.1**	**85.5**	**41.6**	**None**	**Yes**	**Exceeds background**
Explosives/Propellants								
HMX	**2691-41-0**	**1/ 29**	**0.013**	**0.013**	**0.12**	**None**	**Yes**	**Detected organic**
Nitrocellulose	**9004-70-0**	**3/ 5**	**0.89**	**1.2**	**1.8**	**None**	**Yes**	**Detected organic**
PETN	**78-11-5**	**1/ 12**	**0.036**	**0.036**	**0.23**	**None**	**Yes**	**Detected organic**

Table 4–26. SRC Screening Summary for FPA 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
Metals								
Acenaphthene	**83-32-9**	**2/ 14**	**0.012**	**0.065**	**0.0405**	**None**	**Yes**	**Detected organic**
Anthracene	**120-12-7**	**4/ 14**	**0.011**	**0.13**	**0.0469**	**None**	**Yes**	**Detected organic**
Benz(a)anthracene	**56-55-3**	**9/ 14**	**0.013**	**0.32**	**0.0656**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**8/ 14**	**0.014**	**0.28**	**0.0741**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**7/ 14**	**0.022**	**0.41**	**0.0985**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**8/ 14**	**0.013**	**0.21**	**0.0626**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**7/ 14**	**0.0094**	**0.13**	**0.0593**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**9/ 14**	**0.016**	**0.28**	**0.0693**	**None**	**Yes**	**Detected organic**
Dibenz(a,h)anthracene	**53-70-3**	**1/ 14**	**0.069**	**0.069**	**0.0404**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**11/ 14**	**0.011**	**0.78**	**0.137**	**None**	**Yes**	**Detected organic**
Fluorene	**86-73-7**	**1/ 14**	**0.049**	**0.049**	**0.0389**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**7/ 14**	**0.011**	**0.19**	**0.0599**	**None**	**Yes**	**Detected organic**
Naphthalene	**91-20-3**	**2/ 14**	**0.0094**	**0.01**	**0.0365**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**8/ 14**	**0.012**	**0.52**	**0.0907**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**10/ 14**	**0.01**	**0.59**	**0.116**	**None**	**Yes**	**Detected organic**
Pesticide/PCB								
PCB-1254	**11097-69-1**	**1/ 14**	**0.035**	**0.035**	**0.0206**	**None**	**Yes**	**Detected organic**

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

SRC screening tables include all available and appropriate data as presented in Section 4.5.4.

CAS = Chemical Abstract Service.

FPA = Former production area.

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

mg/kg = Milligrams per kilogram.

PCB = Polychlorinated biphenyl.

PETN = Pentaerythritol tetranitrate.

SRC = Site-related contaminant.

Bold indicates analyte identified as an SRC.

Table 4–27. SRC Screening Summary for NPA 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**	**45/ 45**	**4720**	**24500**	**9790**	**19500**	**Yes**	**Exceeds background**
Antimony	7440-36-0	15/ 45	0.077	0.56	0.18	0.96	No	Below background
Arsenic	**7440-38-2**	**39/ 45**	**6**	**44.1**	**14.2**	**19.8**	**Yes**	**Exceeds background**
Barium	**7440-39-3**	**45/ 45**	**19.7**	**4190**	**139**	**124**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**39/ 45**	**0.25**	**3.2**	**0.531**	**0.88**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**21/ 45**	**0.037**	**0.38**	**0.119**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	45/ 45	112	20400	2000	35500	No	Essential Nutrient
Chromium	7440-47-3	45/ 45	5.9	24.7	12.8	27.2	No	Below background
Cobalt	**7440-48-4**	**45/ 45**	**3.3**	**24.7**	**8.42**	**23.2**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**45/ 45**	**6**	**62.3**	**18.6**	**32.3**	**Yes**	**Exceeds background**
Cyanide	**57-12-5**	**7/ 25**	**0.0097**	**1**	**0.163**	**0**	**Yes**	**Exceeds background**
Iron	7439-89-6	45/ 45	9560	54800	21800	35200	No	Essential Nutrient
Lead	**7439-92-1**	**40/ 45**	**5.3**	**160**	**14.2**	**19.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	45/ 45	786	4710	2440	8790	No	Essential Nutrient
Manganese	7439-96-5	45/ 45	103	1930	411	3030	No	Below background
Mercury	**7439-97-6**	**6/ 45**	**0.025**	**0.068**	**0.0317**	**0.044**	**Yes**	**Exceeds background**
Nickel	7440-02-0	45/ 45	8.6	33.5	17.6	60.7	No	Below background
Potassium	7440-09-7	45/ 45	449	2600	1100	3350	No	Essential Nutrient
Selenium	7782-49-2	23/ 45	0.52	1.5	0.543	1.5	No	Below background
Silver	**7440-22-4**	**6/ 45**	**0.0059**	**0.019**	**0.159**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	35/ 45	27.4	1530	396	145	No	Essential Nutrient
Thallium	**7440-28-0**	**19/ 45**	**0.097**	**2.5**	**0.169**	**0.91**	**Yes**	**Exceeds background**
Vanadium	7440-62-2	45/ 45	8.9	31.5	16.9	37.6	No	Below background
Zinc	**7440-66-6**	**45/ 45**	**29**	**390**	**64.9**	**93.3**	**Yes**	**Exceeds background**
Anions								
Nitrate	**14797-55-8**	**14/ 25**	**0.4**	**2.9**	**0.662**	**None**	**Yes**	**Exceeds background**
Sulfate	**14808-79-8**	**15/ 25**	**13.6**	**44.9**	**28.1**	**None**	**Yes**	**Exceeds background**
Sulfide	**18496-25-8**	**9/ 25**	**12.2**	**81.8**	**19.8**	**None**	**Yes**	**Exceeds background**
Miscellaneous								
TPH-Diesel Range Organics	**NS791**	**1/ 15**	**34**	**34**	**5.42**	**None**	**Yes**	**Exceeds background**
TPH-Gasoline Range Organics	**NS834**	**2/ 14**	**0.026**	**0.054**	**0.0319**	**None**	**Yes**	**Exceeds background**
Explosives								
Nitrocellulose	**9004-70-0**	**15/ 17**	**0.77**	**2**	**1.4**	**None**	**Yes**	**Detected organic**

Table 4–27. SRC Screening Summary for NPA 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
SVOCs								
Benz(a)anthracene	56-55-3	1/ 36	0.011	0.011	0.128	None	No	<5% Detected
Benzo(a)pyrene	**50-32-8**	**2/ 36**	**0.011**	**0.12**	**0.126**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**3/ 36**	**0.0085**	**0.022**	**0.129**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	191-24-2	1/ 36	0.01	0.01	0.129	None	No	<5% Detected
Bis(2-ethylhexyl)phthalate	117-81-7	1/ 25	0.024	0.024	0.19	None	No	<5% Detected
Chrysene	**218-01-9**	**2/ 36**	**0.0082**	**0.01**	**0.128**	**None**	**Yes**	**Detected organic**
Di-n-butyl phthalate	84-74-2	1/ 25	0.019	0.019	0.19	None	No	<5% Detected
Fluoranthene	**206-44-0**	**2/ 36**	**0.025**	**0.16**	**0.128**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**2/ 36**	**0.01**	**0.013**	**0.129**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**2/ 36**	**0.0094**	**0.019**	**0.129**	**None**	**Yes**	**Detected organic**
VOCs								
Carbon tetrachloride	56-23-5	1/ 26	0.001	0.001	0.00298	None	No	<5% Detected

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

SRC screening tables include all available and appropriate data as presented in Section 4.5.4.

CAS = Chemical Abstract Service.

mg/kg = Milligrams per kilogram.

NPA = Non-production area.

SRC = Site-related contaminant.

SVOC = Semi-volatile organic compound.

TPH = Total petroleum hydrocarbon.

VOC = Volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–28. SRC Screening Summary for East Ditch 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**	**2/ 2**	**10600**	**15100**	**12900**	**13900**	**Yes**	**Exceeds background**
Antimony	**7440-36-0**	**1/ 2**	**0.13**	**0.13**	**0.155**	**0**	**Yes**	**Exceeds background**
Arsenic	**7440-38-2**	**1/ 2**	**19.7**	**19.7**	**10.5**	**19.5**	**Yes**	**Exceeds background**
Barium	7440-39-3	2/ 2	85.2	98.2	91.7	123	No	Below background
Beryllium	**7440-41-7**	**2/ 2**	**0.61**	**1**	**0.805**	**0.38**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**1/ 2**	**0.47**	**0.47**	**0.268**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	2/ 2	2390	3190	2790	5510	No	Essential Nutrient
Chromium	**7440-47-3**	**2/ 2**	**16.5**	**18.6**	**17.6**	**18.1**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**2/ 2**	**8.2**	**17.4**	**12.8**	**9.1**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**2/ 2**	**19.7**	**31.4**	**25.6**	**27.6**	**Yes**	**Exceeds background**
Iron	7439-89-6	2/ 2	19200	39300	29300	28200	No	Essential Nutrient
Lead	7439-92-1	1/ 2	25.7	25.7	15.3	27.4	No	Below background
Magnesium	7439-95-4	2/ 2	2140	3660	2900	2760	No	Essential Nutrient
Manganese	7439-96-5	2/ 2	665	754	710	1950	No	Below background
Nickel	**7440-02-0**	**2/ 2**	**15.2**	**32.6**	**23.9**	**17.7**	**Yes**	**Exceeds background**
Potassium	7440-09-7	2/ 2	856	1230	1040	1950	No	Essential Nutrient
Selenium	**7782-49-2**	**2/ 2**	**2**	**3.2**	**2.6**	**1.7**	**Yes**	**Exceeds background**
Sodium	7440-23-5	2/ 2	68.1	817	443	112	No	Essential Nutrient
Thallium	7440-28-0	1/ 2	0.14	0.14	0.13	0.89	No	Below background
Vanadium	7440-62-2	2/ 2	21.4	24.2	22.8	26.1	No	Below background
Zinc	7440-66-6	2/ 2	77.6	234	156	532	No	Below background
SVOCs								
2-Methylnaphthalene	**91-57-6**	**1/ 1**	**0.013**	**0.013**	**0.013**	**None**	**Yes**	**Detected organic**
Anthracene	**120-12-7**	**1/ 1**	**0.025**	**0.025**	**0.025**	**None**	**Yes**	**Detected organic**
Benz(a)anthracene	**56-55-3**	**1/ 1**	**0.11**	**0.11**	**0.11**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**1/ 1**	**0.098**	**0.098**	**0.098**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**1/ 1**	**0.13**	**0.13**	**0.13**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**1/ 1**	**0.064**	**0.064**	**0.064**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**1/ 1**	**0.056**	**0.056**	**0.056**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**1/ 1**	**0.096**	**0.096**	**0.096**	**None**	**Yes**	**Detected organic**
Dibenz(a,h)anthracene	**53-70-3**	**1/ 1**	**0.017**	**0.017**	**0.017**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**1/ 1**	**0.23**	**0.23**	**0.23**	**None**	**Yes**	**Detected organic**

Table 4–28. SRC Screening Summary for East Ditch 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
Fluorene	**86-73-7**	**1/ 1**	**0.012**	**0.012**	**0.012**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**1/ 1**	**0.056**	**0.056**	**0.056**	**None**	**Yes**	**Detected organic**
Naphthalene	**91-20-3**	**1/ 1**	**0.01**	**0.01**	**0.01**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**1/ 1**	**0.1**	**0.1**	**0.1**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**1/ 1**	**0.18**	**0.18**	**0.18**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (USACE 2001b).
SRC screening tables include all available and appropriate data as presented in Section 4.5.4.
CAS = Chemical Abstract Service.
mg/kg = Milligrams per kilogram.
SRC = Site-related contaminant.
SVOC= Semi-volatile organic compound.
Bold indicates analyte identified as an SRC.

Table 4–29. SRC Screening Summary for West Ditch 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**	**4/ 4**	**10100**	**17700**	**14600**	**13900**	**Yes**	**Exceeds background**
Antimony	**7440-36-0**	**3/ 3**	**0.14**	**0.9**	**0.483**	**0**	**Yes**	**Exceeds background**
Arsenic	7440-38-2	4/ 4	7.9	19.5	12.3	19.5	No	Below background
Barium	7440-39-3	4/ 4	64	111	86.3	123	No	Below background
Beryllium	**7440-41-7**	**4/ 4**	**0.61**	**1**	**0.835**	**0.38**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**1/ 4**	**0.51**	**0.51**	**0.231**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	4/ 4	2170	3800	2900	5510	No	Essential Nutrient
Chromium	**7440-47-3**	**4/ 4**	**12.2**	**21**	**17.7**	**18.1**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**4/ 4**	**7.1**	**14.1**	**9.63**	**9.1**	**Yes**	**Exceeds background**
Copper	7440-50-8	4/ 4	14.6	26.3	20.1	27.6	No	Below background
Iron	7439-89-6	4/ 4	17100	30000	24500	28200	No	Essential Nutrient
Lead	7439-92-1	4/ 4	14.7	27	20.9	27.4	No	Below background
Magnesium	7439-95-4	4/ 4	1820	3630	2810	2760	No	Essential Nutrient
Manganese	7439-96-5	4/ 4	164	530	289	1950	No	Below background
Mercury	**7439-97-6**	**2/ 4**	**0.049**	**0.1**	**0.05**	**0.059**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**4/ 4**	**15.6**	**27.7**	**21**	**17.7**	**Yes**	**Exceeds background**
Potassium	7440-09-7	4/ 4	685	2010	1440	1950	No	Essential Nutrient
Selenium	7782-49-2	4/ 4	0.5	1.7	1.07	1.7	No	Below background
Silver	**7440-22-4**	**1/ 4**	**0.072**	**0.072**	**0.155**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	4/ 4	35	1060	517	112	No	Essential Nutrient
Thallium	7440-28-0	3/ 4	0.13	0.23	0.17	0.89	No	Below background
Vanadium	**7440-62-2**	**4/ 4**	**17.8**	**30.8**	**24.9**	**26.1**	**Yes**	**Exceeds background**
Zinc	7440-66-6	4/ 4	65.3	120	86.4	532	No	Below background
Anions								
Sulfide	**18496-25-8**	**1/ 1**	**43.4**	**43.4**	**43.4**	**None**	**Yes**	**Exceeds background**
Explosives								
Nitrocellulose	**9004-70-0**	**1/ 1**	**1.4**	**1.4**	**1.4**	**None**	**Yes**	**Detected organic**
SVOCs								
Acenaphthene	**83-32-9**	**1/ 2**	**0.013**	**0.013**	**0.026**	**None**	**Yes**	**Detected organic**
Anthracene	**120-12-7**	**1/ 2**	**0.02**	**0.02**	**0.0295**	**None**	**Yes**	**Detected organic**
Benz(a)anthracene	**56-55-3**	**2/ 2**	**0.019**	**0.077**	**0.048**	**None**	**Yes**	**Detected organic**
Benzenemethanol	**100-51-6**	**1/ 2**	**0.054**	**0.054**	**0.155**	**None**	**Yes**	**Detected organic**

Table 4–29. SRC Screening Summary for West Ditch 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
Benzo(a)pyrene	**50-32-8**	**2/ 2**	**0.021**	**0.09**	**0.0555**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**2/ 2**	**0.038**	**0.14**	**0.089**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**2/ 2**	**0.017**	**0.068**	**0.0425**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**2/ 2**	**0.011**	**0.066**	**0.0385**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**2/ 2**	**0.023**	**0.099**	**0.061**	**None**	**Yes**	**Detected organic**
Dibenz(a,h)anthracene	**53-70-3**	**1/ 2**	**0.016**	**0.016**	**0.0275**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**2/ 2**	**0.043**	**0.21**	**0.127**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**2/ 2**	**0.015**	**0.061**	**0.038**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**2/ 2**	**0.016**	**0.098**	**0.057**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**2/ 2**	**0.033**	**0.16**	**0.0965**	**None**	**Yes**	**Detected organic**

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

SRC screening tables include all available and appropriate data as presented in Section 4.5.4.

CAS = Chemical Abstract Service.

mg/kg = Milligrams per kilogram.

SRC = Site-related contaminant.

SVOC= Semi-volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–30. SRC Screening Summary for Sewer Outfall 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	1/ 1	4300	4300	4300	13900	No	Below background
Arsenic	7440-38-2	1/ 1	12.8	12.8	12.8	19.5	No	Below background
Barium	7440-39-3	1/ 1	48	48	48	123	No	Below background
Calcium	7440-70-2	1/ 1	2960	2960	2960	5510	No	Essential Nutrient
Chromium	7440-47-3	1/ 1	7.1	7.1	7.1	18.1	No	Below background
Cobalt	7440-48-4	1/ 1	5.3	5.3	5.3	9.1	No	Below background
Copper	7440-50-8	1/ 1	13.4	13.4	13.4	27.6	No	Below background
Iron	7439-89-6	1/ 1	12100	12100	12100	28200	No	Essential Nutrient
Lead	7439-92-1	1/ 1	19.3	19.3	19.3	27.4	No	Below background
Magnesium	7439-95-4	1/ 1	1340	1340	1340	2760	No	Essential Nutrient
Manganese	7439-96-5	1/ 1	1760	1760	1760	1950	No	Below background
Nickel	7440-02-0	1/ 1	11.1	11.1	11.1	17.7	No	Below background
Potassium	7440-09-7	1/ 1	521	521	521	1950	No	Essential Nutrient
Sodium	7440-23-5	1/ 1	396	396	396	112	No	Essential Nutrient
Vanadium	7440-62-2	1/ 1	8.9	8.9	8.9	26.1	No	Below background
Zinc	7440-66-6	1/ 1	47.2	47.2	47.2	532	No	Below background
Anions								
Sulfate	**14808-79-8**	**1/ 1**	**248**	**248**	**248**	**None**	**Yes**	**Exceeds background**
Sulfide	**18496-25-8**	**1/ 1**	**540**	**540**	**540**	**None**	**Yes**	**Exceeds background**

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

SRC screening tables include all available and appropriate data as presented in Section 4.5.4.

CAS = Chemical Abstract Service.

mg/kg = Milligrams per kilogram.

SRC = Site-related contaminant.

Bold indicates analyte identified as an SRC.

Table 4–31. SRC Screening for East Ditch Surface Water

Analyte	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC? (yes/no)	SRC Justification
Metals (mg/L)								
Aluminum	7429-90-5	1/ 1	0.674	0.674	0.674	3.37	No	Below background
Arsenic	7440-38-2	1/ 1	0.00058	0.00058	0.00058	0.0032	No	Below background
Barium	7440-39-3	1/ 1	0.0136	0.0136	0.0136	0.0475	No	Below background
Calcium	7440-70-2	1/ 1	33.1	33.1	33.1	41.4	No	Essential Nutrient
Chromium	**7440-47-3**	**1/ 1**	**0.00078**	**0.00078**	**0.00078**	**0**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**1/ 1**	**0.00017**	**0.00017**	**0.00017**	**0**	**Yes**	**Exceeds background**
Copper	7440-50-8	1/ 1	0.0014	0.0014	0.0014	0.0079	No	Below background
Iron	7439-89-6	1/ 1	0.637	0.637	0.637	2.56	No	Essential Nutrient
Lead	**7439-92-1**	**1/ 1**	**0.00044**	**0.00044**	**0.00044**	**0**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	1/ 1	5.59	5.59	5.59	10.8	No	Essential Nutrient
Manganese	7439-96-5	1/ 1	0.0161	0.0161	0.0161	0.391	No	Below background
Nickel	**7440-02-0**	**1/ 1**	**0.00091**	**0.00091**	**0.00091**	**0**	**Yes**	**Exceeds background**
Potassium	7440-09-7	1/ 1	1.21	1.21	1.21	3.17	No	Essential Nutrient
Selenium	**7782-49-2**	**1/ 1**	**0.00026**	**0.00026**	**0.00026**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	1/ 1	1.86	1.86	1.86	21.3	No	Essential Nutrient
Vanadium	**7440-62-2**	**1/ 1**	**0.0011**	**0.0011**	**0.0011**	**0**	**Yes**	**Exceeds background**
Pesticides/PCBs (mg/L)								
beta-BHC	**319-85-7**	**1/ 1**	**0.000013**	**0.000013**	**0.000013**	**None**	**Yes**	**Detected organic**
gamma-Chlordane	**5103-74-2**	**1/ 1**	**0.000015**	**0.000015**	**0.000015**	**None**	**Yes**	**Detected organic**

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

BHC = Hexachlorocyclohexane.

CAS = Chemical Abstract Service.

mg/L = Milligrams per liter.

PCB = Polychlorinated biphenyl.

SRC = Site-related contaminant.

Bold indicates analyte identified as an SRC.

Table 4–32. SRC Screening for West Ditch Surface Water

Analyte	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC? (yes/no)	SRC Justification
Metals (mg/L)								
Aluminum	7429-90-5	1/ 1	2.72	2.72	2.72	3.37	No	Below background
Antimony	**7440-36-0**	**1/ 1**	**0.00036**	**0.00036**	**0.00036**	**0**	**Yes**	**Exceeds background**
Arsenic	**7440-38-2**	**1/ 1**	**0.0043**	**0.0043**	**0.0043**	**0.0032**	**Yes**	**Exceeds background**
Barium	**7440-39-3**	**1/ 1**	**0.0576**	**0.0576**	**0.0576**	**0.0475**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**1/ 1**	**0.00011**	**0.00011**	**0.00011**	**0**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**1/ 1**	**0.00024**	**0.00024**	**0.00024**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	1/ 1	61.9	61.9	61.9	41.4	No	Essential Nutrient
Chromium	**7440-47-3**	**1/ 1**	**0.0033**	**0.0033**	**0.0033**	**0**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**1/ 1**	**0.0019**	**0.0019**	**0.0019**	**0**	**Yes**	**Exceeds background**
Copper	7440-50-8	1/ 1	0.0062	0.0062	0.0062	0.0079	No	Below background
Iron	7439-89-6	1/ 1	5.83	5.83	5.83	2.56	No	Essential Nutrient
Lead	**7439-92-1**	**1/ 1**	**0.0062**	**0.0062**	**0.0062**	**0**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	1/ 1	12.8	12.8	12.8	10.8	No	Essential Nutrient
Manganese	**7439-96-5**	**1/ 1**	**0.559**	**0.559**	**0.559**	**0.391**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**1/ 1**	**0.0039**	**0.0039**	**0.0039**	**0**	**Yes**	**Exceeds background**
Potassium	7440-09-7	1/ 1	1.92	1.92	1.92	3.17	No	Essential Nutrient
Selenium	**7782-49-2**	**1/ 1**	**0.00073**	**0.00073**	**0.00073**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	1/ 1	6.26	6.26	6.26	21.3	No	Essential Nutrient
Vanadium	**7440-62-2**	**1/ 1**	**0.0051**	**0.0051**	**0.0051**	**0**	**Yes**	**Exceeds background**
SVOCs (mg/L)								
Benz(a)anthracene	**56-55-3**	**1/ 1**	**0.00035**	**0.00035**	**0.00035**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**1/ 1**	**0.00033**	**0.00033**	**0.00033**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**1/ 1**	**0.00041**	**0.00041**	**0.00041**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**1/ 1**	**0.00024**	**0.00024**	**0.00024**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**1/ 1**	**0.00024**	**0.00024**	**0.00024**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**1/ 1**	**0.00035**	**0.00035**	**0.00035**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**1/ 1**	**0.00073**	**0.00073**	**0.00073**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**1/ 1**	**0.00021**	**0.00021**	**0.00021**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**1/ 1**	**0.00022**	**0.00022**	**0.00022**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**1/ 1**	**0.00057**	**0.00057**	**0.00057**	**None**	**Yes**	**Detected organic**

Table 4–32. SRC Screening for West Ditch Surface Water (continued)

Analyte	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC? (yes/no)	SRC Justification
Pesticides/PCBs (mg/L)								
beta-BHC	**319-85-7**	**1/ 1**	**0.0000096**	**0.0000096**	**0.0000096**	**None**	**Yes**	**Detected organic**

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

BHC = Hexachlorocyclohexane.

CAS = Chemical Abstract Service.

mg/L = Milligrams per liter.

PCB = Polychlorinated biphenyl.

SRC = Site-related Contaminant.

SVOC= Semi-volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–33. 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										
RV-264A	D	01/31/96	0-0.5	1997 RRSE	--	--	--	--	--	Used for initial evaluation of site.
RV-441	D	10/23/98	0-0.5	1998 RRSE	--	--	--	--	--	Used for initial evaluation of site.
RV-442	D	10/23/98	0-0.5	1998 RRSE	--	--	--	--	--	Used for initial evaluation of site.
RV-443	D	10/23/98	0-0.5	1998 RRSE	--	--	--	--	--	Used for initial evaluation of site.
RV-444	D	10/23/98	0-0.5	1998 RRSE	--	--	--	--	--	Used for initial evaluation of site.
RV-445	D	10/23/98	0-0.5	1998 RRSE	--	--	--	--	--	Used for initial evaluation of site.
RV-446	D	10/23/98	0-0.5	1998 RRSE	--	--	--	--	--	Used for initial evaluation of site.
LL11cs-001-0001-SO	D	01/24/01	5–6	IRA	--	X	X	X	--	Confirmation sample – Sump excavation.
LL11cs-002-0001-FD	D	01/26/01	5–6	IRA	X	--	--	--	--	Field duplicate.
LL11cs-002-0001-SO	D	01/26/01	5–6	IRA	--	X	X	X	--	Confirmation sample – Sump excavation.
LL11cs-003-0001-SO	D	01/26/01	5–6	IRA	--	X	X	X	--	Confirmation sample – Sump excavation.
LL11cs-004-0001-SO	D	02/21/01	5–6	IRA	--	X	X	X	--	Confirmation sample – Sump excavation.
LL11cs-005-0001-SO	D	02/21/01	5–6	IRA	--	X	X	X	--	Confirmation sample – Sump excavation.
LL11cs-006-0001-SD	D	03/21/01	0–1	IRA	--	X	X	X	X	Confirmation sample – Ditch southeast of Building AP-3.
LL11cs-007-0001-SO	D	03/21/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch southeast of Building AP-3.
LL11cs-008-0001-SO	D	03/21/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch southeast of Building AP-3.
LL11cs-009-0001-SO	D	03/21/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch southeast of Building AP-3.
LL11cs-010-0001-SD	D	03/21/01	0–1	IRA	--	X	X	X	X	Confirmation sample – Ditch southeast of Building AP-3.

Table 4–33. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
LL11cs-011-0001-FD	D	03/23/01	0–1	IRA	X	--	--	--	--	Field duplicate.
LL11cs-011-0001-SD	D	03/23/01	0–1	IRA	--	X	X	X	X	Confirmation sample – Ditch east of Building AP-4.
LL11cs-012-0001-SO	D	03/23/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch east of Building AP-4.
LL11cs-013-0001-SO	D	03/23/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch east of Building AP-4.
LL11cs-014-0001-SO	D	03/23/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch east of Building AP-4.
LL11cs-016-0001-SD	D	03/23/01	0–1	IRA	--	X	X	X	X	Confirmation sample – Ditch north of Building AP-14.
LL11cs-017-0001-FD	D	03/23/01	1–2	IRA	X	--	--	--	--	Field duplicate.
LL11cs-017-0001-SO	D	03/23/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch north of Building AP-14.
LL11cs-018-0001-SO	D	03/23/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch north of Building AP-14.
LL11cs-019-0001-SO	D	03/23/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch north of Building AP-14.
LL11cs-020-0001-SO	D	03/23/01	0–1	IRA	--	X	X	X	X	Confirmation sample – Ditch north of Building AP-14.
LL11cs-021-0001-SD	D	03/21/01	0–1	IRA	--	X	X	X	X	Confirmation sample – Ditch east of Load Line 11 entrance road.
LL11cs-022-0001-SO	D	03/21/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch east of Load Line 11 entrance road.
LL11cs-023-0001-SO	D	03/21/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch east of Load Line 11 entrance road.
LL11cs-024-0001-SO	D	03/21/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch east of Load Line 11 entrance road.
LL11cs-025-0001-SD	D	03/21/01	0–1	IRA	--	X	X	X	X	Confirmation sample – Ditch east of Load Line 11 entrance road.
LL11cs-026-0001-SD	D	03/21/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch west of Building AP-8.

Table 4–33. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
LL11cs-027-0001-SO	D	03/21/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch west of Building AP-8.
LL11cs-028-0001-SO	D	03/21/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch west of Building AP-8.
LL11cs-029-0001-SO	D	03/21/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch west of Building AP-8.
LL11cs-030-0001-SD	D	03/21/01	0–1	IRA	--	X	X	X	X	Confirmation sample – Ditch west of Building AP-8.
LL11cs-032-0001-SO	D	03/20/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch north of Building AP-19.
LL11cs-033-0001-SO	D	03/20/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch north of Building AP-19.
LL11cs-034-0001-SO	D	03/20/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch north of Building AP-19.
LL11cs-035-0001-SO	D	03/20/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch north of Building AP-19.
LL11cs-036-0001-SO	D	03/20/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch north of Building AP-19.
LL11cs-037-0001-SO	D	03/20/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch north of Building AP-19.
LL11cs-038-0001-SO	D	03/20/01	1–2	IRA	--	X	X	X	--	Confirmation sample – Ditch north of Building AP-19.
LL11cs-039-0001-SD	D	03/20/01	0–1	IRA	--	X	X	X	X	Confirmation sample – Ditch north of Building AP-19.
LL11cs-040-0001-FD	D	03/22/01	3–7	IRA	X	--	--	--	--	Field duplicate.
LL11cs-040-0001-SO	D	03/22/01	3–7	IRA	--	X	X	X	--	Confirmation sample – Hot spot excavation.
LL11cs-041-0001-SO	D	03/22/01	3–7	IRA	--	X	X	X	--	Confirmation sample – Hot spot excavation.
LL11cs-042-0001-SO	D	03/22/01	3–7	IRA	--	X	X	X	--	Confirmation sample – Hot spot excavation.
LL11cs-043-0001-SO	D	03/22/01	3–7	IRA	--	X	X	X	--	Confirmation sample – Hot spot excavation.
LL11cs-044-0001-SO	D	03/22/01	7–8	IRA	--	X	X	X	--	Confirmation sample – Hot spot excavation.
LL11cs-045-0001-FD	D	03/22/01	7–8	IRA	X	--	--	--	--	Field duplicate.
LL11cs-045-0001-SO	D	03/22/01	7–8	IRA	--	X	X	X	--	Confirmation sample – Hot

Table 4–33. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
										spot excavation.
LL11cs-046-0001-SO	D	03/22/01	3–4	IRA	--	X	X	X	--	Confirmation sample – Test trenches.
LL11cs-047-0001-SO	D	03/22/01	3–4	IRA	--	X	X	X	--	Confirmation sample – Test trenches.
LL11cs-048-0001-SO	D	03/22/01	3–4	IRA	--	X	X	X	--	Confirmation sample – Test trenches.
LL11cs-049-0001-SO	D	03/22/01	3–4	IRA	--	X	X	X	--	Confirmation sample – Test trenches.
LL11cs-050-0001-SO	D	03/22/01	3–4	IRA	--	X	X	X	--	Confirmation sample – Test trenches.
LL11sb-001-0001-FD	D	10/31/00	0–1	Phase I RI	X	--	--	--	--	Field duplicate.
LL11sb-001-0001-SO	D	10/31/00	0–1	Phase I RI	--	X	X	X	X	
LL11sb-001-0002-SO	D	11/03/00	18–20	Phase I RI	--	X	X	--	--	Sample below the exposure depth of all receptors.
LL11sb-002-0001-SO	D	10/30/00	0–1	Phase I RI	--	X	X	X	X	
LL11sb-002-0002-SO	D	11/10/00	6–8	Phase I RI	--	X	X	X	--	
LL11sb-003-0001-SO	D	10/30/00	0–1	Phase I RI	--	X	X	X	X	
LL11sb-003-0002-SO	D	11/09/00	20–40	Phase I RI	--	X	X	--	--	Sample below the exposure depth of all receptors.
LL11sb-004-0001-SO	D	10/31/00	0–1	Phase I RI	--	X	X	X	X	
LL11sb-004-0002-SO	D	11/08/00	10–12	Phase I RI	--	X	X	X	--	
LL11sb-005-0001-SO	D	10/31/00	0–1	Phase I RI	--	X	X	X	X	
LL11sb-005-0002-SO	D	11/09/00	6–8	Phase I RI	--	X	X	X	--	
LL11sb-006-0001-SO	D	10/31/00	0–1	Phase I RI	--	X	X	X	X	
LL11sb-006-0002-SO	D	11/13/00	2–4	Phase I RI	--	X	X	X	--	
LL11sb-007-0001-SO	D	10/31/00	0–1	Phase I RI	--	X	X	X	X	
LL11sb-007-0002-SO	D	11/07/00	14–16	Phase I RI	--	X	X	--	--	Sample below the exposure depth of all receptors.
LL11sb-008-0001-SO	D	10/31/00	0–1	Phase I RI	--	X	X	X	X	
LL11sb-008-0002-FD	D	11/08/00	12–13	Phase I RI	X	--	--	--	--	Field duplicate.
LL11sb-008-0002-SO	D	11/08/00	12–13	Phase I RI	--	X	X	X	--	
LL11sb-009-0001-SO	D	10/30/00	0–1	Phase I RI	--	X	X	X	X	
LL11sb-009-0002-SO	D	11/13/00	4–6	Phase I RI	--	X	X	X	--	
LL11sb-010-0001-SO	D	10/31/00	0–1	Phase I RI	--	X	X	X	X	
LL11sb-010-0002-SO	D	11/07/00	14–16	Phase I RI	--	X	X	--	--	Sample below the exposure

Table 4–33. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
										depth of all receptors.
LL11sb-011-0001-SO	D	08/21/00	4–6	Phase I RI	--	X	X	X	--	
LL11sb-012-0001-FD	D	08/22/00	8–10	Phase I RI	X	--	--	--	--	Field duplicate.
LL11sb-012-0001-SO	D	08/22/00	8–10	Phase I RI	--	X	X	X	--	
LL11sb-013-0001-SO	D	08/22/00	8–10	Phase I RI	--	X	X	X	--	
LL11sb-014-0001-SO	D	08/22/00	11–13	Phase I RI	--	X	X	X	--	
LL11sb-015-0001-SO	D	08/22/00	10–12	Phase I RI	--	X	X	X	--	
LL11sb-016-0001-SO	D	08/22/00	8.5–11.5	Phase I RI	--	X	X	X	--	
LL11sb-017-0001-SO	D	08/22/00	4–6	Phase I RI	--	X	X	X	--	
LL11sb-018-0001-SO	D	08/22/00	4–6	Phase I RI	--	X	X	X	--	
LL11sb-019-0001-FD	D	08/21/00	0–1	Phase I RI	X	--	--	--	--	Field duplicate.
LL11sb-019-0001-SO	D	08/21/00	0–1	Phase I RI	--	X	X	X	X	
LL11sb-019-0002-SO	D	08/21/00	6–8	Phase I RI	--	X	X	X	--	
LL11sb-020-0001-SO	D	08/21/00	0–1	Phase I RI	--	X	X	X	X	
LL11sb-020-0002-SO	D	08/21/00	6–8	Phase I RI	--	X	X	X	--	
LL11sb-021-0001-SO	D	08/21/00	0–1	Phase I RI	--	X	X	X	X	
LL11sb-021-0002-SO	D	08/21/00	6–8	Phase I RI	--	X	X	X	--	
LL11sb-022-0001-SO	D	08/22/00	0–1	Phase I RI	--	X	X	X	X	
LL11sb-022-0002-SO	D	08/22/00	6–8	Phase I RI	--	X	X	X	--	
LL11sb-023-0001-SO	D	08/22/00	0–1	Phase I RI	--	X	X	X	X	
LL11sb-023-0002-SO	D	08/22/00	6–8	Phase I RI	--	X	X	X	--	
LL11sb-024-0001-SO	D	11/16/00	7–9	Phase I RI	--	X	X	X	--	
LL11sb-025-0001-SO	D	11/17/00	5–7	Phase I RI	--	X	X	X	--	
LL11sb-026-0001-SO	D	11/16/00	4–6	Phase I RI	--	X	X	X	--	
LL11sb-027-0001-FD	D	11/16/00	6–8	Phase I RI	X	--	--	--	--	Field duplicate.
LL11sb-027-0001-SO	D	11/16/00	6–8	Phase I RI	--	X	X	X	--	
LL11sb-028-0001-SO	D	11/16/00	4–6	Phase I RI	--	X	X	X	--	
LL11sb-029-0001-SO	D	11/16/00	6–8	Phase I RI	--	X	X	X	--	
LL11sb-030-0001-SO	D	11/17/00	8–10	Phase I RI	--	X	X	X	--	
LL11sb-031-0001-SO	D	11/16/00	4–6	Phase I RI	--	--	--	--	--	Excavated hot spot location.
LL11sb-031A-0001-SO	D	03/13/01	6–8	Phase I RI	--	--	--	--	--	Excavated hot spot location.
LL11sb-032-0001-SO	D	11/17/00	4–6	Phase I RI	--	--	--	--	--	Excavated hot spot location.
LL11sb-033-0001-SO	D	11/17/00	6–8	Phase I RI	--	--	--	--	--	Excavated hot spot location.
LL11sb-034-0001-SO	D	11/17/00	2–4	Phase I RI	--	--	--	--	--	Excavated hot spot location.
LL11sb-035-0001-FD	D	11/17/00	4–6	Phase I RI	X	--	--	--	--	Field duplicate.
LL11sb-035-0001-SO	D	11/17/00	4–6	Phase I RI	--	X	X	X	--	

Table 4–33. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
LL11sb-036-0001-SO	D	11/17/00	4–6	Phase I RI	--	--	--	--	--	Excavated hot spot location.
LL11sb-037-0001-SO	D	03/13/01	6–8	Phase I RI	--	X	X	X	--	
LL11sb-038-0001-SO	D	03/13/01	6–8	Phase I RI	--	X	X	X	--	
LL11sb-039-0001-SO	D	03/13/01	6–8	Phase I RI	--	X	X	X	--	
LL11sb-040-0001-SO	D	03/13/01	6–8	Phase I RI	--	X	X	X	--	
LL11sb-041-0001-SO	D	03/13/01	6–8	Phase I RI	--	X	X	X	--	
LL11sb-042-0001-SO	D	03/13/01	6–8	Phase I RI	--	X	X	X	--	
LL11sb-043-0001-SO	D	03/13/01	6–8	Phase I RI	--	X	X	X	--	
LL11sb-060-5551-SO	D	03/18/10	0–1	PBA08 RI	--	X	X	X	X	
LL11sb-060-5552-SO	D	03/18/10	1–4	PBA08 RI	--	X	X	X	--	
LL11sb-060-5553-SO	D	03/18/10	4–7	PBA08 RI	--	X	X	X	--	
LL11sb-061-5555-SO	D	03/17/10	0–1	PBA08 RI	--	X	X	X	X	
LL11sb-061-5556-SO	D	03/17/10	1–4	PBA08 RI	--	X	X	X	--	
LL11sb-061-5557-SO	D	03/17/10	4–7	PBA08 RI	--	X	X	X	--	
LL11sb-062-5559-SO	D	03/18/10	0–1	PBA08 RI	--	X	X	X	X	
LL11sb-062-5560-SO	D	03/18/10	1–4	PBA08 RI	--	X	X	X	--	
LL11sb-062-5561-SO	D	03/18/10	4–7	PBA08 RI	--	X	X	X	--	
LL11sb-062-6189-FD	D	03/18/10	0–1	PBA08 RI	X	--	--	--	--	Field duplicate.
LL11sb-063-5563-SO	D	03/22/10	0–1	PBA08 RI	--	X	X	X	X	
LL11sb-063-5564-SO	D	03/22/10	1–4	PBA08 RI	--	X	X	X	--	
LL11sb-063-5565-SO	D	03/22/10	4–5	PBA08 RI	--	X	X	X	--	
LL11sb-064-5569-SO	D	03/18/10	0–1	PBA08 RI	--	X	X	X	X	
LL11sb-064-5570-SO	D	03/18/10	1–4	PBA08 RI	--	X	X	X	--	
LL11sb-064-5571-SO	D	03/18/10	4–7	PBA08 RI	--	X	X	X	--	
Sediment										
LL11cs-015-0001-SD	D	03/23/01	0–1	IRA	--	X	X	X	X	Confirmation sample – Ditch east of Building AP-4.
LL11cs-031-0001-FD	D	03/20/01	0–1	IRA	X	--	--	--	--	Field duplicate.
LL11cs-031-0001-SD	D	03/20/01	0–1	IRA	--	X	X	X	X	Confirmation sample – Ditch north of Building AP-19.
LL11sd-002-0001-SD	D	08/02/00	3–3	Phase I RI	--	--	--	--	--	Excavated former sump location.
LL11sd-003-0001-SD	D	08/02/00	3–3	Phase I RI	--	--	--	--	--	Excavated former sump location.
LL11sd-005-0001-SD	D	10/09/00	7–7	Phase I RI	--	--	--	--	--	Excavated former sump location.

Table 4–33. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
LL11sd-007-0001-SD	D	07/31/00	10.6–10.6	Phase I RI	--	--	--	--	--	Sample from sewer system.
LL11sd-008-0001-SD	D	08/01/00	12–12	Phase I RI	--	--	--	--	--	Sample from sewer system.
LL11sd-009-0001-SD	D	08/01/00	16–16	Phase I RI	--	--	--	--	--	Sample from sewer system.
LL11sd-010-0001-SD	D	07/31/00	8–8	Phase I RI	--	--	--	--	--	Sample from sewer system.
LL11sd-011-0001-SD	D	08/01/00	12–12	Phase I RI	--	--	--	--	--	Sample from sewer system.
LL11sd-017-0001-FD	D	11/15/00	0–1	Phase I RI	X	--	--	--	--	Field duplicate.
LL11sd-017-0001-SD	D	11/15/00	0–1	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
LL11sd-018-0001-SD	D	11/15/00	0–0.5	Phase I RI	--	--	--	--	--	Excavated ditch location.
LL11sd-021-0001-SD	D	11/16/00	0–1	Phase I RI	--	X	X	X	X	
LL11sd-024-0001-SD	D	11/16/00	0–1	Phase I RI	--	X	X	X	X	
LL11sd-027-0001-SD	D	11/15/00	0–0.5	Phase I RI	--	--	--	--	--	Excavated ditch location.
LL11sd-028-0001-SD	D	11/15/00	0–0.5	Phase I RI	--	--	--	--	--	Excavated ditch location.
LL11sd-030-0001-SD	D	11/16/00	0–1	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
LL11sd-082-5593-SD	D	02/24/10	0–0.5	PBA08 RI	--	X	--	--	--	Sample represents drainage off AOC.
LL11sd-083-5594-SD	D	02/25/10	0–0.5	PBA08 RI	--	X	X	X	X	
LL11sd-084-5595-SD	D	02/25/10	0–0.5	PBA08 RI	--	X	X	X	X	
LL11sd-096-5874-SD	D	08/09/12	0–0.5	PBA08 RI	--	X	X	X	X	
RV-447	D	10/23/98	0–0.5	1998 RRSE	--	--	--	--	--	Used for initial evaluation of site.
Surface Water										
LL11sw-001-0001-SW	D	06/28/00	1.1–1.1	Phase I RI	--	--	--	--	--	Excluded excavated sump.
LL11sw-001-0002-SW	D	07/31/00	3–3	Phase I RI	--	--	--	--	--	Excluded excavated sump.
LL11sw-002-0001-SW	D	06/28/00	0.5–0.5	Phase I RI	--	--	--	--	--	Excluded excavated sump.
LL11sw-002-0002-SW	D	07/31/00	3–3	Phase I RI	--	--	--	--	--	Excluded excavated sump.
LL11sw-003-0001-SW	D	06/28/00	3–3	Phase I RI	--	--	--	--	--	Excluded excavated sump.
LL11sw-003-0002-SW	D	07/31/00	3–3	Phase I RI	--	--	--	--	--	Excluded excavated sump.
LL11sw-004-0001-SW	D	06/29/00	3.4–3.4	Phase I RI	--	--	--	--	--	Excluded excavated sump.
LL11sw-004-0002-SW	D	07/31/00	3.4–3.4	Phase I RI	--	--	--	--	--	Excluded excavated sump.
LL11sw-005-0001-SW	D	10/09/00	3–3	Phase I RI	--	--	--	--	--	Excluded excavated sump.

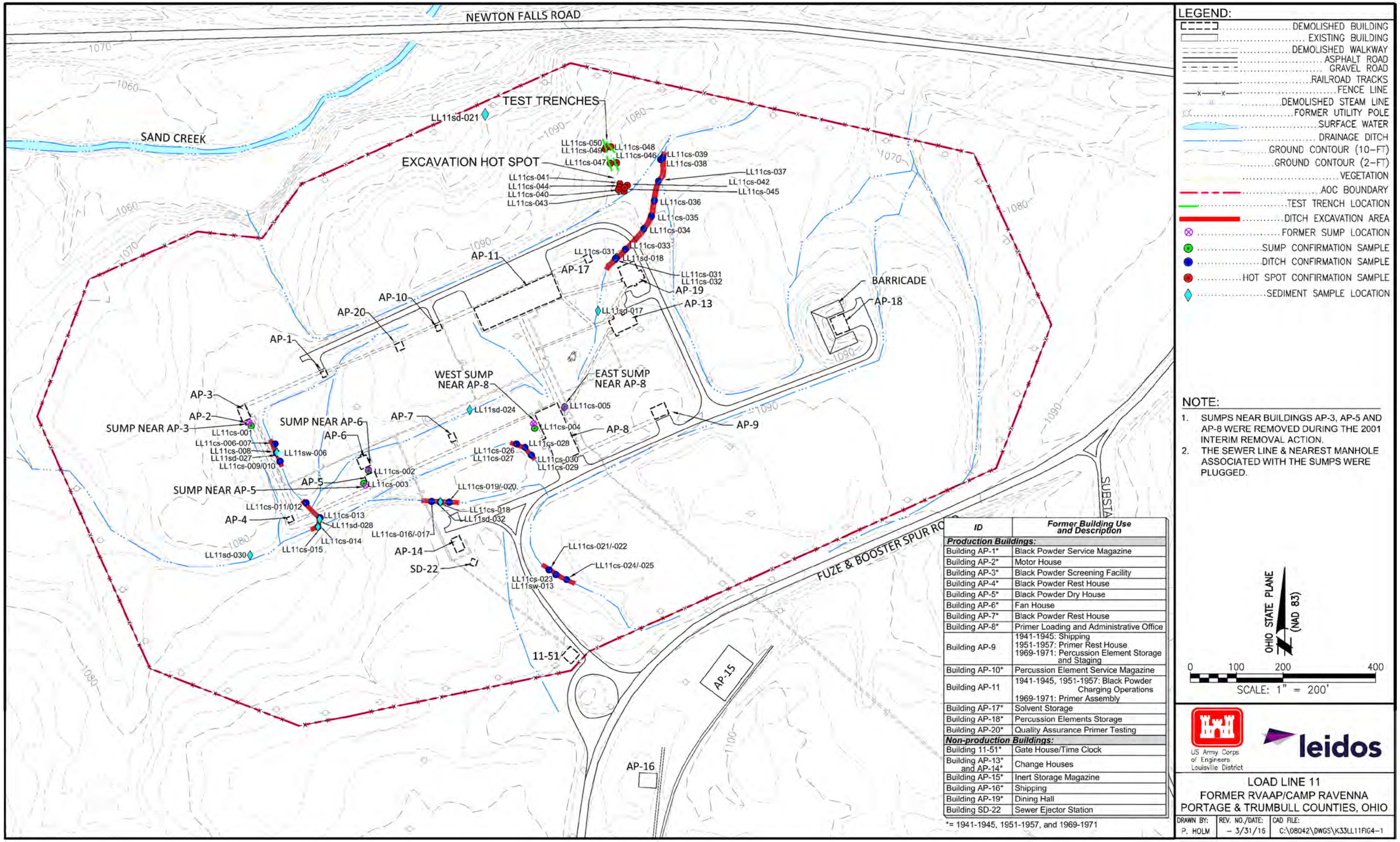
Table 4–33. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
LL11sw-006-0001-SW	D	06/28/00	1.2–1.2	Phase I RI	--	--	--	--	--	Excluded excavated ditch location.
LL11sw-006-0002-SW	D	07/31/00	1.2–1.2	Phase I RI	--	--	--	--	--	Excluded excavated ditch location.
LL11sw-007-0001-SW	D	06/29/00	5.4–5.4	Phase I RI	--	--	--	--	--	Excluded sewer location.
LL11sw-007-0002-SW	D	07/31/00	8–8	Phase I RI	--	--	--	--	--	Excluded sewer location.
LL11sw-008-0001-FD	D	06/29/00	7.7–7.7	Phase I RI	--	--	--	--	--	Excluded sewer location.
LL11sw-008-0001-SW	D	06/29/00	7.7–7.7	Phase I RI	--	--	--	--	--	Excluded sewer location.
LL11sw-008-0002-SW	D	08/01/00	7–7	Phase I RI	--	--	--	--	--	Excluded sewer location.
LL11sw-009-0001-SW	D	06/29/00	10.5–10.5	Phase I RI	--	--	--	--	--	Excluded sewer location.
LL11sw-009-0002-SW	D	08/01/00	10–10	Phase I RI	--	--	--	--	--	Excluded sewer location.
LL11sw-010-0001-SW	D	06/29/00	5–5	Phase I RI	--	--	--	--	--	Excluded sewer location.
LL11sw-010-0002-SW	D	07/31/00	5–5	Phase I RI	--	--	--	--	--	Excluded sewer location.
LL11sw-011-0001-FD	D	06/28/00	7.8–7.8	Phase I RI	--	--	--	--	--	Excluded sewer location.
LL11sw-011-0001-SW	D	06/28/00	7.8–7.8	Phase I RI	--	--	--	--	--	Excluded sewer location.
LL11sw-011-0002-FD	D	07/12/00	7.8–7.8	Phase I RI	--	--	--	--	--	Excluded sewer location.
LL11sw-011-0002-SW	D	08/01/00	7.8–7.8	Phase I RI	--	--	--	--	--	Excluded sewer location.
LL11sw-011-0002b-SW	D	07/12/00	7.8–7.8	Phase I RI	--	--	--	--	--	Excluded sewer location.
LL11sw-012-0001-FD	D	11/17/00	0.5–0.5	Phase I RI	X	--	--	--	--	Field duplicate.
LL11sw-012-0001-SW	D	11/17/00	0.5–0.5	Phase I RI	--	X	--	--	--	Sample used for nature and extent evaluation only. More recent sample at LL11sd-083 used for screening.
LL11sw-013-0001-SW	D	11/20/00	0–0.1	Phase I RI	--	--	--	--	--	Excluded excavated ditch location.
LL11sw-013-0001b-SW	D	02/07/01	0–0.1	Phase I RI	--	--	--	--	--	Excluded excavated ditch location.
LL11sw-014-0001-SW	D	11/20/00	0–0.1	Phase I RI	--	X	--	--	--	Sample used for Nature and Extent evaluation only. More recent sample at LL11sd-084 used for screening.
LL11sw-014-0001b-SW	D	02/07/01	0–0.1	Phase I RI	--	X	--	--	--	Sample used for nature and extent evaluation only. More recent sample at LL11sd-084 used for screening.
LL11sw-015-0001-SW	D	11/20/00	0–0.1	Phase I RI	--	X	--	--	--	Sample used for nature and extent evaluation only. More

Table 4–33. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
										recent sample at LL11sd-084 used for screening.
LL11sw-015-0001b-SW	D	02/07/01	0–0.1	Phase I RI	--	X	--	--	--	Sample used for nature and extent evaluation only. More recent sample at LL11sd-084 used for screening.
LL11sw-082-5608-SW	D	02/24/10		PBA08 RI	--	X	--	--	--	Sample represents drainage off AOC used for nature and extent evaluation.
LL11sw-083-5609-SW	D	02/25/10		PBA08 RI	--	X	X	X	X	
LL11sw-084-5610-SW	D	02/25/10		PBA08 RI	--	X	X	X	X	

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



ID	Former Building Use and Description
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
Building AP-9	1941-1945: Shipping 1951-1957: Primer Rest House 1969-1971: Percussion Element Storage and Staging
Building AP-10*	Percussion Element Service Magazine
Building AP-11	1941-1945, 1951-1957: Black Powder Charging Operations 1969-1971: Primer Assembly
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

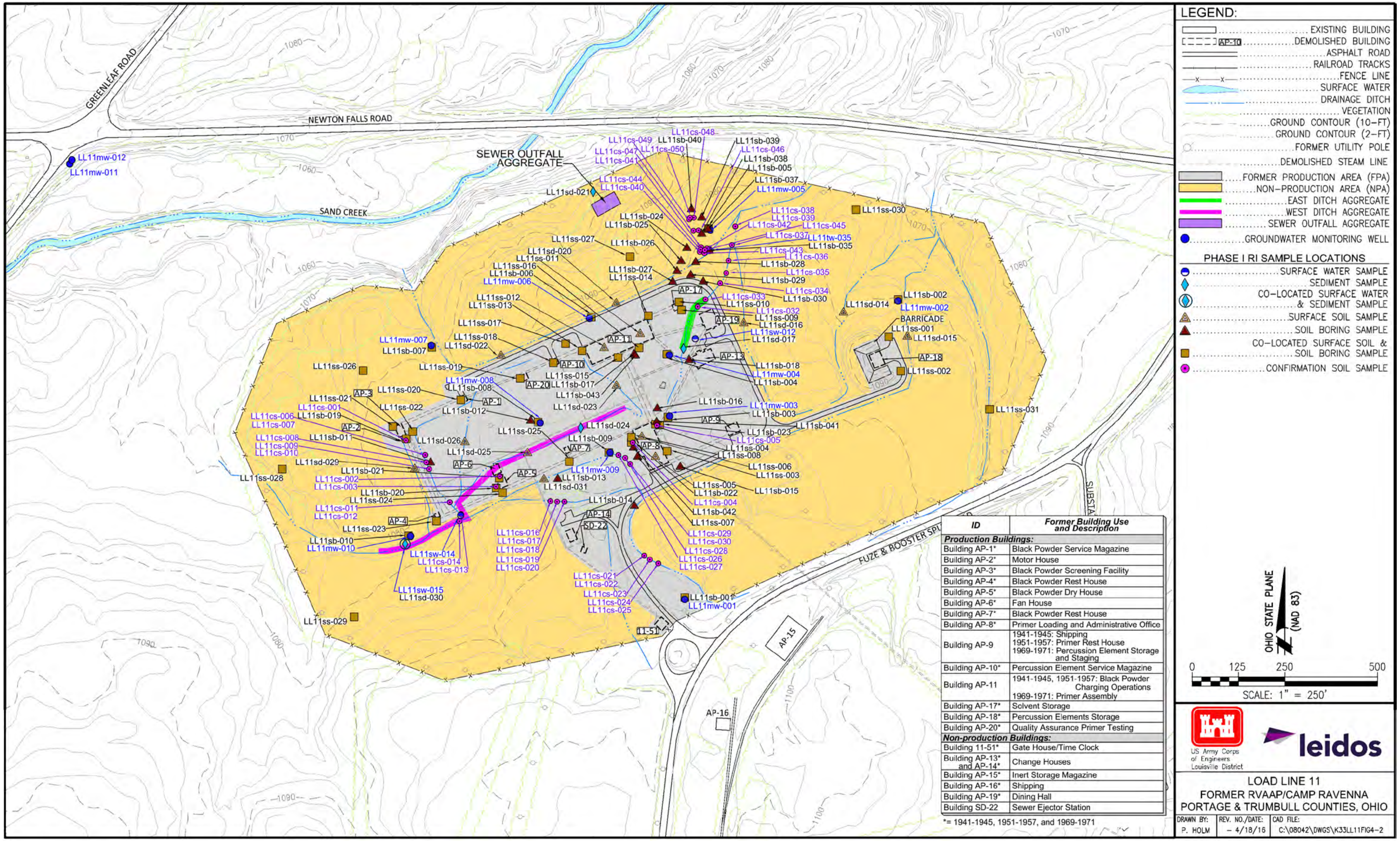
NOTE:

1. SUMPS NEAR BUILDINGS AP-3, AP-5 AND AP-8 WERE REMOVED DURING THE 2001 INTERIM REMOVAL ACTION.
2. THE SEWER LINE & NEAREST MANHOLE ASSOCIATED WITH THE SUMPS WERE PLUGGED.

LOAD LINE 11
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
P. HOLM	– 3/31/16	C:\08042\DWGS\K33LL11FIG4–1

Figure 4–1. IRA Sample Locations at Load Line 11



ID	Former Building Use and Description
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
Building AP-9	1941-1945: Shipping 1951-1957: Primer Rest House 1969-1971: Percussion Element Storage and Staging
Building AP-10*	Percussion Element Service Magazine
Building AP-11	1941-1945, 1951-1957: Black Powder Charging Operations 1969-1971: Primer Assembly
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

Figure 4–2. Phase I RI Sample Locations at Load Line 11

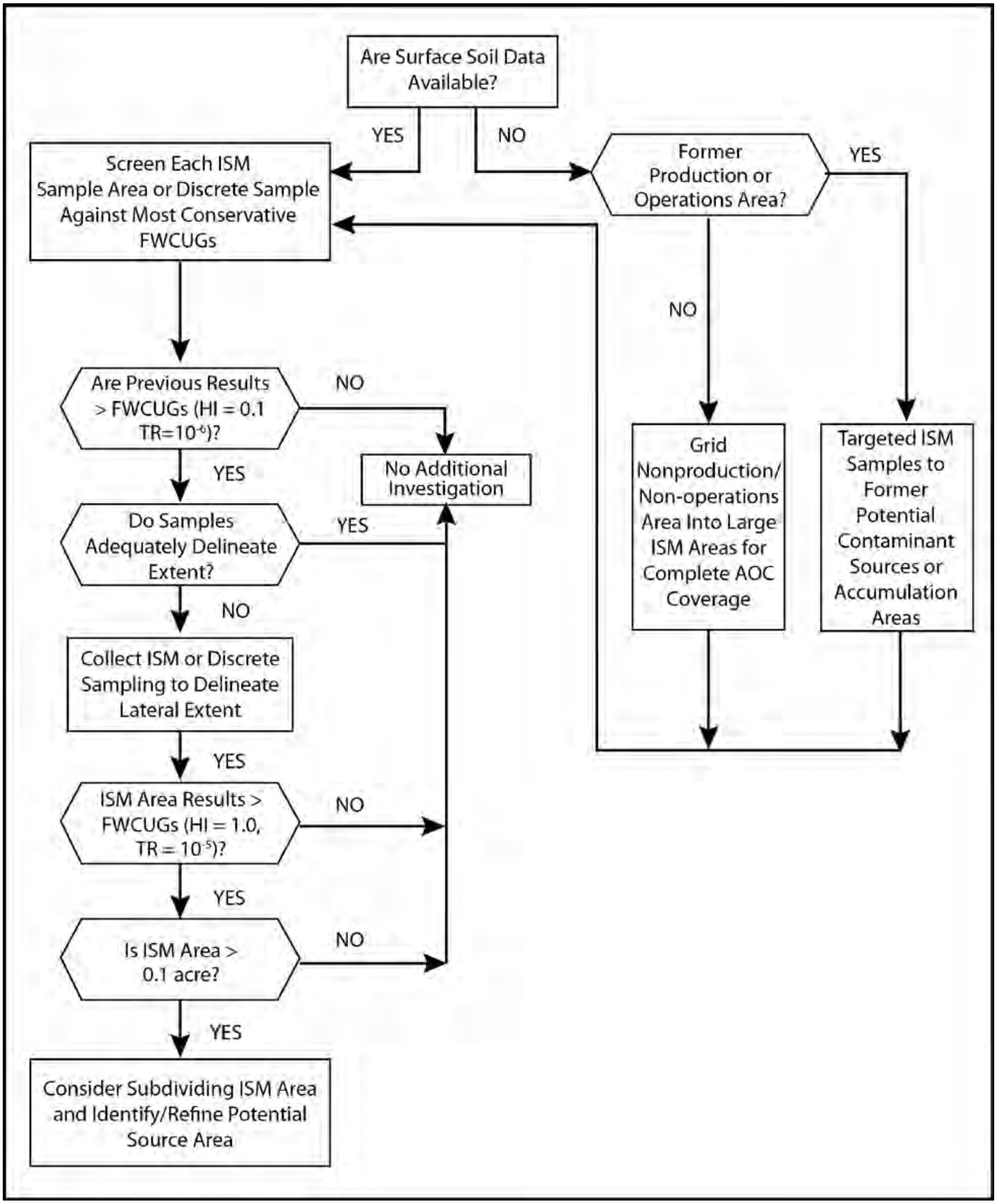


Figure 4–3. PBA08 RI Surface Soil Sampling

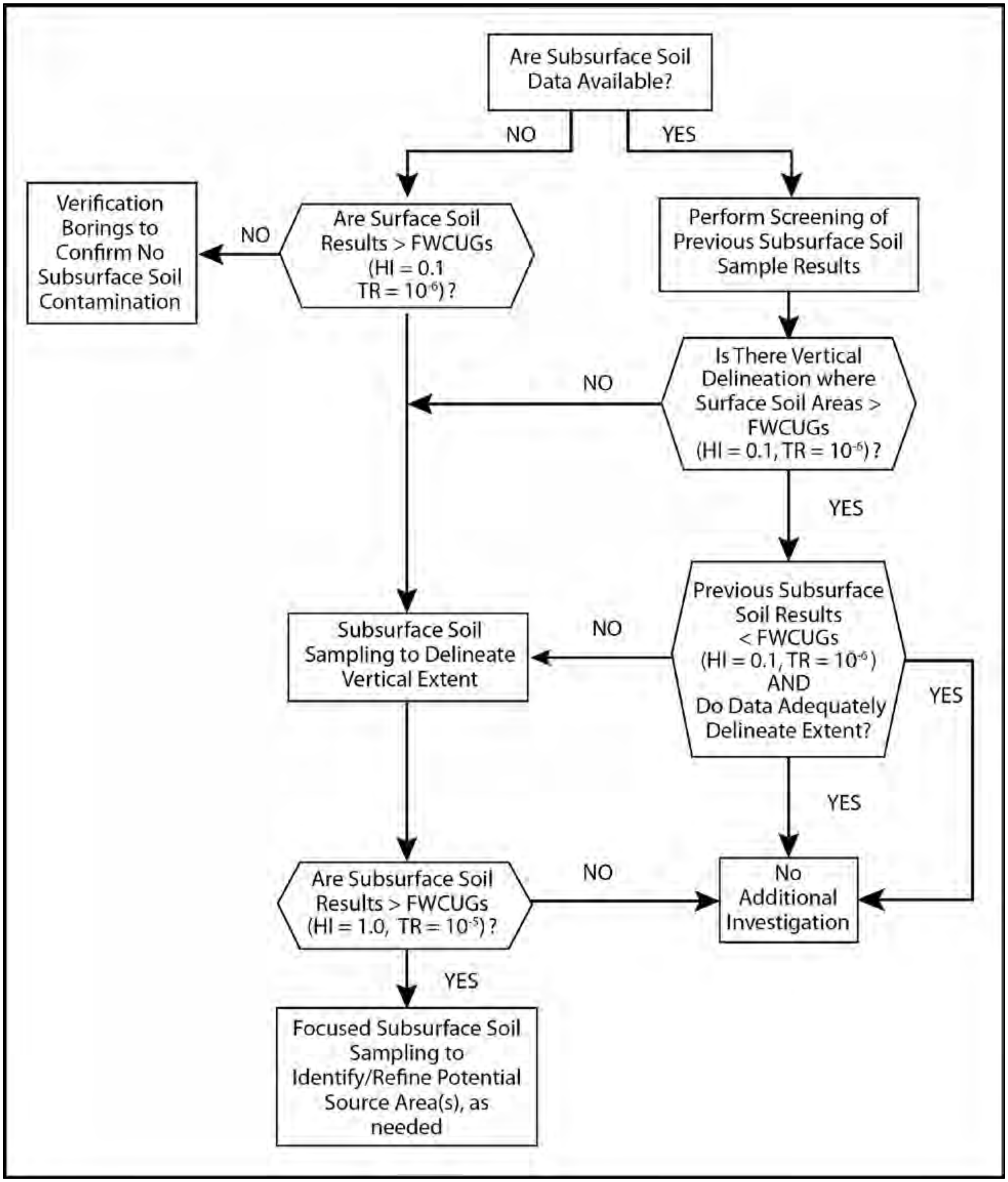
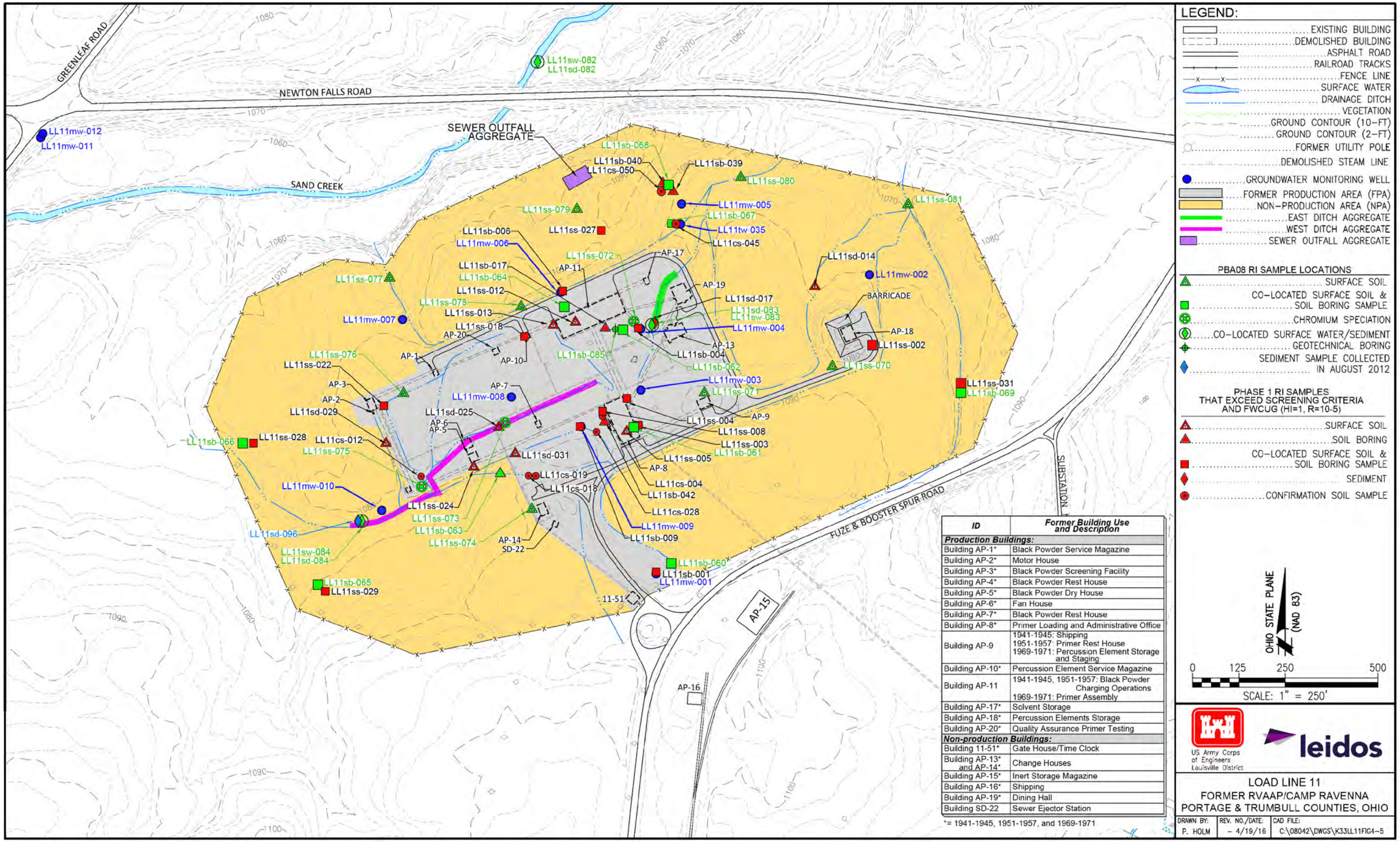


Figure 4–4. PBA08 RI Subsurface Soil Sampling



ID	Former Building Use and Description
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
Building AP-9	1941-1945: Shipping 1951-1957: Primer Rest House 1969-1971: Percussion Element Storage and Staging
Building AP-10*	Percussion Element Service Magazine
Building AP-11	1941-1945, 1951-1957: Black Powder Charging Operations 1969-1971: Primer Assembly
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

Figure 4–5. 2010 PBA08 RI Sample Locations

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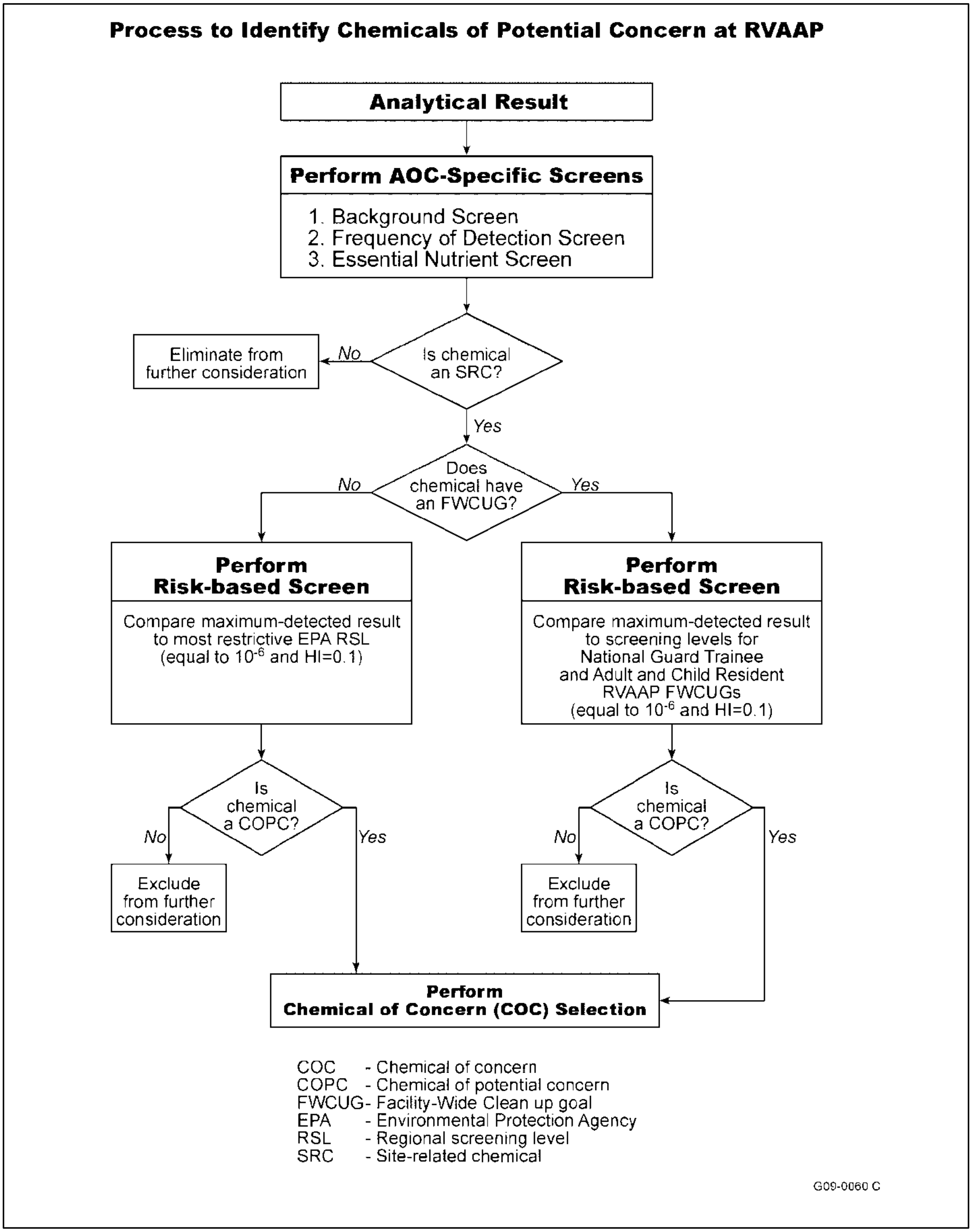

Figure 4–6. Process to Identify RVAAP COPCs in the HHRA (USACE 2010a)

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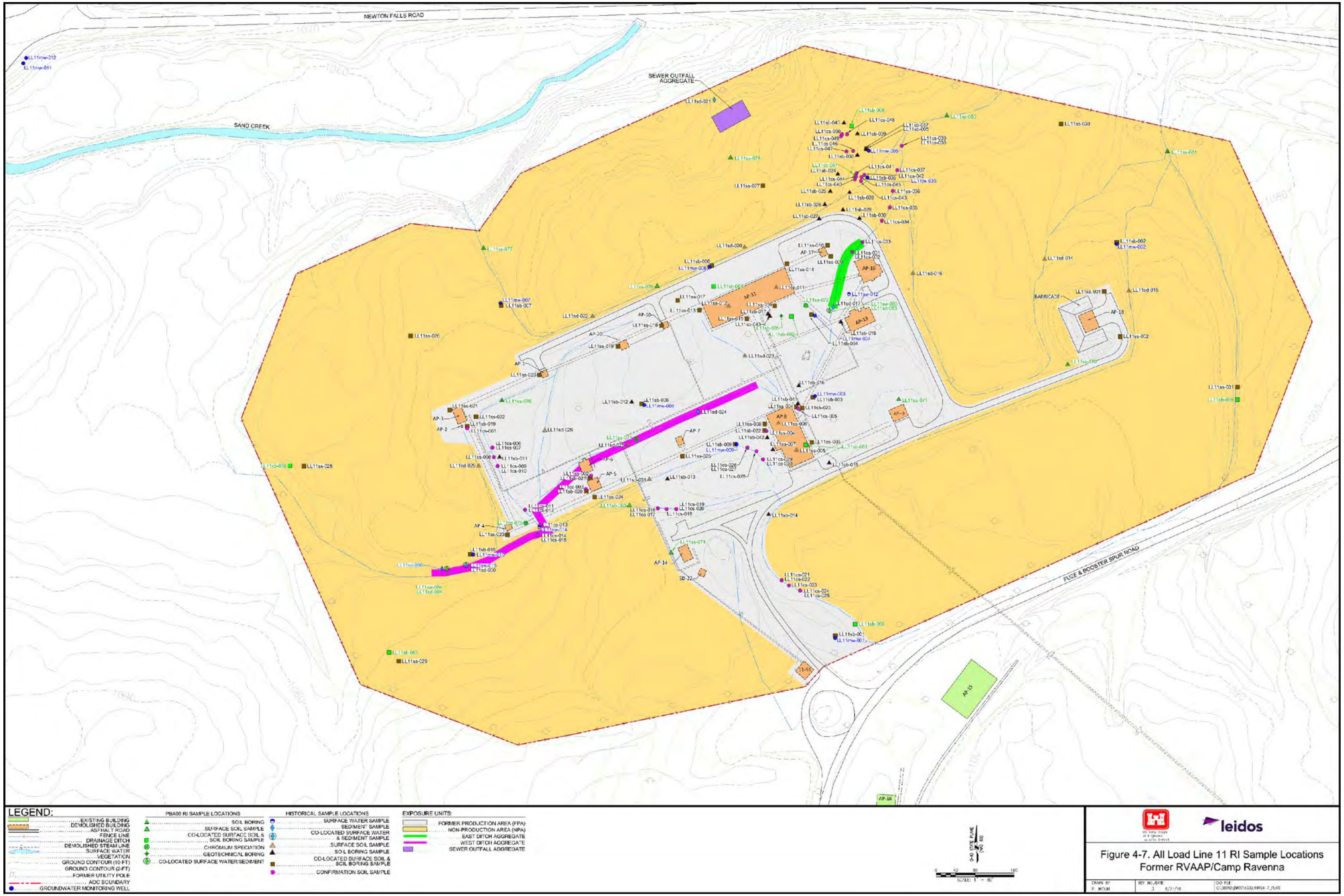

Figure 4–7. All Load Line 11 RI Sample Locations

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5.0 NATURE AND EXTENT OF CONTAMINATION

This section evaluates the nature and extent of contamination at Load Line 11. 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 11, focusing on chemicals previously used during operational activities and using analytical data results obtained during the 2000 Phase I RI, 2001 IRA, and 2010 and 2012 PBA08 RIs.

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. The following figures illustrate the concentration and distribution of SRCs that exceed SLs.

- Figure 5-1 – EUs and Sample Locations.
- Figure 5-2 – Detected Concentrations of Explosives and Propellants in Soil at the FPA.
- Figure 5-3 – Detected Concentrations of Explosives and Propellants in Soil at the NPA.
- Figure 5-4 – Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) for Arsenic, Chromium, Lead, Mercury, Aluminum, Barium, Cobalt, Cyanide, Manganese, and Thallium in Soil at the FPA.
- Figure 5-5 – Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) for Arsenic, Chromium, Lead, Mercury, Aluminum, Barium, Cobalt, Cyanide, Manganese, and Thallium in Soil at the NPA.
- Figure 5-6 – PAH Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) in Soil at the FPA and NPA.
- Figure 5-7 – Detected Concentrations of VOCs, Pesticides, and PCBs in Soil at the FPA and NPA.
- Figure 5-8 – Detected Concentrations of Explosives and Propellants in Surface Water and Sediment.
- Figure 5-9 – Exceedances of FWCUG (HQ of 0.1, TR 1E-06) for Arsenic, Chromium, Lead, Mercury, Aluminum, and Cobalt in Surface Water and Sediment.
- Figure 5-10 – PAH Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) in Surface Water and Sediment.
- Figure 5-11 – 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 11. All validated Load Line 11 data from the RIs (2000 Phase I RI and 2010 and 2012 PBA08 RIs) and 2001 IRA are included in Appendix D. Complete analytical data packages from the PBA08 RIs are also included in Appendix D.

The following sections discuss the source removal activities that took place under the IRA (MKM 2004a) as well as a current assessment of contaminant nature and extent for each medium and class of analyte.

5.1 PREVIOUS CONTAMINANT SOURCE REMOVAL (INTERIM REMOVAL ACTION)

As discussed in Section 4.2, contaminant source removal was conducted in 2001 under an IRA (MKM 2004a) as an early response action to mitigate migration of contaminants identified during the Phase I RI. This IRA is summarized in the IRA Report (MKM 2004a) and Phase I RI Report (MKM 2005a). The contaminant source removal consisted of the actions listed below.

- Sump excavation and sewer line grouting – Five sumps were excavated, removed, and disposed. One confirmation sample was collected from each sump location to confirm removal.
- Sewer line grouting – Sewer manholes and sewer lines were filled with bentonite cement to prevent water from infiltrating back into the sumps during excavation and removal operations.
- Drainage ditch excavation – A total of 230 yd^3 of contaminated sediment was removed from six ditch lines within Load Line 11. These drainage ditches exhibited elevated concentrations of metals, VOCs, SVOCs, pesticides, and/or PCBs. Numerous samples were collected to confirm that the contaminant removal was complete.
- Hot spot excavation – One location, a 30 by 30 by 8 ft hot spot area, located in an open field north of Building AP-17, was excavated due to petroleum contamination. Upon removing the contaminated soil, six samples were collected to confirm that the contaminated soil was removed.
- Test Trench Excavation – Test trenches were excavated to assess high readings indicated on magnetometers used by UXO technicians immediately north of the hot spot excavation. Upon excavating test trenches, cable, scrap metal, bolts, and magnetite-containing rock were found. No UXO was identified. Five samples were collected to confirm there was no contamination present at this location.

The information and results of these IRA activities were used in the current nature and extent evaluation of Load Line 11.

5.2 SURFACE SOIL DISCRETE SAMPLE RESULTS FOR CHROMIUM SPECIATION

During the 2010 PBA08 RI, surface soil samples were collected from three discrete sample locations and analyzed for hexavalent chromium and total chromium. One sample was collected from an area previously identified during the Phase I RI as having an elevated total chromium concentration (LL11ss-072), another sample was collected from an area previously identified during the IRA as having an elevated total chromium concentration (LL11ss-075), and an additional sample was collected from an area previously identified as having a total chromium concentration near background (LL11ss-073). This sampling attempted to determine the contribution of hexavalent chromium to total chromium over a range of concentrations in soil at Load Line 11 for use in the HHRA (Section 7.2).

Chromium speciation results are shown in Table 5-1. All three samples were below the facility-wide background concentration of 17.4 mg/kg. The range of hexavalent chromium concentrations was 0.44J to less than 1 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.

5.3 CONTAMINANT NATURE AND EXTENT IN SURFACE SOIL

Tables 4-24 and 4-25 present the SRC screening results for surface soil at Load Line 11 that was still present after the source removals. The following subsections discuss the concentration and distribution of the discrete surface soil results.

5.3.1 Explosives and Propellants

The FPA and NPA were evaluated for explosives during both RIs and the IRA, comprising the Phase II RI data set. Specifically, the soil samples around the buildings were analyzed during the Phase I RI, the confirmation samples were evaluated following the IRA, and data gaps were assessed during the 2010 PBA08 RI. Figures 5-2 and 5-3 present locations that had detectable concentrations of explosives and propellants at the FPA and NPA.

Former Production Area

Two propellants (nitrocellulose and nitroguanidine) were identified as SRCs and as potentially related to previous AOC operations. Nitrocellulose was detected at concentrations ranging from 0.89 to 1.1 mg/kg in four of four samples with the maximum detection at location LL11ss-009. Nitroguanidine was detected only at LL11ss-001 at a concentration of 0.077J mg/kg. The maximum concentrations of nitrocellulose and nitroguanidine were below their respective SLs (19,000,000 and 630 mg/kg) and were not considered COPCs.

In addition to the explosive contaminants identified as being used historically, two explosives [pentaerythritol tetranitrate (PETN) and tetryl] were detected in the surface soil at the FPA. The explosives PETN and tetryl were detected only in PBA08 RI sample LL11sb-061 at concentrations of 0.049J and 0.02J mg/kg, respectively. LL11sb-061 is located immediately adjacent to former Building AP-8.

Non-Production Area

One explosive (HMX) and one propellant (nitrocellulose) were identified as SRCs and as potentially related to previous AOC operations. HMX was detected only in PBA08 RI sample LL11ss-081 (0.013J mg/kg), which is within a ditch line adjacent to the northeast fence line of Load Line 11. Nitrocellulose was detected in three of five samples analyzed, ranging from 0.89 (LL11sb-005) to 1.2 mg/kg (LL11ss-029). Nitrocellulose was not detected in either of the two PBA08 RI samples analyzed. The maximum concentrations of HMX and nitrocellulose were below their respective SLs (359 and 19,000,000 mg/kg) and were not considered COPCs.

In addition to the explosive contaminants identified as being used historically, one explosive (PETN) was identified as a SRC in the surface soil at the NPA. PETN was detected only in PBA08 RI sample LL11sb-067 (0.036J mg/kg), located at the downstream portion of the northeast ditch line that was excavated during the IRA in 2001.

5.3.2 Inorganic Chemicals

Former Production Area

Arsenic, chromium, lead, and mercury were identified as potential SRCs and as potentially related to the previous site use. All four of these inorganic chemicals exceeded their respective background concentrations in the surface soil in the FPA, as summarized in the list below.

- Arsenic was detected above the background concentration of 15.4 mg/kg in 11 samples, with a maximum concentration of 30.2 mg/kg observed at the Phase I RI sample location LL11ss-022 that evaluated former Building AP-3.
- Chromium was detected above the background concentration of 17.4 mg/kg in 10 samples, with a maximum concentration of 28.4 mg/kg observed at the IRA sample location LL11cs-011. Confirmation sample LL11cs-011 was collected to evaluate the effectiveness of the drainage ditch excavation near former Building AP-4.
- Lead was detected above the background concentration of 26.1 mg/kg in 21 samples, with a maximum concentration of 102 mg/kg observed at the IRA sample LL11cs-006. Confirmation sample LL11cs-006 was collected to evaluate the effectiveness of the drainage ditch excavation along the western side of the FPA.
- Mercury was detected above the background concentration of 0.036 mg/kg in 13 samples, with a maximum concentration of 0.34 mg/kg observed at the Phase I RI sample location LL11ss-013 that evaluated former Building AP-11.

Figure 5-4 presents the locations with concentrations that exceeded SLs and background for these four chemicals. Of the four chemicals, only arsenic was detected at concentrations above the SL and was considered a COPC.

Although not identified as previously used during historical operations, 12 other inorganic chemicals and 2 anions were identified as SRCs from the RVAAP screening process, as presented in Table 4-24. Of these constituents, four (aluminum, cobalt, cyanide, and manganese) exceeded their respective SLs and background concentrations. Figure 5-4 also presents exceedances of the SL and background for these four chemicals in the surface soil. Observations regarding other individual inorganic SRCs that exceeded their respective SLs in FPA surface soil are presented below:

- Aluminum was detected above the background concentration of 17,700 mg/kg in three samples, with a maximum concentration of 23,800 mg/kg observed at the IRA sample location LL11cs-025. Confirmation sample LL11cs-025 was collected to evaluate the effectiveness of the drainage ditch excavation on the south end of the AOC, just east of the entrance road.

- Cobalt was detected above the background concentration of 10.4 mg/kg in six samples, with a maximum concentration of 33.8 mg/kg observed at the Phase I RI sample location LL11sd-025 that evaluated the drainage ditch northwest of Building AP-7.
- Cyanide exceeded the SL of 0.27 mg/kg in three samples, with a maximum concentration of 1.6 mg/kg observed at the Phase I RI sample location LL11ss-014 that evaluated former Building AP-11.
- Manganese was detected above the background concentration of 1,450 mg/kg in two samples, with a maximum concentration of 1,540 mg/kg observed at the Phase I RI sample location LL11ss-018 that evaluated former Building AP-10.

Non-Production Area

All four inorganic chemicals potentially related to previous site use exceeded their respective background concentrations in the surface soil in the NPA, as summarized in the list below.

- Arsenic was detected above the background concentration of 15.4 mg/kg in five samples, with a maximum concentration of 40.4 mg/kg observed at the 2010 PBA08 RI sample location LL11ss-070 that evaluated the earthen barricade associated with former Building AP-18.
- Chromium was detected above the background concentration of 17.4 mg/kg only in the Phase I RI sample location LL11ss-030, at a concentration of 19 mg/kg just inside the northern perimeter fence.
- Lead was detected above the background concentration of 26.1 mg/kg in four samples, with a maximum concentration of 33.9 mg/kg observed at the 2010 PBA08 RI sample location LL11ss-081 that evaluated the confluence of drainage ditches in the northeastern portion of the NPA.
- Mercury was detected above the background concentration of 0.036 mg/kg in 11 samples, with a maximum concentration of 0.08 mg/kg observed at the Phase I RI sample location LL11sd-020 that evaluated the drainage ditch along northern road, directly across from former Building AP-11.

Figure 5-5 presents the locations with concentrations that exceeded SLs and background for these four chemicals. Of the four chemicals, only arsenic was detected at concentrations above the SL and was considered a COPC.

Although not identified as previously used during historical operations, 10 other inorganic chemicals and 2 anions were identified as SRCs from the RVAAP screening process, as presented in Table 4-25. Of these constituents, three (cobalt, cyanide, and manganese) exceeded their respective SLs and background concentrations. Figure 5-5 also presents exceedances of the SL and background for these three chemicals in the surface soil.

Observations regarding other individual inorganic SRCs that exceeded their respective SLs in NPA surface soil are presented below:

- Cobalt was detected above the background concentration of 10.4 mg/kg in seven samples, with a maximum concentration of 13.9 mg/kg observed at the Phase I RI sample location LL11sd-014 that evaluated the drainage ditch north of the former Building AP-18.
- Cyanide exceeded the SL of 0.27 mg/kg only in the Phase I RI sample location LLss-030, with a concentration of 0.54 mg/kg just inside the northern perimeter fence.
- Manganese was detected above the background concentration of 1,450 mg/kg in two samples, with a maximum concentration of 1,930 mg/kg observed at the Phase I RI sample location LL11sd-014 that evaluated the drainage ditch north of the former Building AP-18.

5.3.3 Semi-volatile Organic Compounds

Former Production Area

SVOCs do not have background concentrations for comparison to chemical results; consequently, a large number of SVOCs were identified as SRCs. A total of 16 SVOC SRCs were identified as a result of the data screening. Of these 16 SVOC SRCs, 5 were PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] that exceeded the SLs and were identified as COPCs. Figure 5-6 presents PAH exceedances of the SL in the FPA surface soil samples.

Although SVOCs were widely distributed in the FPA surface soil, the majority of detections and the highest concentrations were observed in the 2010 PBA08 RI sample locations LL11sb-060 and LL11sb-061 and IRA sample location LL11cs-020. With exception of benzo(a)pyrene at the these three sample locations, all PAH concentrations in samples collected in 2000, 2001, and 2010 were less than the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1.

Benzo(a)pyrene had a maximum concentration in surface soil of 0.45 mg/kg at sample location LL11sb-060. This location evaluated the ditch line immediately east of the entry road into the main gate of Load Line 11. The source of the PAHs observed could be runoff from the adjacent Fuze and Booster Spur Road. PBA08 RI sample location LL11sb-061 is located on the east side of former Building AP-8. IRA Confirmation sample LL11cs-020 evaluated the effectiveness of the excavation efforts of the drainage ditch removal on the south end of the AOC, just northwest of the entrance road. The surface soil samples that evaluated former Building AP-17 did not exceed the SLs.

Non-Production Area

Fifteen SVOCs were identified as SRCs in NPA surface soil, all of which were PAHs (Table 4-25). Of these 15 SVOC SRCs, 4 were PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] that exceeded the SLs and were identified as COPCs. Figure 5-6 presents PAH exceedances of the SL in the NPA surface soil samples.

With exception of benzo(a)pyrene at the 2010 PBA08 RI sample location LL1sb-067, all PAH concentrations in samples collected in 2000, 2001, and 2010 were less than the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. Benzo(a)pyrene had a maximum concentration in NPA surface soil of 0.28 mg/kg at sample location LL11sb-067. This sample location is located at the east ditch line which was excavated in 2001 under the IRA. In PBA08 RI sample L11sb-068, located immediately downgradient of LL11sb-067, 10 PAHs were detected at concentrations approximately an order of magnitude less than those observed at LL11sb-067.

5.3.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

Former Production Area

VOCs and PCBs were identified as potential contaminants from previous site use. Figure 5-7 presents detected concentrations of VOCs, pesticides, and PCBs in FPA surface soil. One VOC (acetone) and one PCB (PCB-1254) were identified as SRCs in FPA surface soil. PCB-1254 was detected in 4 of 12 samples: 1 at the Phase I RI sample location LL11ss-020 (0.11 mg/kg) and 3 at the 2010 PBA08 RI sample locations. The maximum concentration of PCB-1254 detected was at 0.42 mg/kg at LL11sb-061, which exceeded the SL of 0.12 mg/kg. Sample location LL11sb-061 is located immediately adjacent to the east side of former Building AP-8. PCB-1254 also was detected at the 2010 PBA08 RI sample locations LL11sb-064 and LL11ss-074 at a concentration of 0.02J mg/kg. Acetone was detected in 1 of 10 samples (LL11cs-006 at 0.008 mg/kg) below the SL (6,100 mg/kg). No pesticides were detected in surface soil in the FPA.

Non-Production Area

One PCB (PCB-1254) was identified as an SRC in NPA surface soil. PCB-1254 was detected only in 2010 PBA08 RI sample location LL11ss-078 at a concentration of 0.035J mg/kg. LL11ss-078 is located in a ditch line alongside the access road north of former Building AP-10. No pesticides or VOCs were detected in NPA surface soil.

5.4 CONTAMINANT NATURE AND EXTENT IN SUBSURFACE SOIL

As discussed in Section 4.0, data from subsurface soil samples were screened to identify SRCs representing subsurface conditions at Load Line 11. The SRC screening data set included Phase I RI, IRA, and 2010 PBA08 RI samples. Samples excluded from the SRC screening data set are identified in Table 4-33 (e.g., samples impacted by excavations during the IRA). Additionally, Table 4-16 presents the classification of subsurface soil samples into the FPA and NPA. Subsurface soil samples collected during the PBA08 RI were analyzed for TAL metals, explosives, PAHs, and PCBs, with 10% submitted for RVAAP full-suite analysis (TAL metals, explosives, propellants, SVOCs, VOCs, PCBs, pesticides) to meet QA requirements. Table 4-26 and 4-27 present the results of the SRC screening for subsurface soil samples at the FPA and NPA, respectively.

5.4.1 Explosives and Propellants

Former Production Area

The propellant nitrocellulose was identified as an SRC in FPA subsurface soil. Nitrocellulose was detected in all eight samples analyzed, ranging in concentration from 0.87 (1-3 ft bgs at LL11ss-013) to 2 mg/kg (6-8 ft bgs at LL11sb-043). The location of the maximum detection is associated with former Building AP-11. The concentrations detected were all below the SL of 19,000,000 mg/kg.

No explosives were detected in the subsurface soil at the FPA.

Non-Production Area

Nitrocellulose was identified as an SRC in NPA subsurface soil. The propellant was detected in 15 of 17 samples analyzed, at concentrations comparable to those observed in FPA subsurface soil. A maximum nitrocellulose detection of 2 mg/kg was observed at the 2001 sample locations LL11sb-037 and LL11sb-039 within the 6-8 ft bgs interval, both of which were located within the ditch line excavated under an IRA.

No explosives were detected in the subsurface soil at the NPA.

5.4.2 Inorganic Chemicals

Former Production Area

Arsenic, chromium, lead, and mercury were identified as potential SRCs and as potentially related to the previous site use. Three of these four inorganic chemicals exceeded their respective background concentrations in the subsurface soil in the FPA, as summarized in the list below.

- Arsenic was detected above the background concentration of 19.8 mg/kg in six samples, with a maximum concentration of 25.8 mg/kg observed at the Phase I RI sample location LL11sb-022 from the 6-8 ft bgs interval that evaluated the sump near former Building AP-8.
- Chromium was not detected above its respective background concentration.
- Lead was detected above the background concentration of 19.1 mg/kg in 16 samples, with a maximum concentration of 65.1 mg/kg observed at the Phase I RI sample location LL11sb-023 from the 6-8 ft interval that evaluated the sump near former Building AP-8.
- Mercury was detected above the background concentration of 0.044 mg/kg in one sample, with a maximum concentration of 0.05 mg/kg observed at 2000 Phase I RI sample location LL11ss-010 from the 1-3 ft bgs interval that evaluated former Building AP-17.

Figure 5-4 presents the locations with concentrations that exceeded SLs and background for these three chemicals. Of the three chemicals where concentrations were detected above background, only arsenic was detected at a concentration above the SL; therefore, arsenic is considered to be a COPC.

Although not identified as previously used during historical operations, five other inorganic chemicals and three anions were identified as SRCs from the RVAAP screening process, as presented in Table 4-26. Of these constituents, one (cobalt) exceeded its respective SL and background concentration. Cobalt was detected above the background concentration of 23.2 mg/kg in one sample, with a maximum concentration of 27.1J mg/kg observed at the 2010 PBA08 RI sample location LL11sb-060 from the 1-4 ft bgs interval.

5.4.3 Non-Production Area

Three of the four inorganic chemicals potentially related to previous site use exceeded their respective background concentrations in the subsurface soil in the NPA, as summarized in the list below.

- Arsenic was detected above the background concentration of 19.8 mg/kg in seven samples, with a maximum concentration of 44.1 mg/kg observed at sample LL11cs-045 from the 7-8 ft bgs interval that evaluated the effectiveness of the hotspot excavation efforts during the IRA.
- Chromium was not detected above its respective background concentration.
- Lead was detected above the background concentration of 19.1 mg/kg in three samples, with a maximum concentration of 160 mg/kg observed at sample LL11cs-050 from the 3-4 ft bgs interval that evaluated the effectiveness of the hotspot excavation efforts during the IRA.
- Mercury was detected above the background concentration of 0.044 mg/kg in four samples, with a maximum concentration of 0.068 mg/kg observed at 2010 PBA08 RI sample location LL11sb-069.

Figure 5-5 presents the locations with concentrations that exceeded SLs and background for these four chemicals. Of the three chemicals where concentrations were detected above background, only arsenic was detected at a concentration above the SL and was considered a COPC.

Ten other inorganic chemicals and three anions were identified as SRCs from the RVAAP screening process, as presented in Table 4-27. Of these constituents, five (aluminum, barium, cobalt, cyanide, and thallium) exceeded their respective SLs and background concentrations. Figure 5-5 also presents exceedances of the SL and background for these five chemicals in subsurface soil. Observations regarding other individual inorganic SRCs that exceeded their respective SLs in NPA subsurface soil are presented below:

- Aluminum was detected above the background concentration of 19,500 mg/kg in one sample, with a concentration of 24,500 mg/kg observed at sample LL11cs-013 from the 1-2 ft bgs interval that evaluated the effectiveness of the excavation efforts in the drainage ditch east of former Building AP-4 during the IRA.
- Barium was detected above the background concentration of 124 mg/kg in two samples, with a maximum concentration of 4,190 mg/kg observed at sample LL11cs-050 from the 3-4 ft bgs interval that evaluated the effectiveness of the hotspot excavation efforts during the IRA.
- Cobalt was detected above the background concentration of 23.2 mg/kg in one sample, with a concentration of 24.7 mg/kg observed at sample LL11cs-036 that evaluated the effectiveness

of the excavation efforts in the drainage ditch north of former Buildings AP-19 and AP-17 during the IRA.

- Cyanide exceeded the SL of 0.27 mg/kg, with a maximum concentration of 1 mg/kg at the Phase I RI sample location LL11ss-030 from the 1-3 ft bgs interval. This is the same location as the MDC in NPA surface soil.
- Thallium was detected above the background concentration of 0.91 mg/kg in one sample, with a maximum concentration of 2.5 mg/kg observed at sample LL11cs-050 from the 3-4 ft bgs interval that evaluated the effectiveness of the hotspot excavation efforts during the IRA.

5.4.4 Semi-volatile Organic Compounds

Former Production Area

No SVOCs were identified as SRCs in FPA subsurface soil. As shown in Table 4-26, SVOCs were detected in 1 of the 22 samples in the SRC screening data set. The seven PAHs shown in Table 4-26 were only identified at the IRA sample location LL11cs-019, from the 1-2 ft bgs interval; the concentrations of these PAHs were below laboratory detection limits. LL11cs-019 is located in a drainage ditch downstream of the former Building AP-8.

Non-Production Area

Six SVOCs, all of which were PAHs, were identified as SRCs in NPA subsurface soil. Of these six SVOC SRCs, one PAH [benzo(a)pyrene] exceeded the SL and was identified as a COPC. Benzo(a)pyrene was detected at a concentration of 0.12J mg/kg at the IRA sample location LL11cs-043 from the 3-7 ft bgs interval. The concentration detected was below the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1.

5.4.5 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

Former Production Area

One PCB (PCB-1254) was identified as an SRC in the FPA subsurface soil and was detected in 4 of 19 samples in the SRC screening data set. The maximum concentration of PCB-1254 (0.79 mg/kg) was detected at the Phase I RI sample location LL11ss-016 from the 1-3 ft bgs interval, which exceeded the SL (0.12 mg/kg). LL11ss-016 is located in the interior portion of the FPA and immediately adjacent to the former Building AP-11.

No pesticides or VOCs were detected in the subsurface soil at the FPA.

Non-Production Area

No PCBs or pesticides were detected in the subsurface soil at the NPA. One VOC (carbon tetrachloride) was detected in 1 out of 26 samples. Based on its low frequency of detection and low concentration (0.001J mg/kg), carbon tetrachloride was not considered an SRC.

5.5 GEOTECHNICAL SUBSURFACE SOIL SAMPLES

Two samples were collected from one soil boring completed at Load Line 11 for the purposes of obtaining geotechnical parameters to support vadose zone soil leaching and groundwater transport modeling. Samples were collected from the 2-3.9 and 4-5.5 ft bgs intervals at LL1sb-085. Groundwater was encountered at 6.5 ft bgs. Table 5-2 summarizes the results of the geotechnical characteristics of Load Line 11 soil. Laboratory analytical data package results are presented in Appendix D.

5.6 CONTAMINANT NATURE AND EXTENT IN SEDIMENT

Two Load Line 11 sediment samples were collected under the 2010 PBA08 RI, one representative sample each for the East Ditch and West Ditch aggregates. The West Ditch PBA08 RI sediment sample (LL11sd-084) was analyzed for TAL metals, explosives, SVOCs, and VOCs, and the East Ditch sample (LL11sd-083) was analyzed for RVAAP full-suite analytes (i.e., TAL metals, explosives, propellants, SVOCs, VOCs, PCBs, and pesticides). An additional sample (LL11sd-096) was taken under the 2012 PBA08 RI to provide full-suite analytical results in the West Ditch. Two additional samples were used to characterize the West Ditch: LL11sd-024 from the Phase I RI and LL11cs-015 from the IRA. One additional sample was used to characterize the East Ditch: LL11cs-031 from the IRA. Sediment sample LL11sd-017 from the East Ditch and LL11sd-030 from the West Ditch collected during the Phase I RI were not used for determining SRCs because samples from the more recent 2010 PBA08 RI were taken from the same locations.

The sample representative of the Sewer Outfall aggregate (LL11sd-021) was collected under the Phase I RI activities and was not resampled during the 2010 PBA08 RI. Conditions at this location were not considered to have changed, as the former sanitary sewer outfall is outside of Load Line 11 areas that would have been disturbed under IRA activities. Portions of the sanitary sewer system were plugged under the IRA activities, which would have prevented release of sediment to the overflow outfall.

Tables 4-28 through 4-30 present the results of the SRC screening for sediment for the East Ditch, West Ditch, and Sewer Outfall sediment, respectively. Complete copies of the laboratory analytical packages are presented in Appendix D. Figures 5-8 through 5-11 present the location and concentrations of selected SRCs identified in sediment at Load Line 11.

Additionally, under the 2010 PBA08 RI, one sediment sample was collected off-AOC at Sand Creek to assess conditions at the receiving water body north of Load Line 11. The data from this sample (LL11sd-082) were reviewed to assess off-AOC impacts from Load Line 11.

5.6.1 Explosives and Propellants

East Ditch

No explosives or propellants were identified as SRCs in sediment at the East Ditch. The propellant nitrocellulose was detected in the Phase I RI sample LL11sd-017 at a concentration of 1.8 mg/kg; however, nitrocellulose was not detected in the East Ditch 2010 PBA08 RI sample LL11sd-083. Sample LL11sd-017 was not utilized in the SRC screening as it was co-located with and superseded by 2010 PBA08 RI sample LL11sd-083.

West Ditch

The propellant nitrocellulose was detected at the 2012 PBA08 RI sample LL11sd-096 at a concentration of 1.4J mg/kg, which is below the SL of 19,000,000 mg/kg. No explosives were detected in the sediment at the West Ditch.

Sewer Outfall

No explosives or propellants were detected in the sediment at the Sewer Outfall.

Off-AOC

No explosives or propellants were detected in sediment at the off-AOC sample location LL11sd-082.

5.6.2 Inorganic Chemicals

East Ditch

Arsenic, chromium, lead, and mercury were identified as potential inorganic contaminants from previous site use. Mercury was not detected in the sediment sample collected at the East Ditch; lead was detected at a concentration below its respective background concentration. Arsenic and chromium were detected at concentrations (19.7 and 18.6 mg/kg) that were slightly above their respective background concentrations (19.5 and 18.1 mg/kg). Arsenic exceeded the SL of 0.425 mg/kg. Chromium exceeded the SL for hexavalent chromium (1.64 mg/kg), but was detected at a concentration below the SL for trivalent chromium (8,147 mg/kg).

Eight other inorganic chemicals were identified as SRCs from the RVAAP screening process, as presented in Table 4-28. Of these constituents, aluminum and cobalt were detected at concentrations of 15,100 and 17.4 mg/kg, which were above their respective background concentrations (13,900 and 9.1 mg/kg) and exceeded their respective SLs (3,496 and 2.3 mg/kg).

West Ditch

Of the four inorganic contaminants (arsenic, chromium, lead, and mercury) potentially related to previous site use, arsenic and lead were not detected above their respective background concentrations. Mercury was detected above the background concentration (0.059 mg/kg) and below the SL (2.27 mg/kg), with a maximum concentration of 0.1 mg/kg observed at 2012 PBA08 sample location LL11sd-096. Chromium was detected above the background concentration (18.1 mg/kg) and exceeded the SL for hexavalent chromium (1.64 mg/kg) but not the SL for trivalent chromium (8,147 mg/kg), with a maximum concentration of 21 mg/kg observed at the Phase I RI sample location LL11sd-024.

Eight other inorganic chemicals were identified as SRCs from the RVAAP screening process, as presented in Table 4-29. Of these constituents, aluminum and cobalt were detected at concentrations that exceeded their respective SLs (3,496 and 2.3 mg/kg) and were above their background concentrations (13,900 and 9.1 mg/kg), with maximum concentrations of 17,700 mg/kg for aluminum at sample LL11cs-015 and 14.1 mg/kg for cobalt at sample LL11sd-024.

Sewer Outfall

No inorganic chemicals were identified as SRCs in Sewer Outfall sediment, as none were detected above their respective background concentrations.

Off-AOC

No inorganic chemicals were detected above background concentrations; therefore, no inorganic chemicals were identified as SRCs in off-AOC sample location LL11sd-082.

5.6.3 Semi-volatile Organic Compounds

East Ditch

Fifteen SVOCs were identified as SRCs in the East Ditch sediment. All of the SRCs in sediment were detected at the 2010 PBA08 RI sample location LL11sd-083 and had not previously been detected at this location in the Phase I RI sample LL11sd-017. One PAH [benzo(a)pyrene] exceeded the SL and was identified as a COPC. Benzo(a)pyrene was detected at a concentration of 0.098 mg/kg, which is below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1.

West Ditch

Fourteen SVOCs were identified as SRCs in the West Ditch sediment. One PAH [benzo(a)pyrene] exceeded the SL and was identified as a COPC. Benzo(a)pyrene was detected at a maximum concentration of 0.09 mg/kg at the 2012 PBA08 RI sample location LL11sd-096, which exceeded the SL of 0.022 mg/kg. The detected concentration was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1.

Sewer Outfall

SVOC analysis was not performed on the former sanitary system overflow outfall sediment sample.

Off-AOC

Ten SVOCs were detected in sediment at the off-AOC sample location LL11sd-082. None of them exceeded their SLs.

5.6.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

East Ditch

No VOCs, pesticides, or PCBs were detected in the sediment at the East Ditch.

West Ditch

No VOCs, pesticides, or PCBs were detected in the sediment at the West Ditch.

Sewer Outfall

Analysis for VOCs, pesticides, or PCBs was not performed on the former sanitary system overflow outfall sediment sample.

Off-AOC

Two VOCs (carbon disulfide and toluene) were identified at concentrations below laboratory reporting limits and below SLs at the off-AOC sediment sample location LL11sd-082. Pesticide and PCB analysis was not performed on this sample.

5.7 CONTAMINANT NATURE AND EXTENT IN SURFACE WATER

Two Load Line 11 surface water samples were collected under the 2010 PBA08 RI, one representative sample each for the East Ditch and West Ditch aggregates. Both PBA08 RI surface water samples were analyzed for RVAAP full-suite analytes. No surface water was collected at the Sewer Outfall under the Phase I RI, as this location is predominantly dry. Tables 4-31 and 4-33 present the results of the SRC screening for surface water at the East Ditch and West Ditch, respectively. Only the PBA08 RI samples were utilized in the SRC screening, as the Phase I RI surface water samples were not considered to represent current conditions. Complete copies of the laboratory analytical packages are presented in Appendix D. Figures 5-8 through 5-11 present the location and concentrations of selected SRCs identified surface water at Load Line 11.

Additionally, under the 2010 PBA08 RI one surface water sample was collected off-AOC at Sand Creek to assess conditions downstream of Load Line 11. The data from this sample (LL11sw-082) were reviewed to assess off-AOC and downstream impacts from Load Line 11. The data tables for this sample are included in Appendix D.

5.7.1 Explosives and Propellants

No propellants or explosives were detected in the surface water at the East Ditch and West Ditch. In addition, no explosives or propellants were detected in the off-AOC surface water sample location LL11sd-082.

5.7.2 Inorganic Chemicals

East Ditch

Arsenic, chromium, lead, and mercury were identified as potential inorganic contaminants from previous site use. Mercury was not detected in the surface water sample collected at the East Ditch; arsenic, chromium, and lead were detected at concentrations below their respective SLs.

The four other inorganic chemicals detected above background concentrations were not observed at concentrations that exceeded their respective SLs.

West Ditch

Of the four inorganic contaminants (arsenic, chromium, lead, and mercury) potentially related to previous site use, mercury was not detected in the surface water sample collected at the West Ditch and arsenic was detected at a concentration (0.0043J mg/L) above the background concentration (0.0032 mg/L) and exceeded the SL (0.0011 mg/L). In addition, chromium and lead were detected at concentrations of 0.0033 and 0.0062 mg/L, which are above their respective background concentrations and below their SLs (0.0245 and 0.015 mg/L, respectively).

Nine other inorganic chemicals were identified as SRCs from the RVAAP screening process, as presented in Table 4-30. Of these constituents, cobalt was detected at a concentration of 0.0019J mg/L, which exceeded its respective SL (0.0006 mg/L) and background concentration (0 mg/L).

Off-AOC

Six inorganic chemicals were detected above their respective background concentrations. All the detections were at concentrations below their respective SLs.

5.7.3 Semi-volatile Organic Compounds

East Ditch

No SVOCs were detected in the East Ditch surface water sample.

West Ditch

Ten SVOCs were identified as SRCs in West Ditch surface water, all of which were PAHs. Of these 10 SVOCs, 4 [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene] exceeded the SLs and were identified as COPCs. The four PAH concentrations detected were all above the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1.

Off-AOC

No SVOCs were detected in surface water at the off-AOC sample location LL11sw-082.

5.7.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

East Ditch

Two pesticides were identified as SRCs in East Ditch surface water. The pesticides beta-BHC and gamma-chlordane were detected at PBA08 RI sample LL11sw-083 at low estimated concentrations of 0.000013J and 0.000015J mg/L, respectively. No pesticides were detected in the Phase I RI sample LL11sw-012 collected at this location in 2000.

No VOCs or PCBs were detected in the East Ditch surface water sample.

West Ditch

One pesticide (beta-BHC) was identified as an SRC in West Ditch surface water. Beta-BHC was detected at LL11sw-084 at a low estimated concentration below laboratory detection limits (0.0000096J mg/L), but was not detected at the downstream, off-AOC location LL11sw-082.

No VOCs or PCBs were detected in the West Ditch surface water sample.

Off-AOC

No VOCs, pesticides, or PCBs were detected in surface water at the off-AOC sample location LL11sw-082.

5.8 SUMMARY OF CONTAMINANT NATURE AND EXTENT

In 2001, a contaminant source removal was conducted under an IRA (MKM 2004a) as an early response action to mitigate migration of contaminants identified during the Phase I RI. The contaminant source removal consisted of removing sumps, contaminated media in drainage ditches, petroleum contamination in a hot spot area, and evaluated the potential for UXO in an area to the north of the hot spot area. Data from the Phase I RI, IRA, and 2010 and 2012 PBA08 RIs that represent the current status of Load Line 11 effectively characterized the nature and extent of the contamination.

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, TR of 1E-06, as presented in the FWCUG Report. Based on the information provided earlier in this section and the summary below, it can be concluded that:

- The previous IRA removed contamination associated with Load Line 11,
- The vertical and horizontal extent of existing contamination is defined, and
- No further sampling is needed to evaluate Load Line 11.

5.8.1 Surface Soil

5.8.1.1 <u>Former Production Area</u>

Sites where explosives were identified as potential contaminants from previous use were thoroughly evaluated, including around former process buildings and across the AOC as a whole. Two propellants (nitrocellulose and nitroguanidine) were identified as SRCs and as potentially related to previous AOC operations. The maximum concentrations of the propellants were below their respective SLs and were not considered COPCs in the FPA surface soil. Arsenic, chromium, lead, and mercury were identified as potential SRCs and as potentially related to the previous site use. All four of these inorganic chemicals exceeded their respective background concentrations in FPA surface soil; however, only arsenic was detected at a concentration above the SL and was considered to COPC. The maximum concentration of arsenic was observed at the Phase I RI sample location LL11ss-022 that evaluated former Building AP-3. PAH SRC detections were widespread and observed in 11 of 14 surface soil locations in the SRC screening data set. With the exception of benzo(a)pyrene at three sample locations, all PAH concentrations in samples collected in 2000, 2001, and 2010 were less than the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. One VOC (acetone) and PCB-1254 were identified as SRCs in FPA surface soil. PCB-1254 was detected in 4 of 12 SRC screening samples in Phase I RI sample LL11ss-020 (0.11 mg/kg) and in three of the PBA08 RI samples, with the maximum detection (0.42 mg/kg) observed at LL11sb-061 located immediately adjacent to the east side of former Building AP-8. The VOC acetone was detected in only one Phase I RI sample. No pesticides were detected in FPA surface soil.

5.8.1.2 <u>Non-Production Area</u>

One explosive (HMX) and one propellant (nitrocellulose) were identified as SRCs and as potentially related to previous AOC operations. HMX was detected only in 2010 PBA08 RI sample LL11ss-081, which is within a ditch line adjacent to the northeast fence line of Load Line 11. Nitrocellulose was detected in three of five samples analyzed with the maximum detection observed in Phase I RI sample location LL11ss-029. The maximum concentrations of HMX and nitrocellulose were below their respective SLs and were not considered COPCs. All four inorganic chemicals (arsenic, chromium, lead, and mercury) potentially related to previous site use exceeded their respective background concentrations in the surface soil in the NPA. Of the four chemicals, only arsenic was detected at a concentration above the SL and was considered a COPC. The maximum concentration of arsenic was observed at the 2010 PBA08 RI sample location LL11ss-070 that evaluated the earthen barricade associated with former Building AP-18. PAH SRC detections were widespread throughout the AOC and were observed in 11 of 14 surface soil locations in the screening data set. Of the 15 SVOC SRCs, 4 were PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] that exceeded the SLs and were identified as COPCs. With the exception of benzo(a)pyrene at the 2010 PBA08 RI sample location LL1sb-067, all PAH concentrations in samples collected in 2000, 2001, and 2010 were less than the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. PBA08 RI sample location LL11sb-067 had the highest frequency and magnitude of PAH detections and is located at the east ditch line which was excavated in 2001 under the IRA. PCB-1254 was identified as an SRC in NPA surface soil and was detected only in PBA08 RI sample LL11ss-078, located in a ditch line alongside the access road north of former Building AP-10. No pesticides or VOCs were detected in NPA surface soil.

5.8.2 Subsurface Soil

5.8.2.1 <u>Former Production Area</u>

The propellant nitrocellulose was identified as an SRC and was detected in all eight samples analyzed, with the maximum detection associated with former Building AP-11. The highest nitrocellulose detections occurred from the 5-6 and 6-8 ft bgs intervals. The concentrations detected were all below the SL. No explosives were detected in the FPA subsurface soil. Arsenic was the only inorganic chemical of the four potentially related to previous site use that exceeded the SLs and the FWCUG at a TR of 1E-05, HQ of 1. PAHs were detected in 1 out of the 22 samples collected. Based on the low frequency of detection, PAHs were not considered SRCs for the FPA subsurface soil. PCB-1254 was identified as an SRC for the FPA and was detected in 4 of 19 samples in the SRC screening data set. The maximum PCB-1254 detection occurred in the 1-3 ft bgs interval in the Phase I RI sample LL11ss-016, located in the interior portion of the FPA and immediately adjacent to the former Building AP-11. No explosives, pesticides, or VOCs were detected in the FPA subsurface soil.

5.8.2.2 <u>Non-Production Area</u>

The propellant nitrocellulose was identified as an SRC in NPA subsurface soil, with the highest detections noted at the downstream portion of the northeast ditch line excavated under the IRA. Three of the four inorganic chemicals potentially related to previous site use exceeded their respective background concentrations in the NPA subsurface soil; however, only arsenic was detected at a concentration above the SL and was considered a COPC. Six SVOCs, all PAHs, were identified as SRCs in subsurface soil at the NPA. Of these six SVOC SRCs, one PAH [benzo(a)pyrene] exceeded the SL and was identified as a COPC. The concentration detected was below the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. A single VOC was detected in the 26 samples collected. Based on the low frequency of detection, PAHs were not considered SRCs for the NPA subsurface soil. TPH-DRO and TPH-GRO were identified as SRCs in subsurface soil at the NPA and were detected in confirmatory samples collected following the excavations at the northeast ditch line. No explosives, PCBs, or pesticides were detected in the NPA subsurface soil.

5.8.3 Sediment

Arsenic was the only inorganic chemical from previous site use that exceeded the SL and is considered a COPC. Chromium exceeded the SL for hexavalent chromium, but was detected at a concentration below the SL for trivalent chromium. Fifteen SVOCs were identified as SRCs in sediment at the East Ditch; all were PAHs. All of the SRCs in sediment were detected in the 2010 PBA08 RI sample LL11sd-083, but had not been previously detected at this location in Phase I RI sample LL11sd-017. One PAH [benzo(a)pyrene] exceeded the SL and was identified as a COPC. The benzo(a)pyrene concentration was detected at a concentration below the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. No explosives, propellants, VOCs, pesticides, or PCBs were detected in sediment at the East Ditch.

The propellant nitrocellulose was detected at the West Ditch in the 2012 PBA08 RI sample LL11sd-096 at a concentration below the SL. Of the four inorganic contaminants potentially related to previous site use, arsenic and lead were not detected above their respective background concentrations. Mercury was detected above the background concentration and below the SL. Chromium was detected above the background concentration and exceeded the SL for hexavalent chromium but not the SL for trivalent chromium. Fourteen SVOCs were identified as SRCs in sediment at the West Ditch, all of which were PAHs. All maximum PAH SRC detections occurred at 2012 PBA08 RI sample LL11sd-096. One PAH [benzo(a)pyrene] exceeded the SL and was identified as a COPC. The detected concentration was below the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. No explosives, PCBs, pesticides, or VOCs were detected in sediment at the West Ditch.

The only SRCs identified at the Sewer Outfall aggregate at Load Line 11 were the inorganic chemicals sulfate and sulfide, neither of which has an established background concentration for comparison. No explosives were detected at this overflow outfall from the former sanitary sewer system. Inorganic chemicals were not detected above background concentrations at the off-AOC location LL11sd-082 located on Sand Creek. No explosives, propellants, or SVOCs were detected. Two VOCs (carbon disulfide and toluene) were present at low, estimated concentrations below laboratory detection limits.

5.8.4 Surface Water

Of the four inorganic chemicals identified as potential inorganic contaminants from previous site use, arsenic, chromium, and lead were detected at concentrations below their respective SLs. Two pesticides (beta-BHC and gamma-chlordane) were identified as SRCs at low, estimated concentrations. No explosives, propellants, SVOCs, VOCs, or PCBs were detected in the East Ditch surface water.

Three of the four inorganic chemicals potentially related to previous site use were detected in the West Ditch surface water. Arsenic was detected at a concentration above the background concentration and exceeded the SL. Chromium and lead were detected at concentrations above their respective background concentrations and below the SLs. Ten SVOCs (all PAHs) were identified as

SRCs for the West Ditch aggregate. Four PAHs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene] exceeded the SLs and were identified as COPCs. The concentrations of the four PAHs detected were all above the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. One pesticide (beta-BHC) was identified as an SRC and was detected at a low, estimated concentration below laboratory detection limits. No explosives, propellants, VOCs, or PCBs were detected in the West Ditch surface water.

Six inorganic chemicals were the only analytes detected above their background screening criteria at the off-AOC sample location LL11sw-082. All the detections were at concentrations below their respective SLs. No explosives, propellants, SVOCs, VOCS, pesticides, or PCBs were observed at this Sand Creek location.

Table 5–1. Chromium Speciation Results

Sample Location	Hexavalent Chromium Concentration (mg/kg)	Total Chromium Concentration[a] (mg/kg)	Percent Hexavalent Chromium (%)
LL11ss-072	0.44J	10.1	4.4
LL11ss-073	<1U	17.1	NA
LL11ss-075	0.71J	15.4	4.6

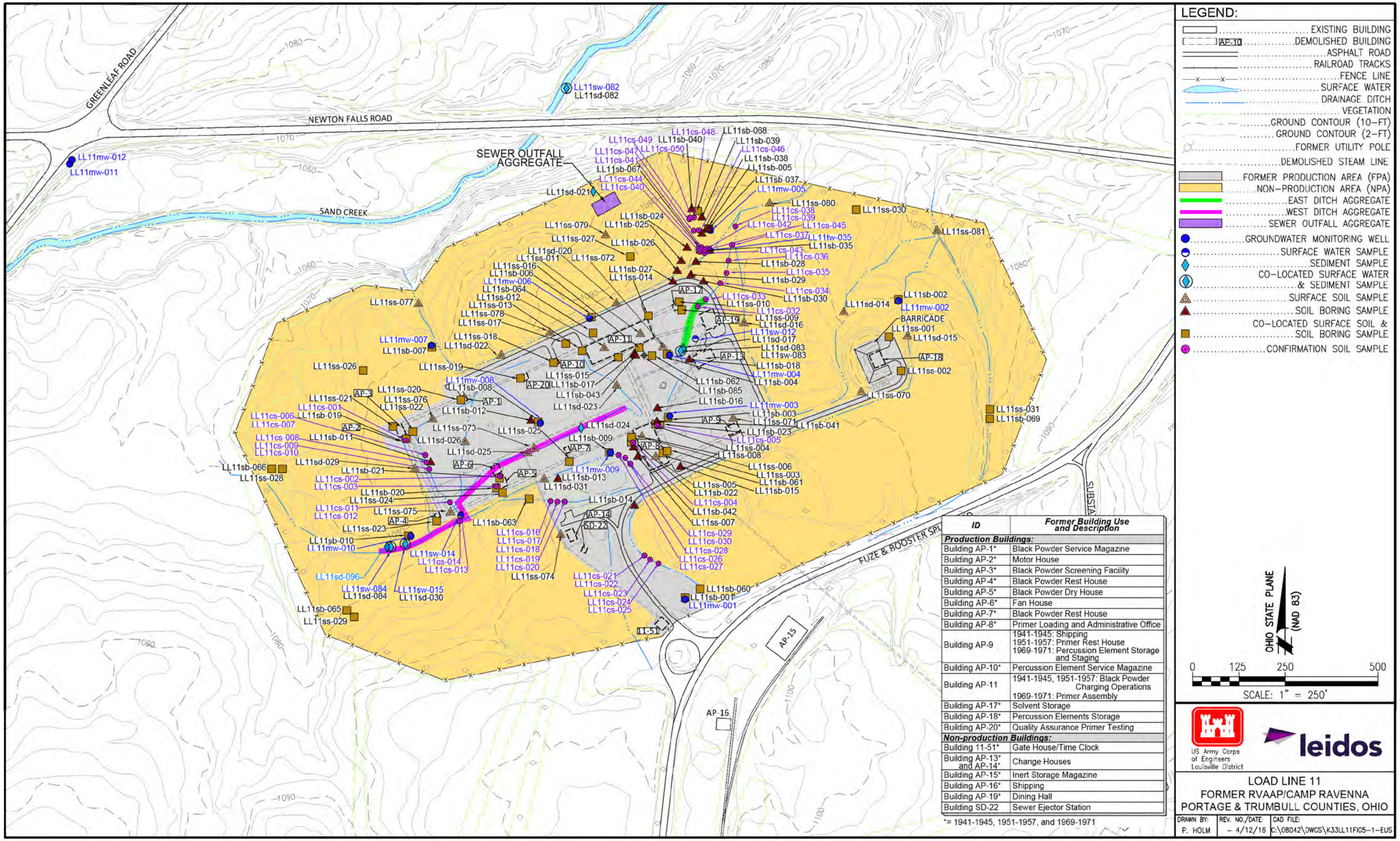
[a] Background screening value for total chromium = 17.4 mg/kg. No background concentration is available for hexavalent chromium.

mg/kg = milligrams per kilogram.
J = Estimated value is less than reporting limits.
NA = Not applicable; hexavalent chromium not detected in sample
U= Non-detectable concentration.

Table 5–2. Summary of Geotechnical Parameters

Sample ID: Parameters	L11sb-085-5567	L11sb-085-5568
Depth	2-3.9 ft bgs	4-5.5 ft bgs
Porosity	33.4 %	38.2 %
Density	1.83 g/cm^3	1.67 g/cm^3
Moisture content	15.4 %	23.9 %
Total organic carbon	720J mg/kg	1,500 mg/kg
Size fraction analysis	6.1% gravel, 27.9% sand, 49.0% silt, 16.9% clay	0.0% gravel, 2.4% sand, 85.4% silt, 12.2 % clay
Permeability (K)	1.7E-07 cm/sec	1.7E-06 cm/sec

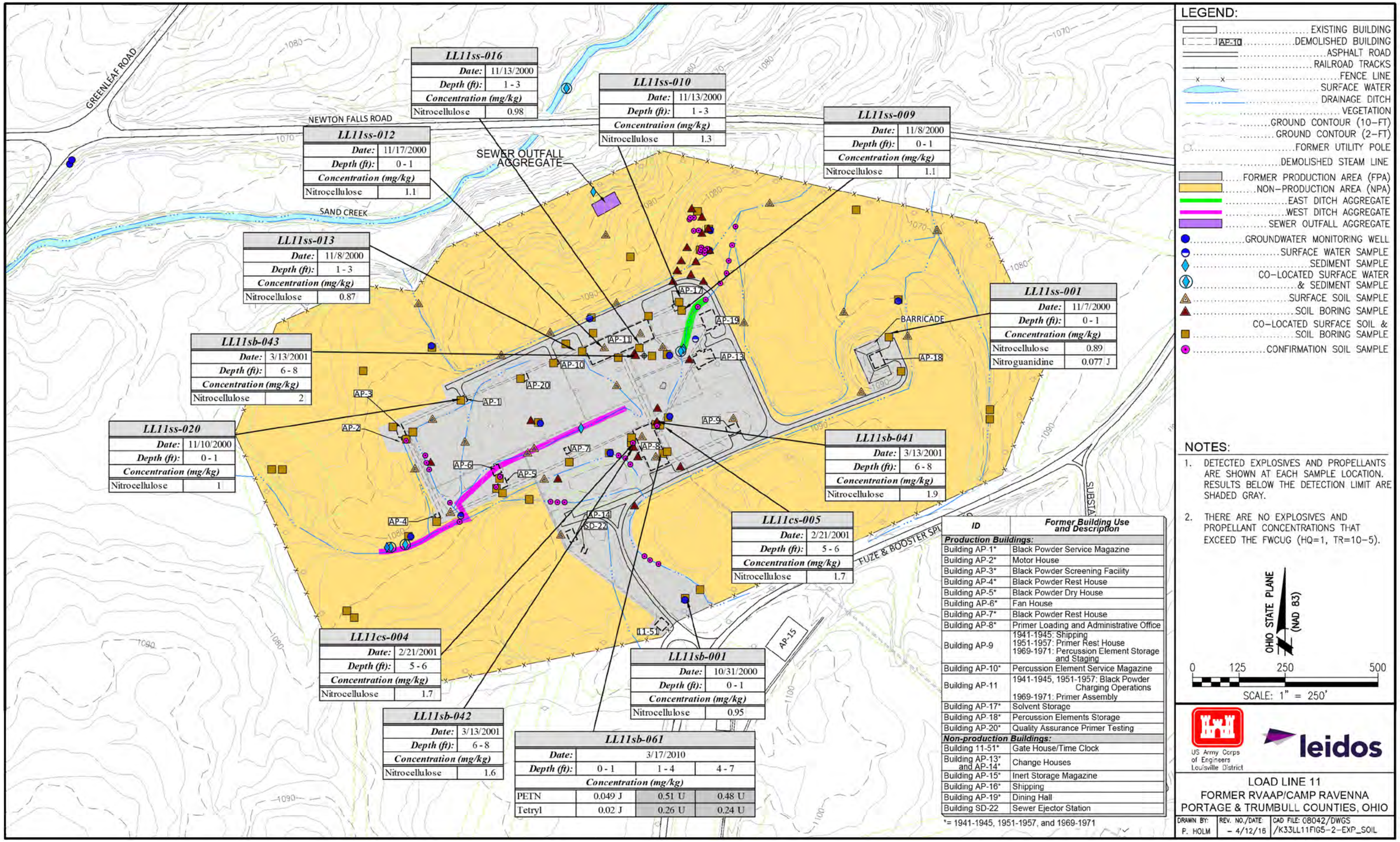
bgs = Below ground surface.
cm/sec = Centimeters per second.
ft = Feet.
g/cm^3 = Grams per cubic centimeter.
ID = Identification.



ID	Former Building Use and Description
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
Building AP-9	1941-1945: Shipping 1951-1957: Primer Rest House 1969-1971: Percussion Element Storage and Staging
Building AP-10*	Percussion Element Service Magazine
Building AP-11	1941-1945, 1951-1957: Black Powder Charging Operations 1969-1971: Primer Assembly
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

Figure 5–1. EUs and Sample Locations



LL11ss-016	
Date:	11/13/2000
Depth (ft):	1 - 3
Concentration (mg/kg)	
Nitrocellulose	0.98

LL11ss-010	
Date:	11/13/2000
Depth (ft):	1 - 3
Concentration (mg/kg)	
Nitrocellulose	1.3

LL11ss-009	
Date:	11/8/2000
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	1.1

LL11ss-012	
Date:	11/17/2000
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	1.1

LL11ss-013	
Date:	11/8/2000
Depth (ft):	1 - 3
Concentration (mg/kg)	
Nitrocellulose	0.87

LL11ss-001	
Date:	11/7/2000
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	0.89
Nitroguanidine	0.077 J

LL11sb-043	
Date:	3/13/2001
Depth (ft):	6 - 8
Concentration (mg/kg)	
Nitrocellulose	2

LL11ss-020	
Date:	11/10/2000
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	1

LL11sb-041	
Date:	3/13/2001
Depth (ft):	6 - 8
Concentration (mg/kg)	
Nitrocellulose	1.9

LL11cs-005	
Date:	2/21/2001
Depth (ft):	5 - 6
Concentration (mg/kg)	
Nitrocellulose	1.7

LL11cs-004	
Date:	2/21/2001
Depth (ft):	5 - 6
Concentration (mg/kg)	
Nitrocellulose	1.7

LL11sb-001	
Date:	10/31/2000
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	0.95

LL11sb-042	
Date:	3/13/2001
Depth (ft):	6 - 8
Concentration (mg/kg)	
Nitrocellulose	1.6

LL11sb-061			
Date:	3/17/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
PETN	0.049 J	0.51 U	0.48 U
Tetryl	0.02 J	0.26 U	0.24 U

ID	***Former Building Use and Description***
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
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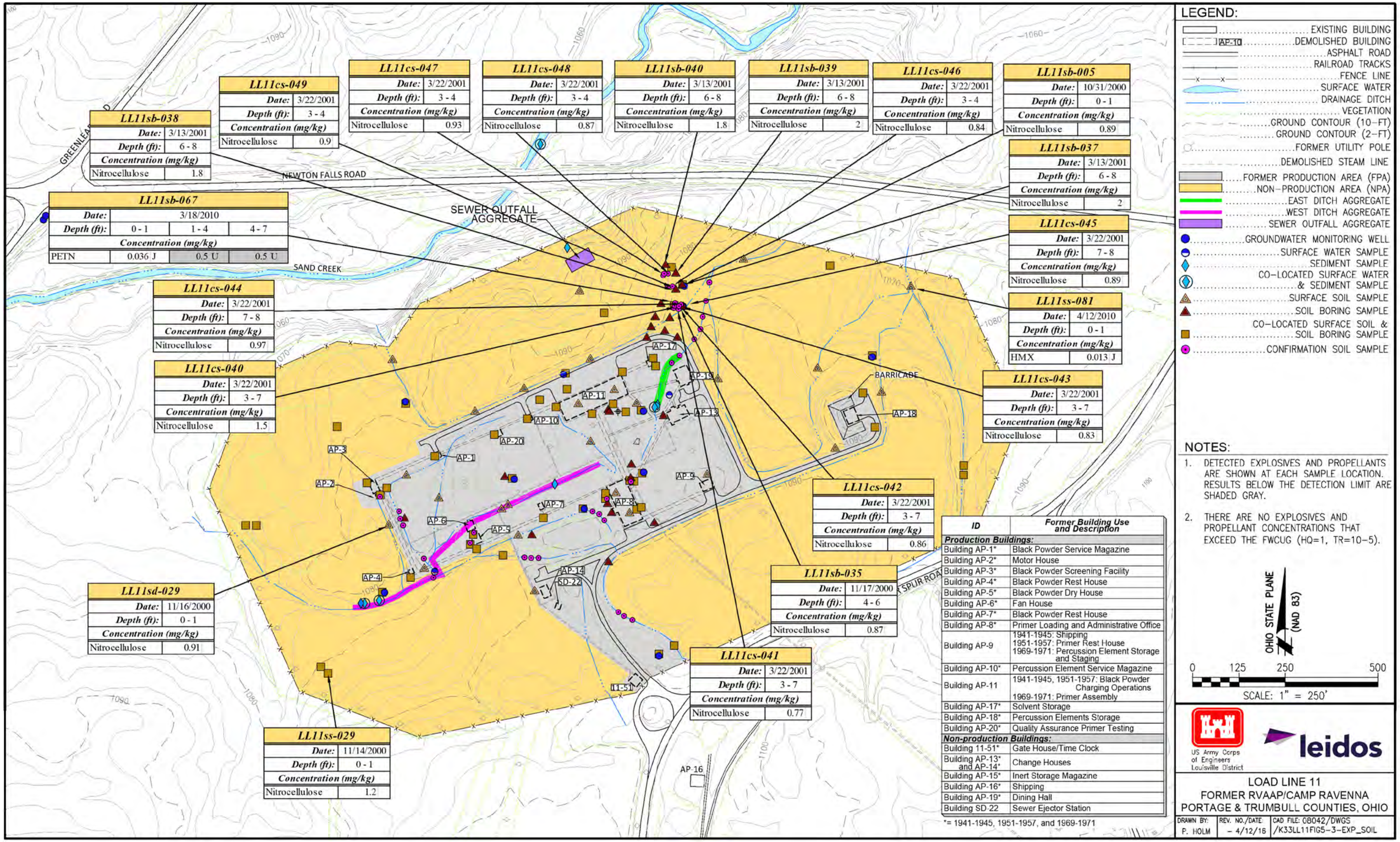
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

NOTES:

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

Figure 5–2. Detected Concentrations of Explosives and Propellants in Soil at the FPA



NOTES:

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

ID	Former Building Use and Description
Production Buildings:	
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Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
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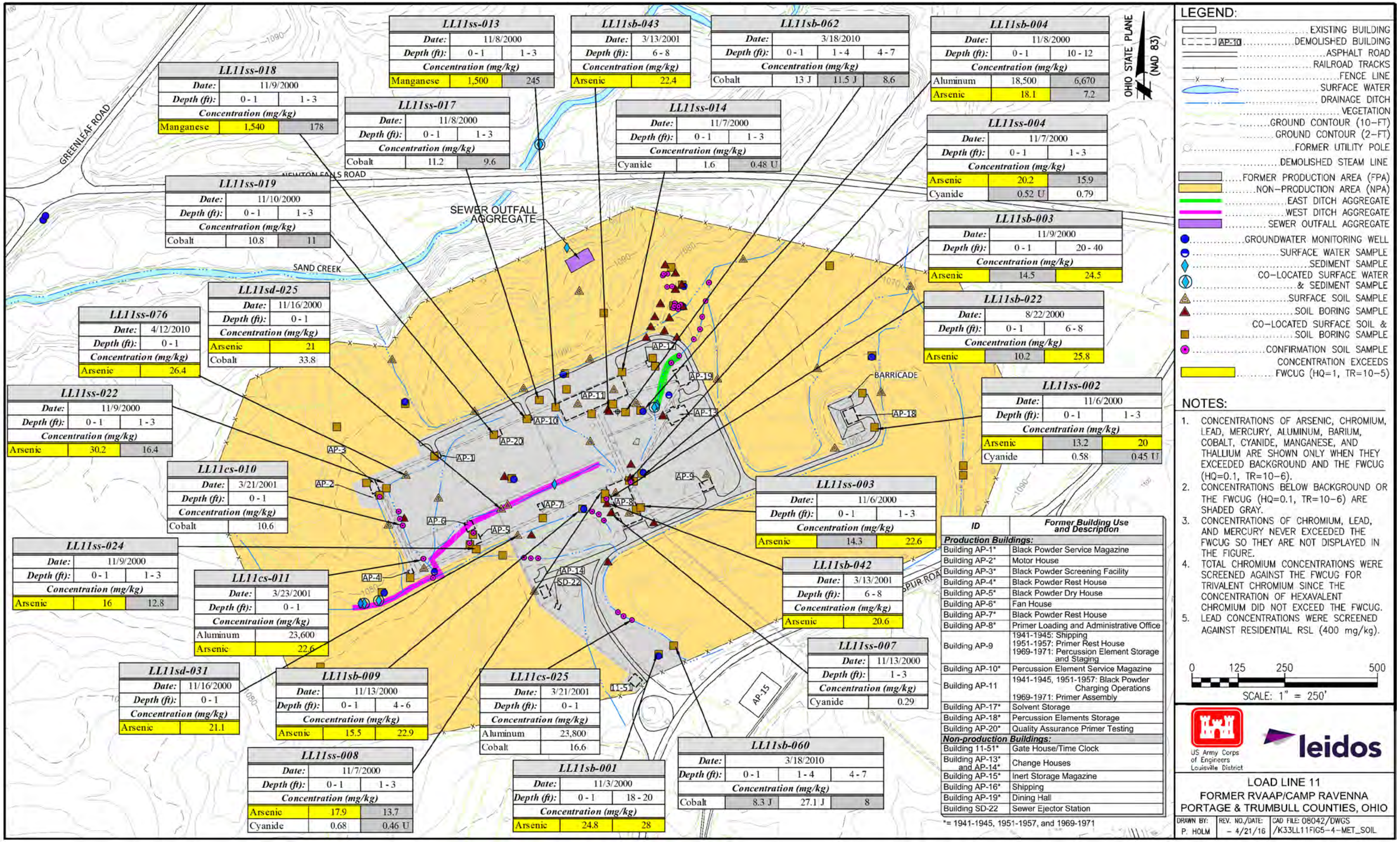
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

LOAD LINE 11
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

Figure 5–3. Detected Concentrations of Explosives and Propellants in Soil at the NPA



LL11ss-018

Date:	11/9/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Manganese	1,540	178

LL11ss-013

Date:	11/8/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Manganese	1,500	245

LL11sb-043

Date:	3/13/2001
Depth (ft):	6 - 8
Concentration (mg/kg)	
Arsenic	22.4

LL11sb-062

Date:	3/18/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Cobalt	13 J	11.5 J	8.6

LL11sb-004

Date:	11/8/2000	
Depth (ft):	0 - 1	10 - 12
Concentration (mg/kg)		
Aluminum	18,500	6,670
Arsenic	18.1	7.2

LL11ss-017

Date:	11/8/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Cobalt	11.2	9.6

LL11ss-014

Date:	11/7/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Cyanide	1.6	0.48 U

LL11ss-004

Date:	11/7/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Arsenic	20.2	15.9
Cyanide	0.52 U	0.79

LL11ss-019

Date:	11/10/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Cobalt	10.8	11

LL11sb-003

Date:	11/9/2000	
Depth (ft):	0 - 1	20 - 40
Concentration (mg/kg)		
Arsenic	14.5	24.5

LL11sd-025

Date:	11/16/2000
Depth (ft):	0 - 1
Concentration (mg/kg)	
Arsenic	21
Cobalt	33.8

LL11ss-076

Date:	4/12/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Arsenic	26.4

LL11sb-022

Date:	8/22/2000	
Depth (ft):	0 - 1	6 - 8
Concentration (mg/kg)		
Arsenic	10.2	25.8

LL11ss-022

Date:	11/9/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Arsenic	30.2	16.4

LL11ss-002

Date:	11/6/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Arsenic	13.2	20
Cyanide	0.58	0.45 U

LL11cs-010

Date:	3/21/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	10.6

LL11ss-003

Date:	11/6/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Arsenic	14.3	22.6

LL11ss-024

Date:	11/9/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Arsenic	16	12.8

LL11sb-042

Date:	3/13/2001
Depth (ft):	6 - 8
Concentration (mg/kg)	
Arsenic	20.6

LL11cs-011

Date:	3/23/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Aluminum	23,600
Arsenic	22.6

LL11ss-007

Date:	11/13/2000
Depth (ft):	1 - 3
Concentration (mg/kg)	
Cyanide	0.29

LL11sd-031

Date:	11/16/2000
Depth (ft):	0 - 1
Concentration (mg/kg)	
Arsenic	21.1

LL11sb-009

Date:	11/13/2000	
Depth (ft):	0 - 1	4 - 6
Concentration (mg/kg)		
Arsenic	15.5	22.9

LL11cs-025

Date:	3/21/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Aluminum	23,800
Cobalt	16.6

LL11sb-060

Date:	3/18/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Cobalt	8.3 J	27.1 J	8

LL11ss-008

Date:	11/7/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Arsenic	17.9	13.7
Cyanide	0.68	0.46 U

LL11sb-001

Date:	11/3/2000	
Depth (ft):	0 - 1	18 - 20
Concentration (mg/kg)		
Arsenic	24.8	28

ID	Former Building Use and Description
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
Building AP-9	1941-1945: Shipping 1951-1957: Primer Rest House 1969-1971: Percussion Element Storage and Staging
Building AP-10*	Percussion Element Service Magazine
Building AP-11	1941-1945, 1951-1957: Black Powder Charging Operations 1969-1971: Primer Assembly
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

LEGEND:

▭	EXISTING BUILDING
⬚ AP-10	DEMOLISHED BUILDING
═	ASPHALT ROAD
┼	RAILROAD TRACKS
—x—x—	FENCE LINE
🟦	SURFACE WATER
─ · · ─	DRAINAGE DITCH
	VEGETATION
— — —	GROUND CONTOUR (10–FT)
───	GROUND CONTOUR (2–FT)
○	FORMER UTILITY POLE
— —	DEMOLISHED STEAM LINE
▨	FORMER PRODUCTION AREA (FPA)
🟧	NON–PRODUCTION AREA (NPA)
🟩	EAST DITCH AGGREGATE
▬	WEST DITCH AGGREGATE
🟪	SEWER OUTFALL AGGREGATE
●	GROUNDWATER MONITORING WELL
◒	SURFACE WATER SAMPLE
◆	SEDIMENT SAMPLE
◈	CO–LOCATED SURFACE WATER & SEDIMENT SAMPLE
△	SURFACE SOIL SAMPLE
▲	SOIL BORING SAMPLE
■	CO–LOCATED SURFACE SOIL & SOIL BORING SAMPLE
⊙	CONFIRMATION SOIL SAMPLE
🟨	CONCENTRATION EXCEEDS FWCUG (HQ=1, TR=10–5)

NOTES:

1. CONCENTRATIONS OF ARSENIC, CHROMIUM, LEAD, MERCURY, ALUMINUM, BARIUM, COBALT, CYANIDE, MANGANESE, AND THALLIUM 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).

0 125 250 500

SCALE: 1" = 250'

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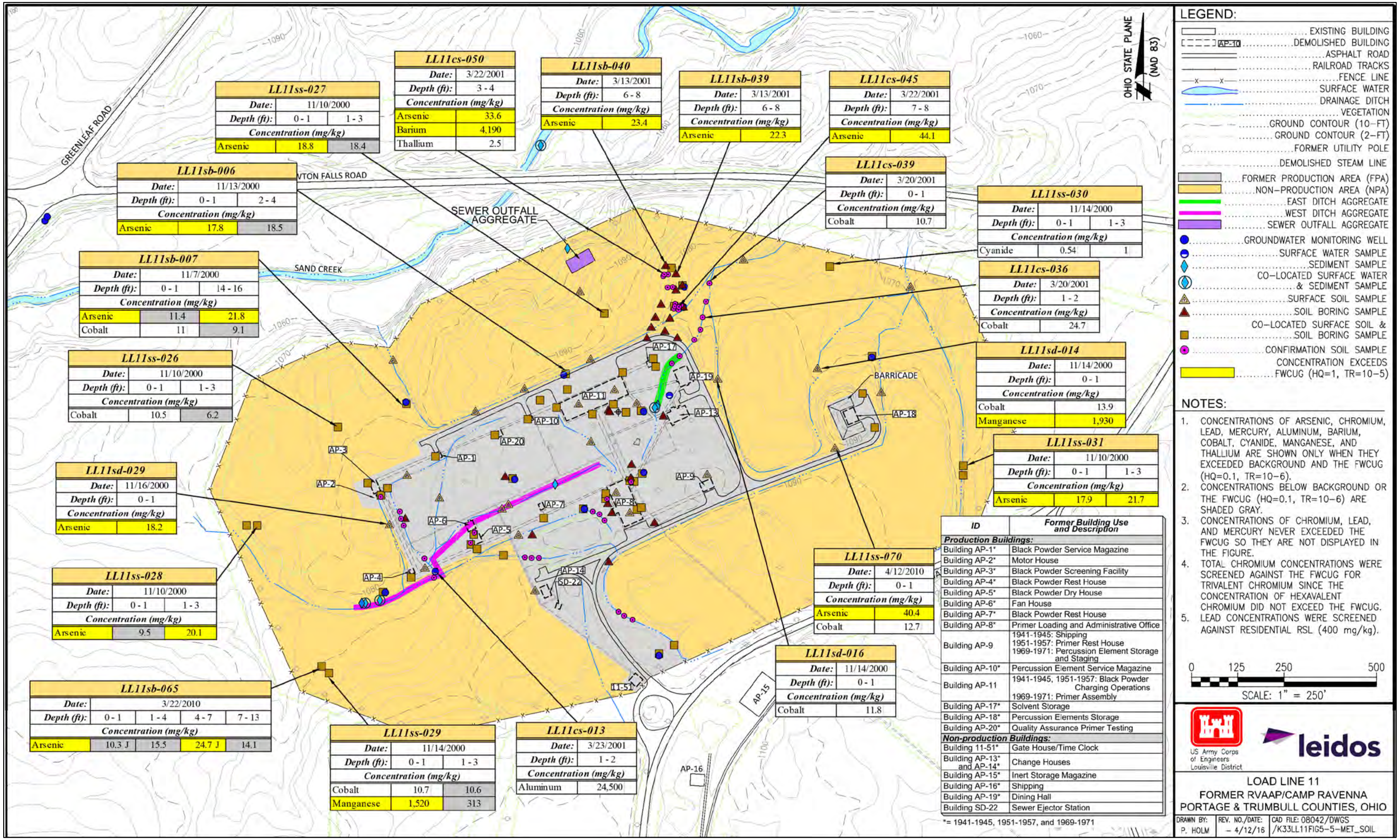
LOAD LINE 11
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE: 08042/DWGS
P. HOLM	– 4/21/16	/K33LL11FIG5–4–MET_SOIL

Figure 5–4. Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) for Arsenic, Chromium, Lead, Mercury, Aluminum, Barium, Cobalt, Cyanide, Manganese, and Thallium in Soil at the FPA



LL11cs-050

Date:	3/22/2001	
Depth (ft):	3 - 4	
Concentration (mg/kg)		
Arsenic	33.6	
Barium	4,190	
Thallium	2.5	

LL11sb-040

Date:	3/13/2001	
Depth (ft):	6 - 8	
Concentration (mg/kg)		
Arsenic	23.4	

LL11sb-039

Date:	3/13/2001	
Depth (ft):	6 - 8	
Concentration (mg/kg)		
Arsenic	22.3	

LL11cs-045

Date:	3/22/2001	
Depth (ft):	7 - 8	
Concentration (mg/kg)		
Arsenic	44.1	

LL11ss-027

Date:	11/10/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Arsenic	18.8	18.4

LL11sb-006

Date:	11/13/2000	
Depth (ft):	0 - 1	2 - 4
Concentration (mg/kg)		
Arsenic	17.8	18.5

LL11cs-039

Date:	3/20/2001	
Depth (ft):	0 - 1	
Concentration (mg/kg)		
Cobalt	10.7	

LL11ss-030

Date:	11/14/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Cyanide	0.54	1

LL11sb-007

Date:	11/7/2000	
Depth (ft):	0 - 1	14 - 16
Concentration (mg/kg)		
Arsenic	11.4	21.8
Cobalt	11	9.1

LL11cs-036

Date:	3/20/2001	
Depth (ft):	1 - 2	
Concentration (mg/kg)		
Cobalt	24.7	

LL11ss-026

Date:	11/10/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Cobalt	10.5	6.2

LL11sd-014

Date:	11/14/2000	
Depth (ft):	0 - 1	
Concentration (mg/kg)		
Cobalt	13.9	
Manganese	1,930	

LL11ss-031

Date:	11/10/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Arsenic	17.9	21.7

LL11sd-029

Date:	11/16/2000	
Depth (ft):	0 - 1	
Concentration (mg/kg)		
Arsenic	18.2	

LL11ss-070

Date:	4/12/2010	
Depth (ft):	0 - 1	
Concentration (mg/kg)		
Arsenic	40.4	
Cobalt	12.7	

LL11ss-028

Date:	11/10/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Arsenic	9.5	20.1

LL11sd-016

Date:	11/14/2000	
Depth (ft):	0 - 1	
Concentration (mg/kg)		
Cobalt	11.8	

LL11sb-065

Date:	3/22/2010			
Depth (ft):	0 - 1	1 - 4	4 - 7	7 - 13
Concentration (mg/kg)				
Arsenic	10.3 J	15.5	24.7 J	14.1

LL11ss-029

Date:	11/14/2000	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Cobalt	10.7	10.6
Manganese	1,520	313

LL11cs-013

Date:	3/23/2001	
Depth (ft):	1 - 2	
Concentration (mg/kg)		
Aluminum	24,500	

ID	Former Building Use and Description
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
Building AP-9	1941-1945: Shipping 1951-1957: Primer Rest House 1969-1971: Percussion Element Storage and Staging
Building AP-10*	Percussion Element Service Magazine
Building AP-11	1941-1945, 1951-1957: Black Powder Charging Operations 1969-1971: Primer Assembly
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

LEGEND:

▭	EXISTING BUILDING
⬚ AP-10	DEMOLISHED BUILDING
═	ASPHALT ROAD
─┼─	RAILROAD TRACKS
—x—x—	FENCE LINE
▬	SURFACE WATER
─ · · ─	DRAINAGE DITCH
	VEGETATION
─ ─	GROUND CONTOUR (10–FT)
─ ─	GROUND CONTOUR (2–FT)
○	FORMER UTILITY POLE
- - -	DEMOLISHED STEAM LINE
⬜	FORMER PRODUCTION AREA (FPA)
🟧	NON–PRODUCTION AREA (NPA)
🟩	EAST DITCH AGGREGATE
▬	WEST DITCH AGGREGATE
🟪	SEWER OUTFALL AGGREGATE
●	GROUNDWATER MONITORING WELL
◒	SURFACE WATER SAMPLE
◆	SEDIMENT SAMPLE
◈	CO–LOCATED SURFACE WATER & SEDIMENT SAMPLE
△	SURFACE SOIL SAMPLE
▲	SOIL BORING SAMPLE
■	CO–LOCATED SURFACE SOIL & SOIL BORING SAMPLE
⊙	CONFIRMATION SOIL SAMPLE
🟨	CONCENTRATION EXCEEDS FWCUG (HQ=1, TR=10–5)

NOTES:

1. CONCENTRATIONS OF ARSENIC, CHROMIUM, LEAD, MERCURY, ALUMINUM, BARIUM, COBALT, CYANIDE, MANGANESE, AND THALLIUM 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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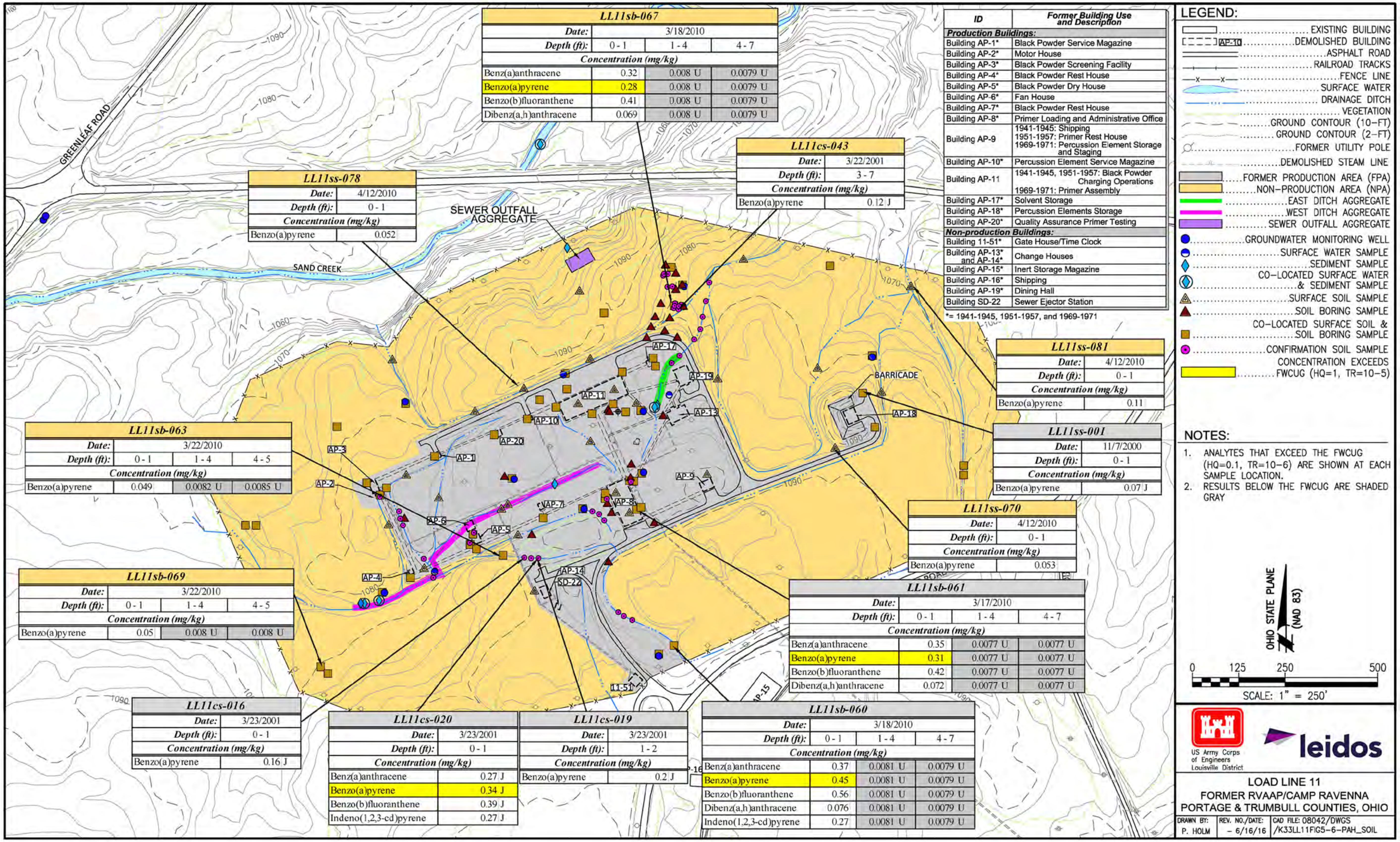
LOAD LINE 11
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
P. HOLM	– 4/12/16	08042/DWGS /K33LL11FIG5–5–MET_SOIL

Figure 5–5. Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) for Arsenic, Chromium, Lead, Mercury, Aluminum, Barium, Cobalt, Cyanide, Manganese, and Thallium in Soil at the NPA



LL11sb-067			
Date:	3/18/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benz(a)anthracene	0.32	0.008 U	0.0079 U
Benzo(a)pyrene	0.28	0.008 U	0.0079 U
Benzo(b)fluoranthene	0.41	0.008 U	0.0079 U
Dibenz(a,h)anthracene	0.069	0.008 U	0.0079 U

LL11ss-078	
Date:	4/12/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.052

LL11cs-043	
Date:	3/22/2001
Depth (ft):	3 - 7
Concentration (mg/kg)	
Benzo(a)pyrene	0.12 J

ID	Former Building Use and Description
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
Building AP-9	1941-1945: Shipping 1951-1957: Primer Rest House 1969-1971: Percussion Element Storage and Staging
Building AP-10*	Percussion Element Service Magazine
Building AP-11	1941-1945, 1951-1957: Black Powder Charging Operations 1969-1971: Primer Assembly
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

LL11ss-081	
Date:	4/12/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.11

LL11sb-063			
Date:	3/22/2010		
Depth (ft):	0 - 1	1 - 4	4 - 5
Concentration (mg/kg)			
Benzo(a)pyrene	0.049	0.0082 U	0.0085 U

LL11ss-001	
Date:	11/7/2000
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.07 J

LL11ss-070	
Date:	4/12/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.053

LL11sb-069			
Date:	3/22/2010		
Depth (ft):	0 - 1	1 - 4	4 - 5
Concentration (mg/kg)			
Benzo(a)pyrene	0.05	0.008 U	0.008 U

LL11sb-061			
Date:	3/17/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benz(a)anthracene	0.35	0.0077 U	0.0077 U
Benzo(a)pyrene	0.31	0.0077 U	0.0077 U
Benzo(b)fluoranthene	0.42	0.0077 U	0.0077 U
Dibenz(a,h)anthracene	0.072	0.0077 U	0.0077 U

LL11cs-016	
Date:	3/23/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.16 J

LL11cs-020	
Date:	3/23/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	0.27 J
Benzo(a)pyrene	0.34 J
Benzo(b)fluoranthene	0.39 J
Indeno(1,2,3-cd)pyrene	0.27 J

LL11cs-019	
Date:	3/23/2001
Depth (ft):	1 - 2
Concentration (mg/kg)	
Benzo(a)pyrene	0.2 J

LL11sb-060			
Date:	3/18/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benz(a)anthracene	0.37	0.0081 U	0.0079 U
Benzo(a)pyrene	0.45	0.0081 U	0.0079 U
Benzo(b)fluoranthene	0.56	0.0081 U	0.0079 U
Dibenz(a,h)anthracene	0.076	0.0081 U	0.0079 U
Indeno(1,2,3-cd)pyrene	0.27	0.0081 U	0.0079 U

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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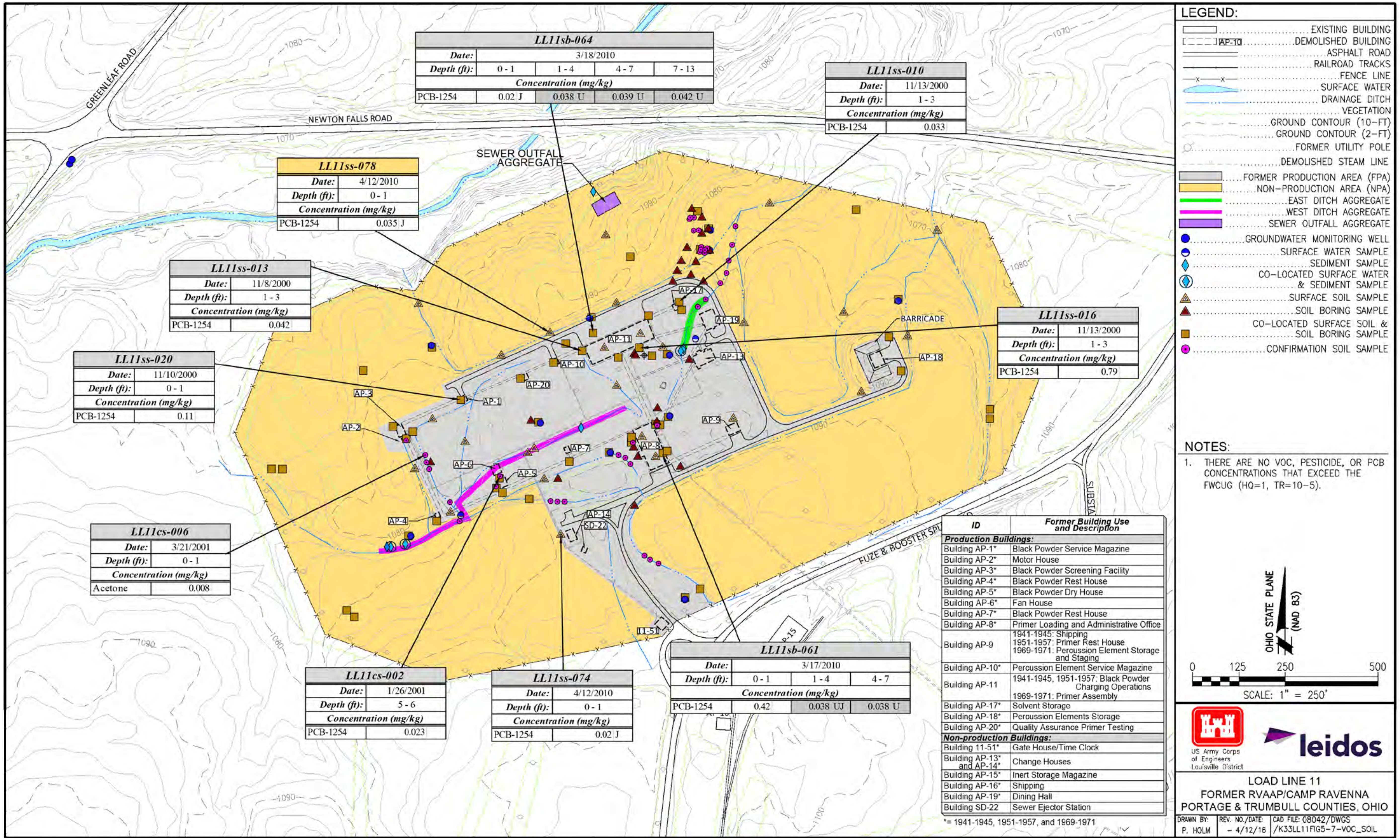
LOAD LINE 11
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
P. HOLM	– 6/16/16	08042/DWGS/K33LL11FIG5–6–PAH_SOIL

Figure 5–6. PAH Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) in Soil at the FPA and NPA



NOTES:

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

LL11sb-064				
Date:	3/18/2010			
Depth (ft):	0 - 1	1 - 4	4 - 7	7 - 13
Concentration (mg/kg)				
PCB-1254	0.02 J	0.038 U	0.039 U	0.042 U

LL11ss-010	
Date:	11/13/2000
Depth (ft):	1 - 3
Concentration (mg/kg)	
PCB-1254	0.033

LL11ss-078	
Date:	4/12/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
PCB-1254	0.035 J

LL11ss-013	
Date:	11/8/2000
Depth (ft):	1 - 3
Concentration (mg/kg)	
PCB-1254	0.042

LL11ss-020	
Date:	11/10/2000
Depth (ft):	0 - 1
Concentration (mg/kg)	
PCB-1254	0.11

LL11ss-016	
Date:	11/13/2000
Depth (ft):	1 - 3
Concentration (mg/kg)	
PCB-1254	0.79

LL11cs-006	
Date:	3/21/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Acetone	0.008

LL11cs-002	
Date:	1/26/2001
Depth (ft):	5 - 6
Concentration (mg/kg)	
PCB-1254	0.023

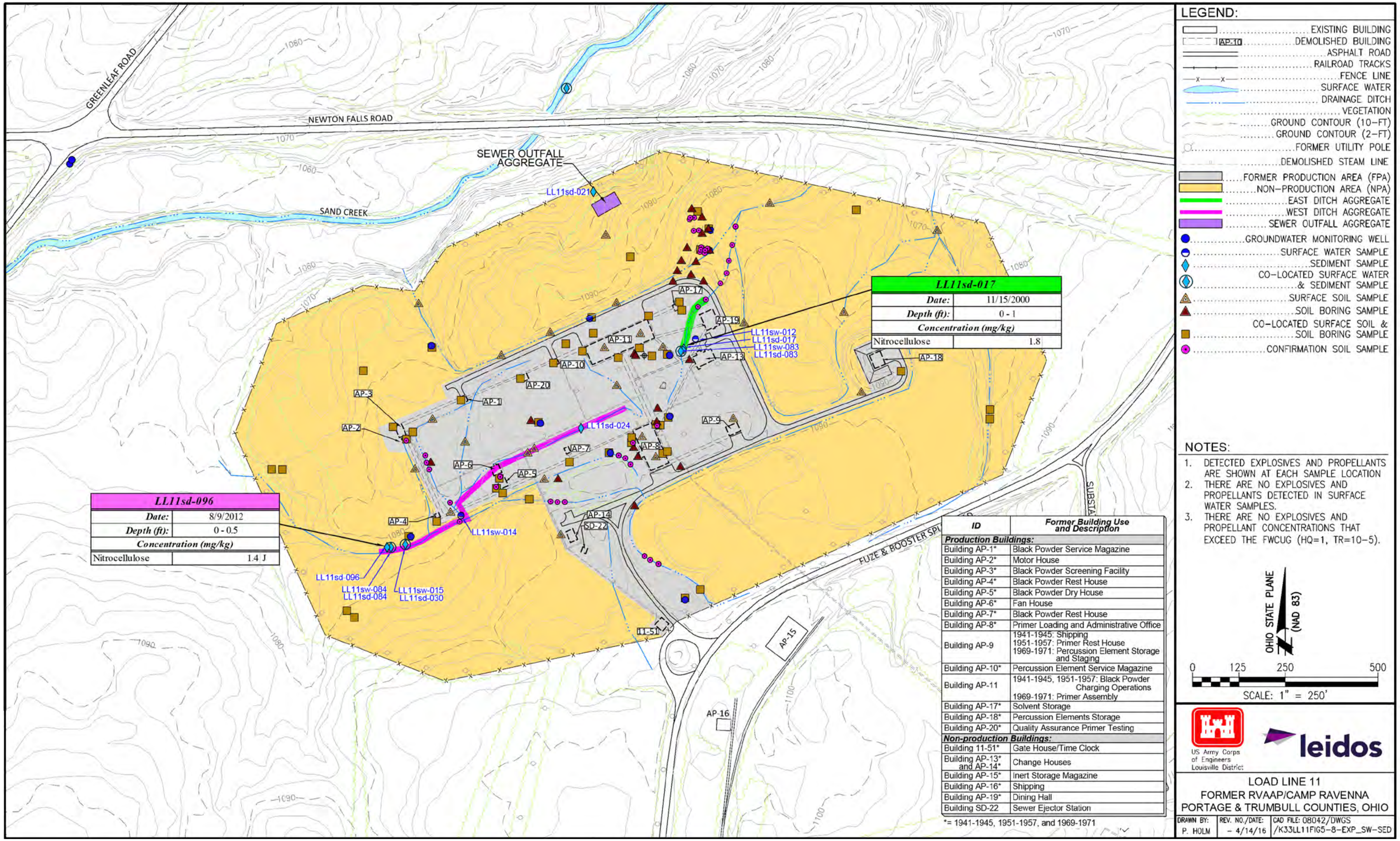
LL11ss-074	
Date:	4/12/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
PCB-1254	0.02 J

LL11sb-061			
Date:	3/17/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
PCB-1254	0.42	0.038 UJ	0.038 U

ID	Former Building Use and Description
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
Building AP-9	1941-1945: Shipping 1951-1957: Primer Rest House 1969-1971: Percussion Element Storage and Staging
Building AP-10*	Percussion Element Service Magazine
Building AP-11	1941-1945, 1951-1957: Black Powder Charging Operations 1969-1971: Primer Assembly
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

Figure 5–7. Detected Concentrations of VOCs, Pesticides, and PCBs in Soil at the FPA and NPA



LL11sd-017	
Date:	11/15/2000
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	1.8

LL11sd-096	
Date:	8/9/2012
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Nitrocellulose	1.4 J

ID	***Former Building Use and Description***
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
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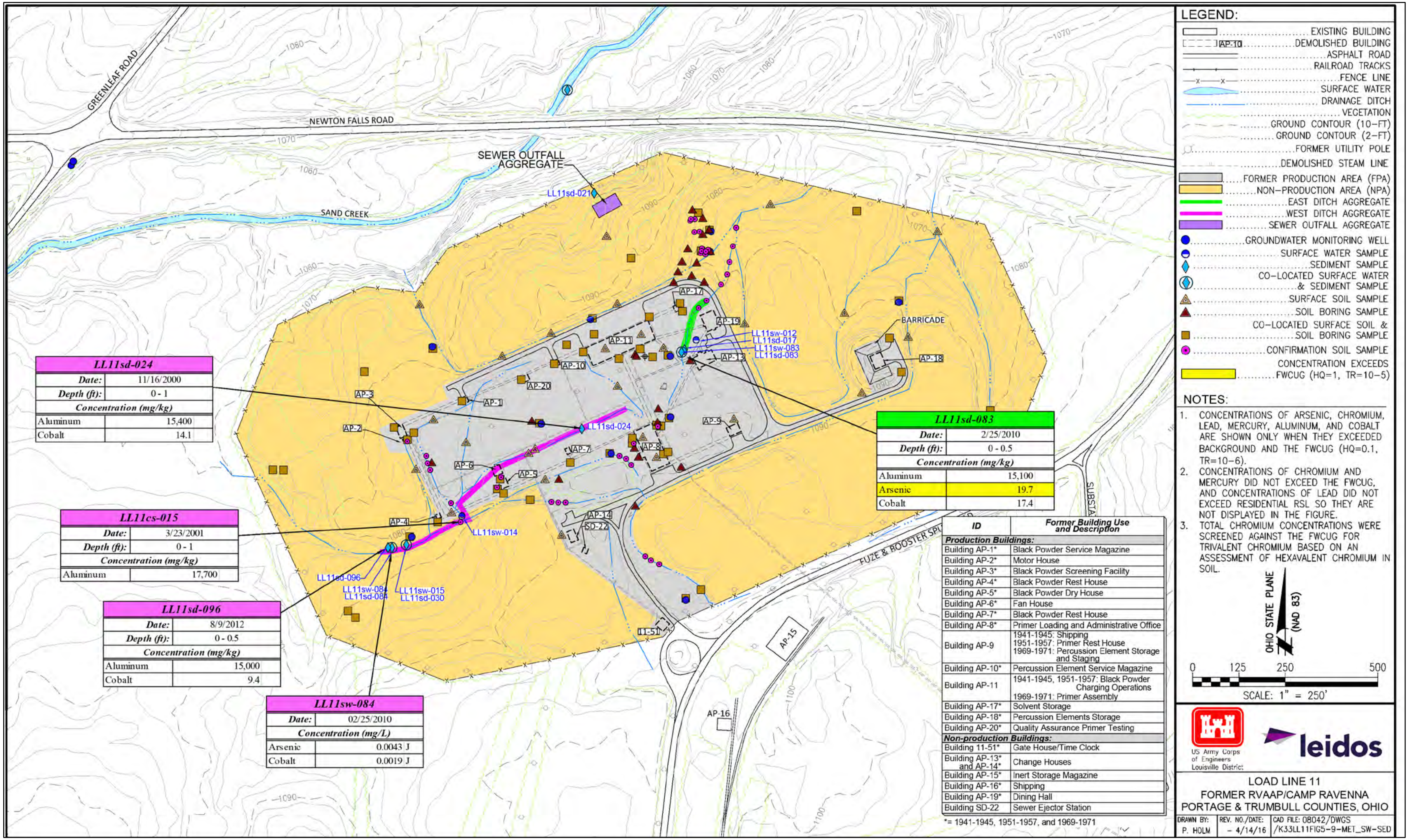
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

NOTES:

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

Figure 5–8. Detected Concentrations of Explosives and Propellants in Surface Water and Sediment



LL11sd-024	
Date:	11/16/2000
Depth (ft):	0 - 1
Concentration (mg/kg)	
Aluminum	15,400
Cobalt	14.1

LL11cs-015	
Date:	3/23/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Aluminum	17,700

LL11sd-096	
Date:	8/9/2012
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Aluminum	15,000
Cobalt	9.4

LL11sw-084	
Date:	02/25/2010
Concentration (mg/L)	
Arsenic	0.0043 J
Cobalt	0.0019 J

LL11sd-083	
Date:	2/25/2010
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Aluminum	15,100
Arsenic	19.7
Cobalt	17.4

ID	Former Building Use and Description
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
Building AP-9	1941-1945: Shipping 1951-1957: Primer Rest House 1969-1971: Percussion Element Storage and Staging
Building AP-10*	Percussion Element Service Magazine
Building AP-11	1941-1945, 1951-1957: Black Powder Charging Operations 1969-1971: Primer Assembly
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

LEGEND:

▭	EXISTING BUILDING
⬚ AP-10	DEMOLISHED BUILDING
═	ASPHALT ROAD
┼	RAILROAD TRACKS
—x—x—	FENCE LINE
⬭	SURFACE WATER
‐‐	DRAINAGE DITCH
‐‐	VEGETATION
‐ ‐	GROUND CONTOUR (10-FT)
‐ ‐	GROUND CONTOUR (2-FT)
○	FORMER UTILITY POLE
‐ ‐	DEMOLISHED STEAM LINE
▨	FORMER PRODUCTION AREA (FPA)
▨	NON-PRODUCTION AREA (NPA)
🟩	EAST DITCH AGGREGATE
▬	WEST DITCH AGGREGATE
🟪	SEWER OUTFALL AGGREGATE
●	GROUNDWATER MONITORING WELL
◒	SURFACE WATER SAMPLE
◆	SEDIMENT SAMPLE
◈	CO-LOCATED SURFACE WATER & SEDIMENT SAMPLE
△	SURFACE SOIL SAMPLE
▲	SOIL BORING SAMPLE
■	CO-LOCATED SURFACE SOIL & SOIL BORING SAMPLE
◉	CONFIRMATION SOIL SAMPLE
🟨	CONCENTRATION EXCEEDS FWCUG (HQ=1, TR=10−5)

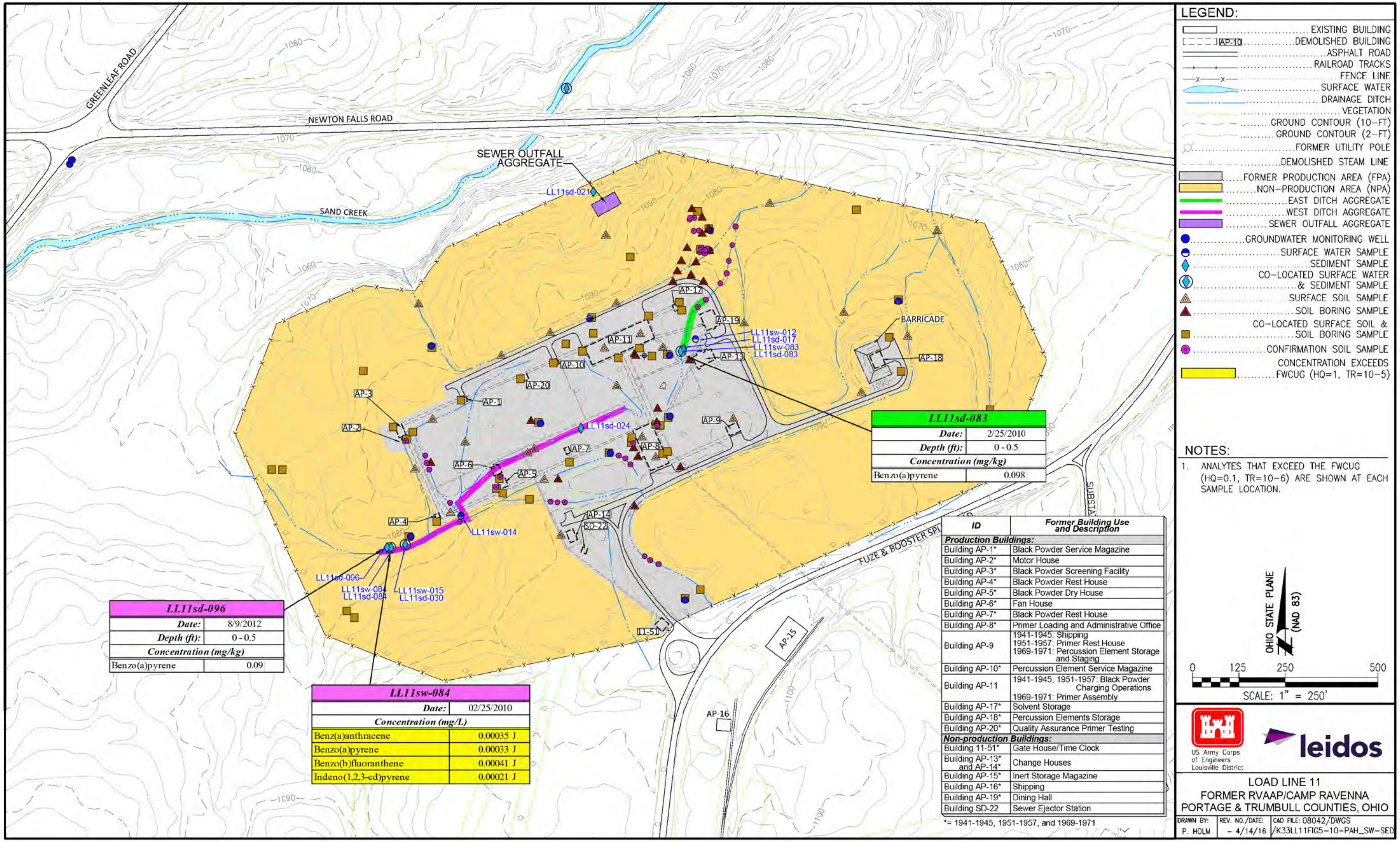
NOTES:

1. CONCENTRATIONS OF ARSENIC, CHROMIUM, LEAD, MERCURY, ALUMINUM, AND COBALT 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 DID NOT EXCEED RESIDENTIAL RSL SO THEY ARE NOT DISPLAYED IN THE FIGURE.
3. TOTAL CHROMIUM CONCENTRATIONS WERE SCREENED AGAINST THE FWCUG FOR TRIVALENT CHROMIUM BASED ON AN ASSESSMENT OF HEXAVALENT CHROMIUM IN SOIL.

LOAD LINE 11
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE: 08042/DWGS
P. HOLM	- 4/14/16	/K33LL11FIG5-9-MET_SW-SED

Figure 5–9. Exceedances of FWCUG (HQ of 0.1, TR 1E-06) for Arsenic, Chromium, Lead, Mercury, Aluminum, and Cobalt in Surface Water and Sediment



LL11sd-083	
Date:	2/25/2010
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Benzo(a)pyrene	0.098

LL11sd-096	
Date:	8/9/2012
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Benzo(a)pyrene	0.09

LL11sw-084	
Date:	02/25/2010
Concentration (mg/L)	
Benz(a)anthracene	0.00035 J
Benzo(a)pyrene	0.00033 J
Benzo(b)fluoranthene	0.00041 J
Indeno(1,2,3-cd)pyrene	0.00021 J

NOTES:

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

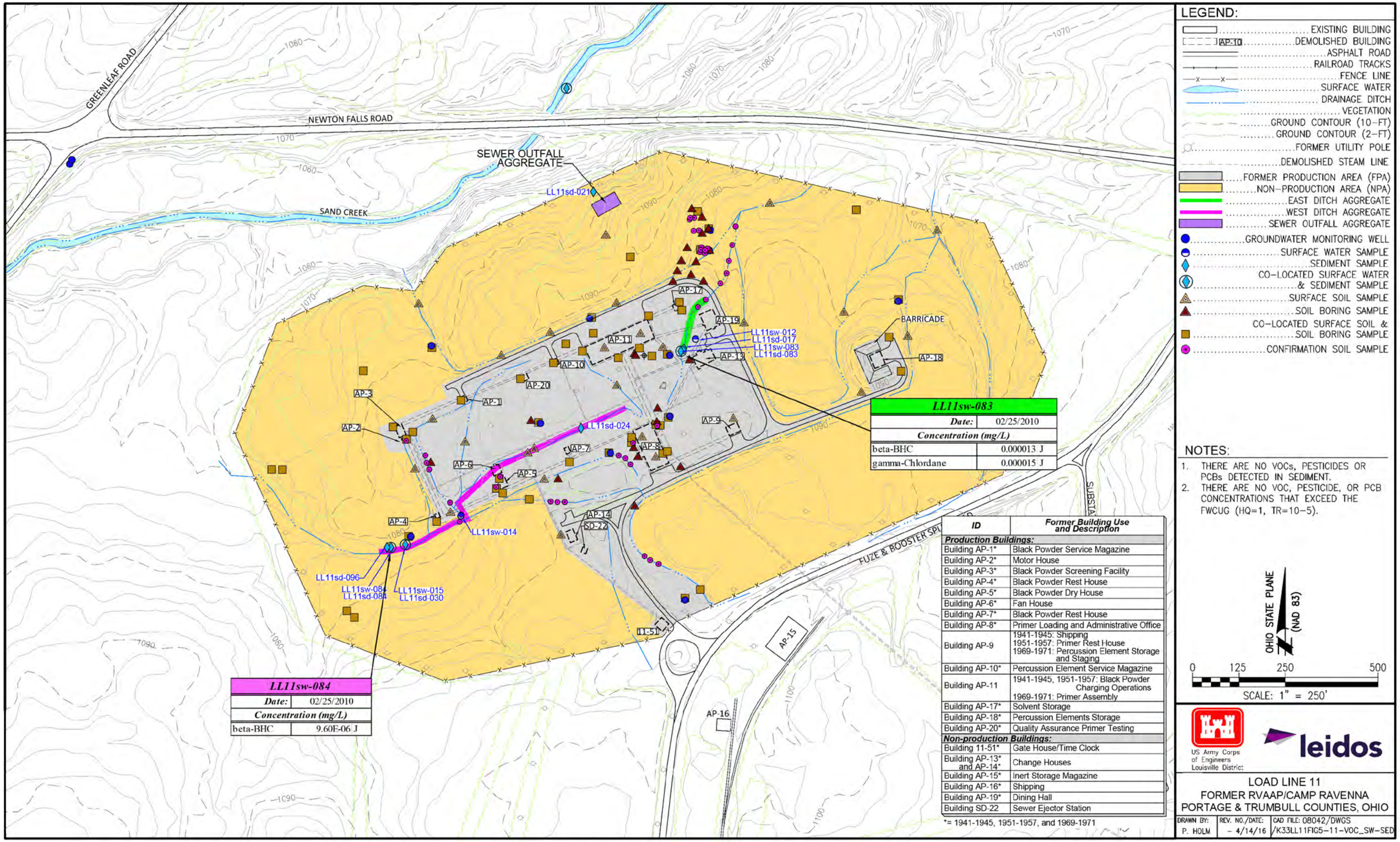
ID	Former Building Use and Description
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
Building AP-9	1941-1945: Shipping 1951-1957: Primer Rest House 1969-1971: Percussion Element Storage and Staging
Building AP-10*	Percussion Element Service Magazine
Building AP-11	1941-1945, 1951-1957: Black Powder Charging Operations 1969-1971: Primer Assembly
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

LOAD LINE 11
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE: 08042/DWGS
P. HOLM	- 4/14/16	/K33LL11FIG5-10-PAH_SW-SED

Figure 5–10. PAH Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) in Surface Water and Sediment



LL11sw-083	
Date:	02/25/2010
Concentration (mg/L)	
beta-BHC	0.000013 J
gamma-Chlordane	0.000015 J

LL11sw-084	
Date:	02/25/2010
Concentration (mg/L)	
beta-BHC	9.60E-06 J

ID	Former Building Use and Description
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
Building AP-9	1941-1945: Shipping 1951-1957: Primer Rest House 1969-1971: Percussion Element Storage and Staging
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Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

NOTES:
1. THERE ARE NO VOCs, PESTICIDES OR PCBs DETECTED IN SEDIMENT.
2. THERE ARE NO VOC, PESTICIDE, OR PCB CONCENTRATIONS THAT EXCEED THE FWCUG (HQ=1, TR=10-5).

LOAD LINE 11
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE: 08042/DWGS
P. HOLM	- 4/14/16	/K33LL11FIG5-11-VOC_SW-SED

Figure 5–11. Detected Concentrations of VOCs, Pesticides, and PCBs in Surface Water and Sediment

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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 11 and impact groundwater beneath the existing sources and downgradient receptor locations. As indicated in Section 4.2, sources identified at Load Line 11 have been removed as part of the IRA (MKM 2004a). Five sedimentation sumps, 230 yd^3 of contaminated sediment within drainage ditches, and petroleum-contaminated soil within a 30 by 30 by 8 ft hotspot area have been removed from the site.

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 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 a list of the remaining final CMCOPCs, a qualitative assessment of the results, and considerations of the limitations and assumptions. Section 6.7 summarizes the conclusions of the fate and transport analysis.

6.1 PHYSICAL AND CHEMICAL PROPERTIES OF SITE-RELATED CONTAMINANTS

The 1978 Installation Assessment identified the major contaminants of the former RVAAP as TNT, composition B (a combination of TNT and RDX), sulfates, nitrates, lead styphnate, and lead azide. Additional site-specific contaminants include black powder, TNT, RDX, HMX, nitroglycerine, nitrocellulose, nitroguanidine, and heavy metals (lead, chromium, mercury, and arsenic) from munitions assembly activities; VOCs from former Building AP-17 that was utilized for solvent storage and lacquer sealing materials used on finished primers in former Building AP-11; and PCBs from on-site transformers.

This evaluation of contaminant fate and transport evaluates not only those chemicals identified as potential contaminants from previous use but also includes an evaluation of chemicals that were evaluated as part of the overall RI.

The comprehensive list of surface and subsurface soil (including 20 inorganic chemicals and 22 organic chemicals in the FPA and 19 inorganic chemicals and 21 organic chemicals in the NPA) and sediment SRCs (including 10 inorganic chemicals and 15 organic chemicals in the East Ditch aggregate, and 11 inorganic chemicals and 10 organic chemicals in the West Ditch aggregate) is detailed in Section 4.0 and are summarized below:

- Inorganic SRCs in surface and subsurface soil: aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, cyanide, lead, manganese, mercury, nickel, nitrate, silver, sulfate, sulfide, thallium, vanadium, and zinc.
- Inorganic SRCs in sediment: aluminum, antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, mercury, nickel, selenium, silver, and vanadium.
- Organic SRCs in surface and subsurface soil: 2-methylnaphthalene, 4-nitrotoluene, acenaphthene, anthracene, benz(a)anthracene, benzenemethanol, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, beta-BHC, bis(2-ethylhexyl)phthalate, carbazole, chrysene, di-n-butyl phthalate, dibenz(a,h)anthracene, dibenzofuran, fluoranthene, fluorene, HMX, indeno(1,2,3-cd)pyrene, naphthalene, nitrocellulose, PCB-1254, phenanthrene, phenol, pyrene, and tetryl.
- Organic SRCs in sediment: 2-methylnaphthalene, acenaphthene, anthracene, benz(a)anthracene, benzenemethanol, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, nitrocellulose, phenanthrene, and pyrene.

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 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. This 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 (i.e., 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

Several explosive compounds were detected in soil and sediment at Load Line 11. Nitrocellulose is an aliphatic nitrate ester that will gelatinize with nitroglycerin 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). 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). Nitroguanidine is a mobile nitramine chemical that can be biotransformed in aquatic environments and in soil under aerobic and anaerobic conditions. The rate of degradation of nitroguanidine in soil is dependent on the amount of organic carbon and microbial adaptation to nitroguanidine. Biotransformation products of nitroguanidine include cyanamide, melamine, and guanidine (USACE 2006). PETN undergoes biodegradation forming trinitrate and then dinitrate, which is then further degraded. PETN has low volatility and low solubility in water, and therefore has low bioavailability for most organisms. Neutron radiation degrades PETN, producing carbon dioxide and some pentaerythritol dinitrate and trinitrate. Like other nitrate esters, the primary degradation mechanism is the loss of nitrogen dioxide. Limited information exists regarding biotransformation or biodegradation of HMX. The biotransformation, primarily by anaerobic degradation (ERDC 2007), of

HMX 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 (ATSDR 1997) shows the biotransformation pathway for HMX.

6.2 CONCEPTUAL MODEL FOR FATE AND TRANSPORT

The conceptual site model (CSM), which defines the framework for fate and transport modeling, describes conditions at Load Line 11, 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; therefore, the more reliable the fate and transport modeling predictions can be. 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 (i.e., contaminated media including sediment) identified in previous investigations at the AOC are further evaluated in this report.

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 11 ranges from approximately 1,070 ft amsl near the northern fence line to 1,100 ft amsl near the southern fence line. Surface water drainage associated with heavy rainfall events follows the topography and drains into the east ditch that flows north and the west ditch that flows west northwest. Both ditches flow into Sand Creek (Figure 3-1).
- Soil beneath the AOC consists of shallow clay to sand-rich silt tills with interbedded sands scattered throughout, as observed in subsurface borings installed during the PBA08 RI (Appendix A).
- Twelve groundwater monitoring wells were installed at the AOC to an average depth of 19 ft bgs. Eleven of these monitoring wells monitor groundwater in the unconsolidated zone to an

average depth of 19 ft bgs. The other well (LL11mw-012) was screened in the bedrock consisting of Sharon Shale to a depth of 115 ft bgs.
- The potentiometric surface shows the groundwater flow direction is to the north with an average hydraulic gradient of 0.017 ft/ft (Figure 3-1).
- Water level elevations at the AOC range from 1,068.40 to 1,091.73 ft amsl with the highest elevation at well LL11mw-001 (Figure 3-1). Potentiometric data indicate the groundwater table occurs within the unconsolidated soil throughout the AOC.

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 the downgradient receptor (i.e., Sand Creek north of Load Line 11);
- Contaminated sediment transported to potential downstream receptors;
- Contaminated surface water migrating to potential downstream receptors; and
- Contaminated sediment from the wetlands as a secondary source of leaching to the water table (vertical migration) and lateral transport to potential downgradient receptors.

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 pathway listed above, which considers a secondary groundwater transport pathway, was 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 11. 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 non-existent.

6.2.4 Water Budget

The potential for contaminant transport begins with precipitation. Percolation is the driving mechanism for soil contaminants leaching 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 runoff loss also occurs through 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 rate 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% (26.7 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. This section describes the soil screening analysis approach and presents the limitations and assumptions.

6.3.1 Analysis Approach

The five steps for the soil leachability analysis are illustrated in Figure 6-2 and are described below.

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 the initial CMCOPCs. However, some chemicals have been assigned surrogates by risk assessors if the chemical without an SSL is similar to another chemical with an SSL. Surrogates used for this analysis include acenaphthene for acenaphthylene and pyrene for benzo(ghi)perylene and phenanthrene.

The initial CMCOPC screen, as presented in Appendix E, Table E-4, eliminated 7 inorganic SRCs and 14 organic SRCs from the FPA and 6 inorganic SRCs and 11 organic SRCs from the NPA from further consideration. Inorganic anion SRCs nitrate, sulfate, and sulfide from FPA and NPA, and organic SRCs TPH-DRO and TPH-GRO from NPA were eliminated from further consideration as there are no SSLs for these SRCs. A total of 10 inorganic and 8 organic SRCs from the FPA and 10 inorganic and 8 organic SRCs from the NPA were carried forward to the third step of the soil CMCOPC screening process.

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 dilution attenuation factor (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 a 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 estimating 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)

and

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

Where:

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

As stated above, if the aquifer thickness is less than the calculated mixing zone depth, then the aquifer thickness is used for “d” in the DAF calculation. The DAF calculation for the AOC is presented in 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 1.04 for the FPA and 1.03 for the NPA, none of the chemicals were eliminated from further consideration. Therefore, all the remaining SRCs from the previous step also 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 which 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. A total of 11 inorganic and organic SRCs at the FPA and 12 inorganic and organic SRCs at the NPA 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) modeling are listed in Table 6-1.

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

6.3.2 Limitations and Assumptions of Soil Screening Analysis

It is important to recognize that acceptable soil concentrations for individual chemicals are highly AOC-specific. The GSSLs used in this screening represent USEPA's protection of groundwater SSLs that were developed 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 CMCOPCs based on contaminant migration from sediment to groundwater. Any identified CMCOPCs are modeled with Analytical Transient 1-, 2-, 3-Dimensional (AT123D) model 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 for the two aggregates (East Ditch and West Ditch).

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), benz(a)anthracene and naphthalene at the East Ditch aggregate, and antimony, benz(a)anthracene, and benzo(b)fluoranthene at the West Ditch aggregate exceeded the risk-based screening criteria and were carried forward for further evaluation with the AT123D model. All other sediment SRCs were eliminated.

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 (i.e., 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 of 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 shallow bedrock is controlled by the groundwater gradient. Vertical transport (evaluated with the SESOIL model) through the overburden to the water table and horizontal transport (evaluated with the AT123D model) through the unconsolidated sediment 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, six discrete sampling locations for the FPA and four discrete sampling locations for the NPA were considered 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, MCLs, and RSLs. If the predicted maximum leachate concentration of an initial CMCOPC was higher than the facility-wide background concentration, and the lowest risk-based screening value (Resident Receptor Adult FWCUG, MCL, or RSL), the CMCOPC was further evaluated using the AT123D model to predict future maximum concentrations in groundwater beneath the source, as well as at downgradient receptor locations, if applicable.

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

For chemicals identified as CMCOPCs, maximum concentrations predicted by AT123D in groundwater directly below the source areas and at the downgradient receptor locations were compared to the applicable RVAAP facility-wide background concentrations, as well as RVAAP FWCUGs for the Resident Receptor Adult, MCLs, and RSLs. If the predicted maximum concentration of a CMCOPC was higher than its facility-wide background concentration, and the lowest risk-based screening value (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 was not 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 or sediment remedial actions. Lines of evidence included 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 or sediment 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 sediment 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

The SESOIL model defines the soil column as compartments extending from the ground surface through the unsaturated zone and to the upper level of the saturated soil zone or top of bedrock. Processes simulated in SESOIL are categorized in three cycles: 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 (i.e., liquid, adsorbed, air, and pure). Data requirements for SESOIL are not extensive and utilize a minimum of AOC-specific soil and chemical parameters and monthly or seasonal meteorological values as input.

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

The input data for SESOIL can be grouped into four types: climatic, chemical, soil, and application data. There are 61 separate parameters contained in these four 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 the SESOIL model (Youngstown station) and HELP model (Cleveland station) produced virtually the same recharge rate (i.e., 9.40 cm/yr for Cleveland and 9.42 cm/yr for Youngstown) for each location. Therefore, the use of the two different weather station data sets did not impact modeling results.

6.5.2.3 Chemical Data

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

6.5.2.4 Soil Data

The soil data file of SESOIL contains input parameters describing the physical characteristics of the subsurface soil and is presented in Table 6-3. These parameters include soil bulk density, intrinsic permeability, soil disconnectedness index, soil porosity, organic carbon content, and cation exchange capacity. AOC-specific data were used from geotechnical samples collected at the AOC during the PBA08 RI (Table 5-4). 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 soil permeability to the moisture content, and the Freundlich exponent relates to 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 modeling. All the samples collected at different depth intervals were compiled to provide a detailed loading option for the SESOIL model. The maximum soil concentrations for each CMCOPC, listed in Table 6-1, were used as source term concentrations for the SESOIL model.

6.5.2.6 Application Data

Five different layering schemes were developed for sample locations within the FPA, and five different layering schemes were developed for sample locations within the NPA 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 in the FPA and NPA consisted of four layers of varying thicknesses. Depending on the analyte being modeled, the top three layers varied between contaminant loading layers and leaching layers. The top layer (Layer 1) for each model consisted of the loading zone and varied in thickness from 0.25–3 ft thick. The thicknesses and purpose of Layers 2 and 3 varied between the models for each chemical. Layer 4 served as a leaching zone in each model. Layer 4 was a thin layer (0.25 ft thick) 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 [arsenic, barium, cobalt, zinc, PETN, benzo(b)fluoranthene, and naphthalene from the FPA; arsenic, cobalt, manganese, nickel, PETN, and naphthalene from the NPA] 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. PETN at the NPA was excluded as a final CMCOPC based on the results of the SESOIL modeling, as the predicted leachate concentration below the source and just above the water table did not exceed its screening criteria. All of the initial CMCOPCs, except PETN at the NPA, modeled in SESOIL were selected as final CMCOPCs based on the results of the SESOIL modeling, as their predicted leachate concentrations below the source and just above the water table exceeded their respective screening criteria. These leachate concentrations do not reflect the groundwater concentrations beneath the source. When the leachate reaches the water table, dilution by groundwater further reduces leachate concentrations. In Appendix E, Figures E-2 through E-13 show the leachate mass flux versus time plots generated by SESOIL that were used as input to the AT123D models.

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 (i.e., 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, 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.

Figures E-14 through E-31 show the predicted concentration versus time curves based on AT123D modeling at the source as well as at the receptor location. The screening criteria (MCL/RSL and Resident Receptor Adult FWCUG) are also plotted in these figures as a constant line.

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., Sand Creek). Using the closest available downgradient monitoring wells for comparison with modeled source areas, observed groundwater concentrations from AOC monitoring wells are included in Table 6-5. 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.

For final soil CMCOPCs, the maximum predicted concentrations of all of the CMCOPCs, except barium at the FPA [i.e., arsenic, cobalt, zinc, PETN, benzo(b)fluoranthene, and naphthalene] and nickel at the NPA (i.e., arsenic, cobalt, manganese, and naphthalene), were predicted to exceed the screening criteria in groundwater beneath the source area and were, therefore, modeled to the downgradient receptor locations (i.e., Sand Creek). The identified sediment CMCOPCs [i.e., benz(a)anthracene and naphthalene at the East Ditch aggregate and antimony, benz(a)anthracene, and benzo(b)fluoranthene at the West Ditch aggregate] were also predicted by analytical solutions to exceed screening criteria in groundwater beneath the source and were retained for lateral transport modeling using AT123D.

Lateral transport modeling showed that none of the soil or sediment CMCOPCs were predicted to exceed the screening criteria at the downgradient receptor location (i.e., Sand Creek). Figure 6-5 presents CMCOCs identified based on AT123D modeling.

6.5.6 Limitations/Assumptions

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

- The contaminant fate and transport evaluation included not only chemicals identified as being previously used during historical operations, but also included all chemicals identified as soil SRCs during the data screening and reduction process.
- Some soil SRCs were identified due to the absence of a background concentration or as having limited or slight exceedances of the established background concentrations.
- Chemical and biological degradation rates for organic CMCOPCs were not considered in the SESOIL and AT123D models.
- Using 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 in the modeling evaluation 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 (i.e., 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. Variability in the distribution of soil contamination and overall impacts to predicted groundwater concentrations were not considered in the models. A realistic distribution of soil contamination was not considered. The maximum concentration value was used as the source term concentration 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 of 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. In this analysis, biodegradation rates for organic chemicals have been assumed to be zero, thereby predicting higher concentrations for organic chemicals in groundwater than would be expected to be observed in the future. 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 CMCOPCs in soil and sediment and a qualitative assessment of the results and considerations of the limitations and assumptions.

6.6.1 Evaluation of Remaining Soil CMCOPCs

6.6.1.1 Former Production Area

Arsenic – The maximum soil concentration for arsenic at the FPA was 30.2 mg/kg at LL11ss-022-0001-SO. Only 8 of 67 soil samples within the FPA had concentrations of arsenic above the subsurface soil background concentration of 19.8 mg/kg. Arsenic was not identified as a soil COC in the HHRA. The modeling estimates that arsenic concentrations in groundwater beneath the source areas in the FPA could potentially exceed its MCL at about 35 years with peak concentrations occurring at approximately 300 years or less. Arsenic is not predicted to migrate to the downgradient receptor location at a detectable concentration within 1,000 years (see Table 6-5). Arsenic concentrations in AOC groundwater samples collected from 2009-2013 were below its MCL in all the wells except LL11mw-007. The observed arsenic concentration in this well exceeded the MCL in all the events during this period with the maximum observed in the most recent event (i.e., 2013) at a concentration of 0.022 mg/L (Table 6-5). However, it should be noted here that the background concentration of arsenic in unconsolidated groundwater also exceeds the MCL and is very close to the observed concentration in LL11mw-007, indicating that the observed concentration of arsenic at LL11mw-007 is background related, and not due to contamination from the site.

Barium – The maximum soil concentration for barium at the FPA (i.e., 127 mg/kg at LL11cs-012-0001-SO) was well below the soil industrial RSL (22,000 mg/kg) and the Resident Receptor Adult FWCUG at a HQ of 0.1 (8,966 mg/kg), and it was not identified as a soil COC in the HHRA. This maximum concentration was only slightly above the subsurface soil background concentration of 124 mg/kg. Barium was not identified as a potential contaminant from historical usage at Load Line 11 and did not have widespread contamination. The modeling estimates that barium concentrations in groundwater beneath the source areas could potentially exceed its RSL at about 100 years or less with peak concentrations occurring at approximately 200 years, and barium is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (see Table 6-5). Barium concentrations in AOC groundwater samples collected from 2009-2013 were below its MCL (Table 6-5).

Cobalt – The maximum soil concentration for cobalt at the FPA (i.e., 33.8 mg/kg at LL11sd-025-0001-SD) was below the soil industrial RSL (35 mg/kg) and the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (803 mg/kg), and it was not identified as a soil COC in the HHRA. This maximum concentration was only slightly above the subsurface soil background concentration of 23.2 mg/kg. Cobalt was not identified as a potential contaminant from historical usage at Load Line 11 and did not have widespread contamination. The modeling estimates that cobalt concentrations in groundwater beneath the source areas could potentially exceed its RSL at about 150 years or less with peak concentrations occurring at approximately 400 years, and cobalt is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (see Table 6-5). Cobalt concentrations in AOC groundwater samples collected from 2010-2013 were below the RSL (Table 6-5).

Zinc – The maximum soil concentration for zinc (i.e., 465 mg/kg at LL11cs-025-0001-SD) was below the soil residential RSL (2300 mg/kg), and it was not identified as a soil COPC in the HHRA. Zinc was not identified as a potential contaminant from historical usage at Load Line 11 and did not have widespread contamination. The modeling estimates that zinc concentrations in groundwater beneath the source areas could potentially exceed its RSL at about 250 years or less with peak concentrations occurring at approximately 350 years, and zinc is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (see Table 6-5). Zinc concentrations in AOC groundwater samples collected from 2010-2013 were well below the RSL (Table 6-5).

PETN – The single detection for PETN at the FPA (i.e., 0.049 mg/kg at LL11sb-061-5555-SO, with frequency of detection 1/16) was well below the soil residential RSL (13 mg/kg), and it was not considered a soil COPC in the HHRA. The modeling estimates that PETN concentrations in groundwater beneath the source areas could potentially exceed its RSL at about 5 years or less with peak concentrations occurring at approximately 10 years or less, and PETN is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5). Based on the AOC period of operations, PETN should have already been detected in groundwater exceeding its RSL. However, PETN has not been detected in the AOC groundwater samples collected from 2010-2013 (Table 6-5). Therefore, this evaluation concludes that the model-predicted concentrations are conservative, and PETN would be expected to be below its RSL based on its site-specific attenuation and biodegradation rates.

Benzo(b)fluoranthene – The maximum soil concentration for benzo(b)fluoranthene at the FPA (i.e., 0.56 mg/kg at LL11sb-060-5551-SO) was slightly above the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (0.221 mg/kg); it was not considered a COC in the HHRA. The modeling estimates that benzo(b)fluoranthene concentrations in groundwater beneath the source areas could potentially exceed its RSL at about 700 years or less with peak concentrations occurring in more than 1,000 years. Benzo(b)fluoranthene is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5). Benzo(b)fluoranthene has not been detected in the AOC groundwater samples collected from 2010-2013 mainly because benzo(b)fluoranthene is expected to degrade before reaching the water table. 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 its site-specific attenuation and biodegradation rates.

Naphthalene – The maximum soil concentration for naphthalene at the FPA (i.e., 0.017 mg/kg at LL11sb-061-5555-SO) was below the soil residential RSL (3.8 mg/kg) and the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (368 mg/kg), and it was not considered a COPC in the HHRA. The modeling estimates that naphthalene concentrations in groundwater beneath the source areas could potentially exceed its RSL in about 3 years or less with peak concentrations occurring in about 12 years or less. Naphthalene is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5). Naphthalene was detected in the AOC groundwater samples collected from 2010-2013 at concentrations below the RSL (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 site-specific attenuation and biodegradation rates.

6.6.1.2 Non-Production Area

Arsenic – The maximum soil concentration for arsenic at the NPA was 44.1 mg/kg at LL11cs-045-0001-SO. Only 8 of 47 soil samples within the NPA had concentrations of arsenic above the subsurface soil background concentration of 19.8 mg/kg. Arsenic was not identified as a soil COC in the HHRA. The modeling estimates that arsenic concentrations in groundwater beneath the source areas in the NPA could potentially exceed its MCL within about 40 years or less with peak concentrations occurring at approximately 150 years. Arsenic is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (see Table 6-5). Arsenic concentrations in AOC groundwater samples collected from 2009-2013 were below its MCL in all wells except in LL11mw-007. The observed arsenic concentration in this well exceeded the MCL in all events with the maximum observed in 2013 at a concentration of 0.022 mg/L (Table 6-5). However, it should be noted here that background concentration of arsenic in unconsolidated groundwater also exceeds the MCL and is very close to the observed concentration in LL11mw-007, indicating that the observed concentration of arsenic at LL11mw-007 is background related, and not due to contamination from the site.

Cobalt – The maximum soil concentration for cobalt at the NPA (i.e., 24.7 mg/kg at LL11cs-036-0001-SO) was below the soil industrial RSL (35 mg/kg) and the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (803 mg/kg), and it was not identified as a soil COC in the HHRA. This maximum concentration was barely above the subsurface soil background concentration of 23.2 mg/kg. Cobalt was not identified as a potential contaminant from historical usage at Load Line 11 and did not have widespread contamination. The modeling estimates that cobalt concentrations in groundwater beneath the source areas could potentially exceed its RSL in 24 years or less (and the Resident Receptor Adult FWCUG within 100 years) with peak concentrations occurring at approximately 250 years or less, and cobalt is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (see Table 6-5). Cobalt concentrations in AOC groundwater samples collected from 2010-2013 were below the RSL (Table 6-5). Based on the AOC period of operations, this indicates that the model-predicted concentrations are conservative.

Manganese – The maximum soil concentration for manganese at the NPA (i.e., 1,930 mg/kg at LL11cs-036-0001-SO) was below the soil industrial RSL (2,600 mg/kg), and it was not identified as a soil COC in the HHRA. This maximum concentration was below the subsurface soil background concentration of 3,030 mg/kg. Manganese was not identified as a potential contaminant from historical usage at Load Line 11 and did not have widespread contamination. The modeling estimates that manganese concentrations in groundwater beneath the source areas could potentially exceed its RSL in 150 years or less (and the unconsolidated background concentration within 200 years) with peak concentrations occurring at approximately 850 years, and manganese is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (see Table 6-5). Manganese concentrations in AOC groundwater samples collected from 2009-2013 were above its RSL and FWCUG in several wells; however, they were below its background concentration, indicating that the observed groundwater concentrations of manganese are background related, and not due to contamination from the site.

Naphthalene – The maximum soil concentration for naphthalene at the NPA (i.e., 0.01 mg/kg at LL11sb-063-5563-SO) was below the soil residential RSL (3.8 mg/kg) and the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (368 mg/kg), and it was not considered a COPC in the HHRA. Naphthalene was infrequently detected at the NPA (2/50, less than 5% detections). The modeling estimates that naphthalene concentrations in groundwater beneath the source areas could potentially exceed its RSL in less than 15 years with peak concentrations occurring in about 24 years or less. Naphthalene is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5). Naphthalene was detected in the AOC groundwater samples collected from 2010-2013 at concentrations below the RSL (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 site-specific attenuation and biodegradation rates.

6.6.2 Evaluation of Remaining Sediment CMCOPCs

6.6.2.1 East Ditch Aggregate

Benz(a)anthracene – There was only one sediment sample (LL11sd-083) for organic SRCs at the East Ditch, and the detected concentration of benz(a)anthracene (0.11 mg/kg) was below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (0.221 mg/kg). Benz(a)anthracene was not identified as a sediment COPC in the HHRA for this area and was not detected above the SL in the AOC groundwater samples collected from 2010–2013 (Table 6-5). Benz(a)anthracene modeling results for sediment in the East Ditch indicate concentrations decreasing below the SL after approximately 10 years and continuing to decrease into the future, and it is not predicted to migrate to the downgradient receptor location at detectable concentrations (see 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 SL based on its estimated site-specific biodegradation rate and accounting for the vertical leaching distance.

Naphthalene – There was only one sediment sample (LL11sd-083) for organic SRCs at the East Ditch, and although there is no sediment-specific Resident Receptor Adult FWCUG for naphthalene, the sediment concentration of naphthalene (i.e., 0.01 mg/kg) was well below the soil Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (368 mg/kg). Naphthalene was not identified as a sediment COPC in the HHRA for this area and was not detected above the RSL in the AOC groundwater samples collected from 2010–2013 (Table 6-5). Naphthalene modeling results for sediment indicate concentrations decreasing below the RSL after approximately five years and continuing to decrease into the future, and it is not predicted to migrate to the downgradient receptor location at detectable concentrations (see 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 conservative, and naphthalene would be expected to be below its SL based on its estimated site-specific biodegradation rate and accounting for the vertical leaching distance.

6.6.2.2 West Ditch Aggregate

Antimony – There were only three sediment samples for antimony at the West Ditch, and the maximum concentration (i.e., 0.9 mg/kg at LL11sd-024) was below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (13.6 mg/kg). Antimony was not identified as a sediment COPC in the HHRA for this area and was not detected above the SL in the AOC groundwater samples collected from 2010–2013 (Table 6-5). Antimony modeling results for sediment in the West Ditch indicate concentrations decreasing below the SL after approximately one year and continuing to decrease into the future, and it is not predicted to migrate to the downgradient receptor location at detectable concentrations (see Table 6-5). It should be noted here that the reason antimony 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 antimony would be expected to be below its SL based on accounting for the vertical leaching distance.

Benz(a)anthracene – There were only two sediment samples for benz(a)anthracene at the West Ditch, and the maximum concentration (i.e., 0.077 mg/kg at LL11sd-096) was below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (0.221 mg/kg). Benz(a)anthracene was not identified as a sediment COPC in the HHRA for this area and was not detected in the AOC groundwater samples collected from 2010–2013 (Table 6-5). Benz(a)anthracene modeling results for sediment in the West Ditch indicate concentrations decreasing below the SL after approximately five years and continuing to decrease into the future, and it is not predicted to migrate to the downgradient receptor location at detectable concentrations (see 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 SL based on its estimated site-specific biodegradation rate and accounting for the vertical leaching distance.

Benzo(b)fluoranthene – There were only two sediment samples for benzo(b)fluoranthene at the West Ditch, and the maximum concentration (i.e., 0.14 mg/kg at LL11sd-096) was below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (0.221 mg/kg). Benzo(b)fluoranthene was not identified as a sediment COPC in the HHRA for this area and was not detected in the AOC groundwater samples collected from 2010–2013 (Table 6-5). Benzo(b)fluoranthene modeling results for sediment in the West Ditch indicate concentrations decreasing below the SL after approximately 50 years and continuing to decrease into the future, and it is not predicted to migrate to the downgradient receptor location at detectable concentrations (see 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 SL based on its estimated site-specific biodegradation rate and accounting for the vertical leaching distance.

Dibenz(a,h)anthracene – There were only two sediment samples for dibenz(a,h)anthracene at the West Ditch, and the maximum concentration (i.e., 0.016 mg/kg at LL11sd-096) was below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (0.022 mg/kg). Dibenz(a,h)anthracene was not identified as a sediment COPC in the HHRA for this area and was not detected in the AOC groundwater samples collected from 2010–2013 (Table 6-5). Dibenz(a,h)anthracene modeling results for sediment in the West Ditch indicate concentrations decreasing below the SL in less than four years and continuing to decrease into the future, and it is not predicted to migrate to the downgradient receptor location at detectable concentrations (see Table 6-5). It should be noted here that the reason dibenz(a,h)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 dibenz(a,h)anthracene would be expected to be below its SL based on its estimated site-specific biodegradation rate and accounting for the vertical leaching distance.

This qualitative assessment concludes that the soil and sediment contaminants identified as final CMCOPCs for evaluation, due to predicted groundwater concentrations beneath a source, 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 11, 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 11. 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 and subsurface soil and sediment at Load Line 11 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:

- Arsenic, barium, cobalt, zinc, PETN, benzo(b)fluoranthene, and naphthalene at the FPA and arsenic, cobalt, manganese, and naphthalene at the NPA among the soil CMCOPCs were predicted to exceed the screening criteria in groundwater beneath the source area; however, none of these CMCOPCs were predicted to be above their respective groundwater criteria at the downgradient receptor location.
- Among the sediment CMCOPCs, benz(a)anthracene and naphthalene at the East Ditch aggregate and antimony, benz(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene

at the West Ditch aggregate were predicted to exceed the screening criteria in groundwater beneath the source area; however, none of these CMCOPCs were predicted to be above 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 11 that may impact the groundwater beneath the source or at the downstream receptor location. This qualitative assessment concluded that there were no CMCOCs present in soil and sediment that may impact the groundwater beneath the source or at the downstream receptor location. No further action is required of soil and sediment at Load Line 11 to be protective of groundwater.

Table 6–1. Initial CMCOPCs Evaluated with SESOIL Modeling

SRCs	Maximum Concentrations (mg/kg)	Discrete Sample Location	Sample Depth (ft bgs)	Leachate Modeling Required? (Yes/No)
Former Production Area				
Inorganic Chemicals				
Arsenic	30.2	LL11ss-022-0001-SO	0–1	Yes
Barium	127	LL11cs-012-0001-SO	1–2	Yes
Cobalt	33.8	LL11sd-025-0001-SD	0–1	Yes
Zinc	465	LL11cs-025-0001-SD	0–1	Yes
Semi-volatile organic compounds				
Benzo(b)fluoranthene	0.56	LL11sb-060-5551-SO	0–1	Yes
Naphthalene	0.017	LL11sb-061-5555-SO	0–1	Yes
Explosives				
PETN	0.049	LL11sb-061-5555-SO	0–1	Yes
Non-Production Area				
Inorganic Chemicals				
Arsenic	44.1	LL11cs-045-0001-SO	7–8	Yes
Cobalt	24.7	LL11cs-036-0001-SO	1–2	Yes
Manganese	1930	LL11cs-036-0001-SO	1–2	Yes
Nickel	33.5	LL11cs-036-0001-SO	1–2	Yes
Semi-volatile organic compounds				
Naphthalene	0.01	LL11sb-063-5563-SO	0–1	Yes
Explosives				
PETN	0.036	LL11sb-067-5581-SO	0–1	Yes

bgs = Below ground surface.
CMCOPC = Contaminant migration contaminant of potential concern.
ft = Feet.
mg/kg = Milligrams per kilogram.
PETN = Pentaerythritol tetranitrate.
SESOIL = Seasonal Soil Compartment Model.
SRC = Site-related contaminant.

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Table 6–2. Sediment Screening Results for Load Line 11

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)
East Ditch Aggregate														
Inorganic Compounds														
Aluminum	7429-90-5	1.39E+04	2.10E+04	LL11cs-031-0001-FD	NA	NA	1.50E+03	d	1.40E+01	15	9.40E-01	2.00E+01	RSL	No
Antimony	7440-36-0	0.00E+00	4.20E-01	LL11sd-017-0001-FD	NA	NA	4.50E+01	d	9.33E-03	15	6.26E-04	6.00E-03	MCL	No
Arsenic	7440-38-2	1.95E+01	2.11E+01	LL11sd-017-0001-SD	NA	NA	2.90E+01	d	7.28E-01	1171	6.21E-04	1.00E-02	MCL	No
Beryllium	7440-41-7	3.80E-01	1.00E+00	LL11sd-083-5594-SD	NA	NA	7.90E+02	d	1.27E-03	15	8.50E-05	4.00E-03	MCL	No
Cadmium	7440-43-9	0.00E+00	4.70E-01	LL11cs-031-0001-SD	NA	NA	7.50E+01	d	6.27E-03	15	4.21E-04	5.00E-03	MCL	No
Chromium	7440-47-3	1.81E+01	2.71E+01	LL11cs-031-0001-FD	NA	NA	1.90E+01	d	1.43E+00	1255	1.14E-03	1.00E-01	MCL	No
Cobalt	7440-48-4	9.10E+00	1.74E+01	LL11sd-083-5594-SD	NA	NA	4.50E+01	d	3.87E-01	2275	1.70E-04	6.00E-03	RSL	No
Copper	7440-50-8	2.76E+01	3.14E+01	LL11sd-083-5594-SD	NA	NA	3.50E+01	d	8.97E-01	641	1.40E-03	1.30E+00	MCL	No
Nickel	7440-02-0	1.77E+01	3.26E+01	LL11sd-083-5594-SD	NA	NA	6.50E+01	d	5.02E-01	551	9.10E-04	3.90E-01	RSL	No
Selenium	7782-49-2	1.70E+00	3.20E+00	LL11sd-083-5594-SD	NA	NA	5.00E+00	d	6.40E-01	2462	2.60E-04	5.00E-02	MCL	No
Semi-volatile Organic Compounds														
2-Methylnaphthalene	91-57-6	None	1.30E-02	LL11sd-083-5594-SD	2.78E+03	d	3.06E+00	e	4.25E-03	15	2.85E-04	3.60E-03	RSL	No
Anthracene	120-12-7	None	2.50E-02	LL11sd-083-5594-SD	1.64E+04	d	1.80E+01	e	1.39E-03	15	9.32E-05	1.80E+00	RSL	No
Benz(*a*)anthracene	**56-55-3**	**None**	**1.10E-01**	**LL11sd-083-5594-SD**	**1.77E+05**	d	**1.95E+02**	e	**5.65E-04**	**15**	**3.79E-05**	**1.20E-05**	**RSL**	**Yes**
Benzo(*a*)pyrene	50-32-8	None	9.80E-02	LL11sd-083-5594-SD	5.87E+05	d	6.46E+02	e	1.52E-04	15	1.02E-05	2.00E-04	MCL	No
Benzo(*b*)fluoranthene	205-99-2	None	1.30E-01	LL11sd-083-5594-SD	5.99E+05	d	6.59E+02	e	1.97E-04	15	1.32E-05	3.40E-05	RSL	No
Benzo(*ghi*)perylene	191-24-2	None	6.40E-02	LL11sd-083-5594-SD	1.07E+07	d	1.18E+04	e	5.44E-06	15	3.65E-07	1.20E-01	RSL	No
Benzo(*k*)fluoranthene	207-08-9	None	5.60E-02	LL11sd-083-5594-SD	5.87E+05	d	6.46E+02	e	8.67E-05	15	5.82E-06	3.40E-04	RSL	No
Chrysene	218-01-9	None	9.60E-02	LL11sd-083-5594-SD	1.81E+05	d	1.99E+02	e	4.84E-04	15	3.25E-05	3.40E-03	RSL	No
Dibenz(*a*,*h*)anthracene	53-70-3	None	1.70E-02	LL11sd-083-5594-SD	1.91E+06	d	2.10E+03	e	8.08E-06	15	5.42E-07	3.40E-06	RSL	No
Fluoranthene	206-44-0	None	2.30E-01	LL11sd-083-5594-SD	5.55E+04	d	6.10E+01	e	3.77E-03	15	2.53E-04	8.00E-01	RSL	No
Fluorene	86-73-7	None	1.20E-02	LL11sd-083-5594-SD	9.16E+03	d	1.01E+01	e	1.19E-03	15	7.99E-05	2.90E-01	RSL	No
Indeno(1,2,3-*cd*)pyrene	193-39-5	None	5.60E-02	LL11sd-083-5594-SD	1.95E+06	d	2.15E+03	e	2.61E-05	15	1.75E-06	3.40E-05	RSL	No
Naphthalene	**91-20-3**	**None**	**1.00E-02**	**LL11sd-083-5594-SD**	**1.54E+03**	**d**	**1.69E+00**	**e**	**5.90E-03**	**15**	**3.96E-04**	**1.70E-04**	**RSL**	**Yes**
Phenanthrene	85-01-8	None	1.00E-01	LL11sd-083-5594-SD	1.82E+04	d	2.00E+01	e	5.00E-03	15	3.35E-04	1.20E-01	RSL	No
Pyrene	129-00-0	None	1.80E-01	LL11sd-083-5594-SD	5.43E+04	d	5.98E+01	e	3.01E-03	15	2.02E-04	1.20E-01	RSL	No
West Ditch Aggregate														
Inorganic Compounds														
Aluminum	7429-90-5	13900.00	21400	LL11cs-015-0001-SD	NA	NA	1.50E+03	d	1.43E+01	2	7.13E+00	2.00E+01	RSL	No
Antimony	**7440-36-0**	**0.00**	**0.9**	**LL11sd-024-0001-SD**	**NA**	**NA**	**4.50E+01**	d	**2.00E-02**	**2**	**1.00E-02**	**6.00E-03**	**MCL**	**Yes**
Beryllium	7440-41-7	0.38	1	LL11sd-024-0001-SD	NA	NA	7.90E+02	d	1.27E-03	7	1.80E-04	4.00E-03	MCL	No
Cadmium	7440-43-9	0	0.51	LL11sd-096-5874-SD	NA	NA	7.50E+01	d	6.80E-03	2	3.40E-03	5.00E-03	MCL	No
Chromium	7440-47-3	18.10	26.2	LL11sd-030-0001-SD	NA	NA	1.90E+01	d	1.38E+00	195	7.07E-03	1.00E-01	MCL	No
Cobalt	7440-48-4	9.10	14.1	LL11sd-024-0001-SD	NA	NA	4.50E+01	d	3.13E-01	83	3.77E-03	6.00E-03	RSL	No
Mercury	7439-97-6	0.059	0.1	LL11sd-096-5874-SD	NA	NA	5.20E+01	d	1.92E-03	2	9.62E-04	2.00E-03	MCL	No
Nickel	7440-02-0	17.70	27.7	LL11sd-030-0001-SD	NA	NA	6.50E+01	d	4.26E-01	62	6.93E-03	3.90E-01	RSL	No
Silver	7440-22-4	0	0.072	LL11sd-096-5874-SD	NA	NA	8.30E+00	d	8.67E-03	2	4.34E-03	9.40E-02	RSL	No
Vanadium	7440-62-2	26.10	35.6	LL11sd-030-0001-SD	NA	NA	1.00E+03	d	3.56E-02	2	1.78E-02	8.60E-02	RSL	No
Sulfide	18496-25-8	None	43.4	LL11sd-024-0001-SD	NA	NA	NA	NA	NA	2	NA	NA	NA	No
Explosives														
Nitrocellulose	9004-70-0	None	1.4	LL11sd-084-5595-SD	1.00E+01	d	1.10E-02	e	1.27E+02	2	6.36E+01	6.00E+04	RSL	No
Semi-volatile Organic Compounds														
Acenaphthene	83-32-9	None	0.013	LL11sd-096-5874-SD	5.03E+03	d	5.53E+00	e	2.35E-03	2	1.18E-03	5.30E-01	RSL	No
Anthracene	120-12-7	None	0.02	LL11sd-096-5874-SD	1.64E+04	d	1.80E+01	e	1.11E-03	2	5.56E-04	1.80E+00	RSL	No
Benz(*a*)anthracene	**56-55-3**	**None**	**0.077**	**LL11sd-096-5874-SD**	**1.77E+05**	**d**	**1.95E+02**	**e**	**6.68E-05**	**2**	**3.34E-05**	**1.20E-05**	**RSL**	**Yes**
Benzenemethanol	100-51-6	None	0.054	LL11sd-096-5874-SD	2.15E+01	d	2.36E-02	e	2.29E+00	2	1.14E+00	2.00E+00	RSL	No

Table 6–2. Sediment Screening Results for Load Line 11 (continued)

Analyte	CAS Number	Background Criteria (mg/kg)[a]	Maximum Sediment Concentration (mg/kg)	Sediment Sample ID	K_{oc} (L/kg)	Reference	K_d (L/kg)	Reference	Maximum Groundwater Concentration (mg/L)[b]	DAF[c]	Maximum Groundwater Concentration (mg/L)/DAF	MCL or RSL (mg/L)	MCL or RSL?	CMCOPC? (Yes/No)
Benzo(*a*)pyrene	50-32-8	None	0.09	LL11sd-096-5874-SD	5.87E+05	d	6.46E+02	e	3.87E-05	2	6.97E-05	2.00E-04	MCL	No
Benzo(*b*)fluoranthene	**205-99-2**	**None**	**0.14**	**LL11sd-096-5874-SD**	**5.99E+05**	d	**6.59E+02**	e	**1.67E-04**	**2**	**1.06E-04**	**3.40E-05**	**RSL**	**Yes**
Benzo(*ghi*)perylene	191-24-2	None	0.068	LL11sd-096-5874-SD	1.07E+07	d	1.18E+04	e	8.33E-06	2	2.89E-06	1.20E-01	RSL	No
Benzo(*k*)fluoranthene	207-08-9	None	0.066	LL11sd-096-5874-SD	5.87E+05	d	6.46E+02	e	2.01E-04	2	5.11E-05	3.40E-04	RSL	No
Chrysene	218-01-9	None	0.099	LL11sd-096-5874-SD	1.81E+05	d	1.99E+02	e	3.22E-04	2	2.49E-04	3.40E-03	RSL	No
Dibenz(a,h)anthracene	**53-70-3**	**None**	**0.016**	**LL11sd-096-5874-SD**	**1.91E+06**	**d**	**2.10E+03**	**e**	**7.61E-06**	**2**	**3.80E-06**	**3.40E-06**	**RSL**	**Yes**
Fluoranthene	206-44-0	None	0.21	LL11sd-096-5874-SD	5.55E+04	d	6.10E+01	e	9.18E-04	2	1.72E-03	8.00E-01	RSL	No
Indeno(1,2,3-*cd*)pyrene	193-39-5	None	0.061	LL11sd-096-5874-SD	1.95E+06	d	2.15E+03	e	4.47E-05	2	1.42E-05	3.40E-05	RSL	No
Semi-volatile Organic Compounds (continued)														
Phenanthrene	85-01-8	None	0.098	LL11sd-096-5874-SD	1.82E+04	d	2.00E+01	e	8.49E-04	2	2.45E-03	1.20E-01	RSL	No
Pyrene	129-00-0	None	0.16	LL11sd-096-5874-SD	5.43E+04	d	5.98E+01	e	3.85E-03	2	1.34E-03	1.20E-01	RSL	No

[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 Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 2001).

[b] Maximum groundwater concentration = maximum sediment concentration divided by the distribution coefficient.

[c] An aggregate-specific DAF was calculated based on the sediment and co-located surface water concentrations. The lowest calculated DAF (15 for aluminum in the East Ditch aggregate, 2 for aluminum in the West Ditch aggregate) was used for analytes that did not have an aggregate-specific DAF.

[d] U.S. Environmental Protection Agency RSL generic tables June 2015; found at: http://www2.epa.gov/risk/risk-based-screening-table-generic-tables.

[e] K_d value for organic chemicals calculated by multiplying K_{oc} by fraction organic carbon (f_{oc}) of 0.0011 (average of the Performance Based Acquisition 2008 Remedial Investigation geotechnical samples LL11SB-085-5567-SO and LL11SB-085-5568-SO).

CAS = Chemical Abstract Service.
CMCOPC = Contaminant migration contaminant of potential concern
DAF = Dilution attenuation factor
K_d = Distribution coefficient.
K_{oc} = Organic carbon distribution coefficient.
L/kg = Liters per kilogram
MCL = Maximum contaminant level.
mg/kg = Milligrams per kilogram.
mg/L = Milligrams per liter.
NA = Not applicable.
RSL = Regional screening level.
Bold = Final CMCOPC to be modeled with Analytical Transient 1-, 2-, 3-Dimensional modeling

Table 6–3. Unit-Specific Parameters Used in SESOIL and AT123D Modeling

Parameters	Symbol	Units	Value	Source for Value
Seasonal Soil Compartment Model (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	4.73E+08 for the FPA 2.03E+09 for the NPA	Calculated from Load Line 11 Aggregate Location Map
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	1.10E-03	Average from the PBA08 RI Geotechnical Samples LL11SB-085-5567-SO and LL11SB-085-5568-SO
Bulk Density	ρ_b	kg/L	1.75	
Moisture Content	w	wt %	19.7	
Water-filled Soil Porosity	Tw	unitless	0.344	
Air-filled Soil Porosity	Ta	unitless	0.014	
Porosity - total	n_T	unitless	0.358	
Vadose Zone Thickness	Vz	m	0.3 to 4.88 for the FPA 0.3 to 2.44 for the NPA	Average based on ground surface elevations and depth to water table from Figure 3-1 and soil boring logs (MKM 2005a and Appendix A)
Leaching Zone Thickness	Th	m	0.0 to 2.13 for the FPA 0.0 to 2.44 for the NPA	Average based on ground surface elevations and depth to water table from Figure 3-1 and soil boring logs (MKM 2005a and Appendix A)
Analytical Transient 1-,2-,3-Dimensional Model (AT123D)				
Aquifer Thickness	h	m	6	Facility-wide assumption for the unconsolidated aquifer presented the Load Line 1 investigation (USACE 2003b)
Hydraulic Conductivity in Saturated Zone	K_S	cm/s	3.49E-05	Average of slug test results from MKM (2005a)
Hydraulic Gradient	i	unitless	0.0131 for the FPA 0.0215 for the NPA	Average gradients determined from Figure 3-1
Effective porosity	n_e	unitless	0.2	Assumed for sandstone (USEPA 1985)
Dispersivity, longitudinal	α_L	m	10	Assumed
Dispersivity, transverse	α_T	m	1	0.1 α_L
Dispersivity, vertical	α_V	m	0.1	0.01 α_L
Retardation factor	R_d	unitless	chemical-specific	Presented in Table E-7, Appendix E

MKM 2005a. *Report for the Remedial Investigation at Load Line 11 (AOC 44).*

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.

cm^2 = Square centimeters.
cm/s = Centimeters per second.
FPA = Former production area.
kg/L = Kilograms per liter.
m = Meter.
m/yr = Meters per year.
NPA = Non-production area.
PBA08 RI = Performance Based Acquisition 2008 Remedial Investigation.
wt % = Weight 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 $C_{leachate, max}$ Beneath Source (mg/L)	Time Required to Reach $C_{leachate, max}$ (years)	MCL/RSL (mg/L)	Resident Receptor Adult FWCUG[a] (mg/L)	Facility-wide Background Unconsolidated Groundwater (mg/L)	Final CMCOPC?[b] (yes/no)
Former Production Area										
Inorganic Chemicals										
Arsenic	**30.2**	**LL11ss-022**	**3**	**3.25**	**1.25E+00**	**181**	**1.00E-02**	**5.60E-05**	**1.17E-02**	**Yes**
Barium	**127**	**LL11cs-012**	**2**	**2.25**	**4.90E+00**	**96**	**2.00E+00**	**7.06E-01**	**8.00E-02**	**Yes**
Cobalt	**33.8**	**LL11sd-025**	**1**	**2**	**9.34E-01**	**226**	**6.00E-03**	**7.29E-02**	**0.00E+00**	**Yes**
Zinc	**465**	**LL11cs-025**	**1**	**1.25**	**2.25E+01**	**202**	**6.00E+00**	**1.09E+00**	**6.09E-02**	**Yes**
Semi-volatile Organic Compounds										
Benzo(b)fluoranthene	**0.56**	**LL11sb-060**	**1**	**1.25**	**8.93E-04**	**1000**	**3.40E-05**	**2.00E-06**	**None**	**Yes**
Naphthalene	**0.017**	**LL11sb-061**	**1**	**1.3**	**1.71E-02**	**7**	**1.70E-04**	**None**	**None**	**Yes**
Explosives										
PETN	**0.049**	**LL11sb-061**	**1**	**2**	**7.01E-02**	**5**	**1.90E-02**	**None**	**None**	**Yes**
Non-Production Area										
Inorganic Chemicals										
Arsenic	**44.1**	**LL11cs-045**	**8**	**8.25**	**1.88E+00**	**73**	**1.00E-02**	**5.60E-05**	**1.17E-02**	**Yes**
Cobalt	**24.7**	**LL11cs-036**	**2**	**2.25**	**8.70E-01**	**105**	**6.00E-03**	**7.29E-02**	**0.00E+00**	**Yes**
Manganese	**1930**	**LL11cs-036**	**2**	**2.25**	**1.63E+01**	**384**	**4.30E-01**	**1.58E-01**	**1.02E+00**	**Yes**
Nickel	**33.5**	**LL11cs-036**	**1**	**2**	**4.97E-01**	**325**	**3.90E-01**	**7.29E-02**	**0.00E+00**	**Yes**
Semi-volatile Organic Compounds										
Naphthalene	**0.01**	**LL11sb-063**	**1**	**3**	**3.74E-03**	**15**	**1.70E-04**	**None**	**None**	**Yes**
Explosives										
PETN	0.036	LL11sb-067	1	9	9.66E-03	22	1.90E-02	None	None	No

[a] The Resident Receptor Adult FWCUG is based on a target risk of 1E-06 and a hazard quotient of 0.1.

[b] The Final CMCOPC was identified comparing predicted maximum leachate concentration to MCL/RSL, Resident Receptor Adult FWCUGs, and facility-wide background concentrations. A constituent is a CMCOPC if its predicted leachate concentration exceeds its MCL/RSL within 1,000 years.

bgs = Below ground surface.
CMCOPC = Contaminant migration chemical of potential concern.
FWCUG = Facility-wide cleanup goal.
ft = Feet.
MCL = Maximum contaminant level.
mg/kg = Milligrams per kilogram.
mg/L = Milligrams per liter.
NA = Not available.
PETN = Pentaerythritol tetranitrate.
RSL = Regional screening level.
SESOIL = Seasonal soil compartment model.
Bold = CMCOPCs exceeding MCL/RSL, Resident Receptor Adult FWCUGs, and facility-wide background concentrations.

Table 6–5. Summary of AT123D Modeling Results

Final CMCOPC	Maximum Leachate Concentration[a] (mg/L)	Predicted Max Groundwater[b] (C_{MAX}) Beneath Source (mg/L)	Predicted Max Groundwater[b] (C_{MAX}) Downgradient Receptor (mg/L)	Distance to Downgradient Receptor (ft)	Observed Maximum Groundwater Concentrations[c] (mg/L)	MCL/RSL (mg/L)	Resident Adult FWCUG[d] (mg/L)	Facility-wide Background Unconsolidated Groundwater (mg/L)	CMCOC for Further WOE Evaluation?[e] (yes/no)
Final CMCOPCs in Soil									
Former Production Area									
Inorganic chemicals									
Arsenic	1.25E+00	7.12E-01	0.00E+00	605	2.20E-02	1.00E-02	5.60E-05	1.17E-02	Yes
Barium	4.90E+00	3.46E+00	0.00E+00	825	8.30E-02	2.00E+00	7.06E-01	8.00E-02	Yes
Cobalt	9.34E-01	7.13E-01	0.00E+00	705	1.60E-03	6.00E-03	7.29E-02	0.00E+00	Yes
Zinc	2.25E+01	1.43E+01	0.00E+00	1140	2.00E-02	6.00E+00	1.09E+00	6.09E-02	Yes
Semi-volatile Organic Compounds									
Benzo(b) fluoranthene	8.93E-04	1.59E-04	0.00E+00	1265	ND	3.40E-05	2.00E-06	None	Yes
Naphthalene	1.71E-02	7.17E-03	0.00E+00	950	1.40E-04	1.70E-04	None	None	Yes
Explosives									
PETN	7.01E-02	3.14E-02	2.67E-08	950	ND	1.90E-02	None	None	Yes
Non-Production Area									
Inorganic chemicals									
Arsenic	1.88E+00	9.12E-01	0.00E+00	558	2.20E-02	1.00E-02	5.60E-05	1.17E-02	Yes
Cobalt	8.70E-01	4.90E-01	0.00E+00	720	1.60E-03	6.00E-03	7.29E-02	0.00E+00	Yes
Manganese	1.63E+01	9.24E+00	0.00E+00	929	9.67E-01	4.30E-01	1.58E-01	1.02E+00	Yes
Nickel	4.97E-01	3.04E-01	0.00E+00	720	3.50E-02	3.90E-01	7.29E-02	0.00E+00	No
Semi-volatile Organic Compounds									
Naphthalene	3.74E-03	1.47E-03	5.27E-10	825	1.40E-04	1.70E-04	None	None	Yes
Final CMCOPCs in Sediment									
East Ditch Aggregate									
Semi-volatile Organic Compounds									
Benz(a)anthracene	3.79E-05	3.78E-05	0.00E+00	650	ND	1.20E-05	4.00E-06	None	Yes
Naphthalene	3.96E-04	3.69E-04	3.10E-12	650	1.40E-04	1.70E-04	None	None	Yes
West Ditch Aggregate									
Inorganic chemicals									
Antimony	1.00E-02	1.00E-02	0.00E+00	700	1.50E-04	6.00E-03	1.30E-03	0.00E+00	Yes
Semi-volatile Organic Compounds									
Benz(a)anthracene	3.34E-05	3.27E-05	0.00E+00	700	ND	1.20E-05	4.00E-06	None	Yes
Benzo(b)fluoranthene	1.06E-04	1.04E-04	0.00E+00	700	ND	3.40E-05	2.00E-06	None	Yes
Dibenz(a,h)anthracene	3.80E-06	3.73E-06	0.00E+00	700	ND	3.40E-06	1.50E-07	None	Yes

[a] Represents seasonal soil compartment model (SESOIL) predicted maximum leachate concentration just above the water table.

[b] The predicted maximum groundwater concentration was estimated using the results from SESOIL and applying AT123D model.

[c] Observed groundwater concentrations were reported in the *RVAAP Facility-wide Groundwater Monitoring Program 2009 Annual Report* (EQM 2010) and sampling events through 2013.

[d] The Resident Receptor Adult FWCUG is based on a target risk of 1E-06 and a hazard quotient of 0.1.

[e] The CMCOC was identified comparing predicted concentration in groundwater to MCL/RSL, Resident Receptor Adult FWCUGs, and facility-wide background concentrations. A constituent is a CMCOC if its predicted concentration in groundwater exceeds all its screening criteria within 1,000 years.

[f] Maximum groundwater concentration = maximum sediment concentration divided by the distribution coefficient.

AT123D = Analytical transient 1-,2-,3-dimensional model.
CMCOC = Contaminant migration chemical of concern.
CMCOPC = Contaminant migration chemical of potential concern.
FWCUG = Facility-wide cleanup goal.
ft = Feet.
MCL = Maximum contaminant level.
mg/L = Milligrams per liter.
ND = Not detected.
PETN = Pentaerythritol tetranitrate.
RSL = Regional screening level.

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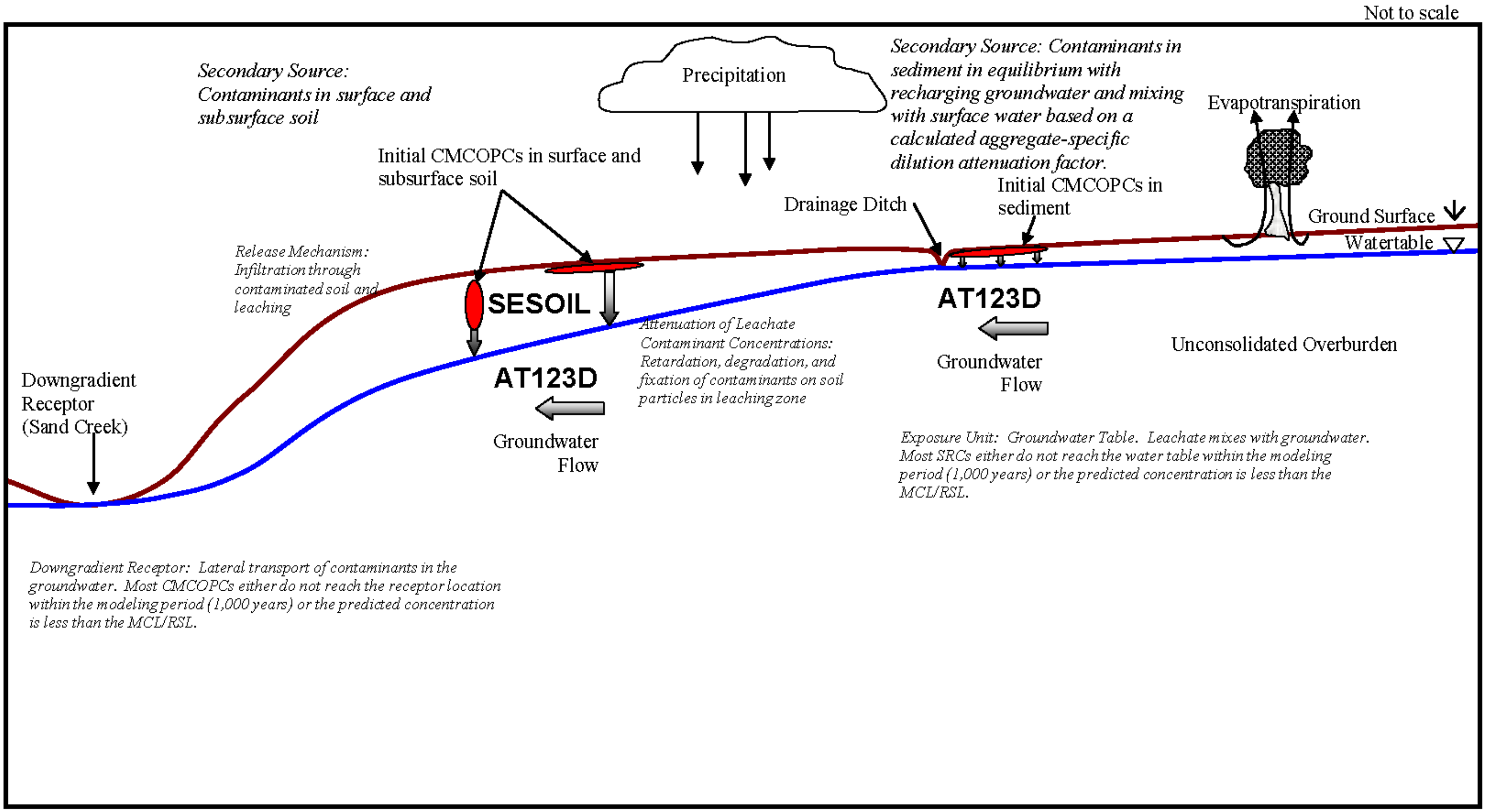


Secondary Source: Contaminants in surface and subsurface soil

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

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.

Downgradient Receptor: Lateral transport of contaminants in the groundwater. 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.

Figure 6–1. Contaminant Migration Conceptual Model

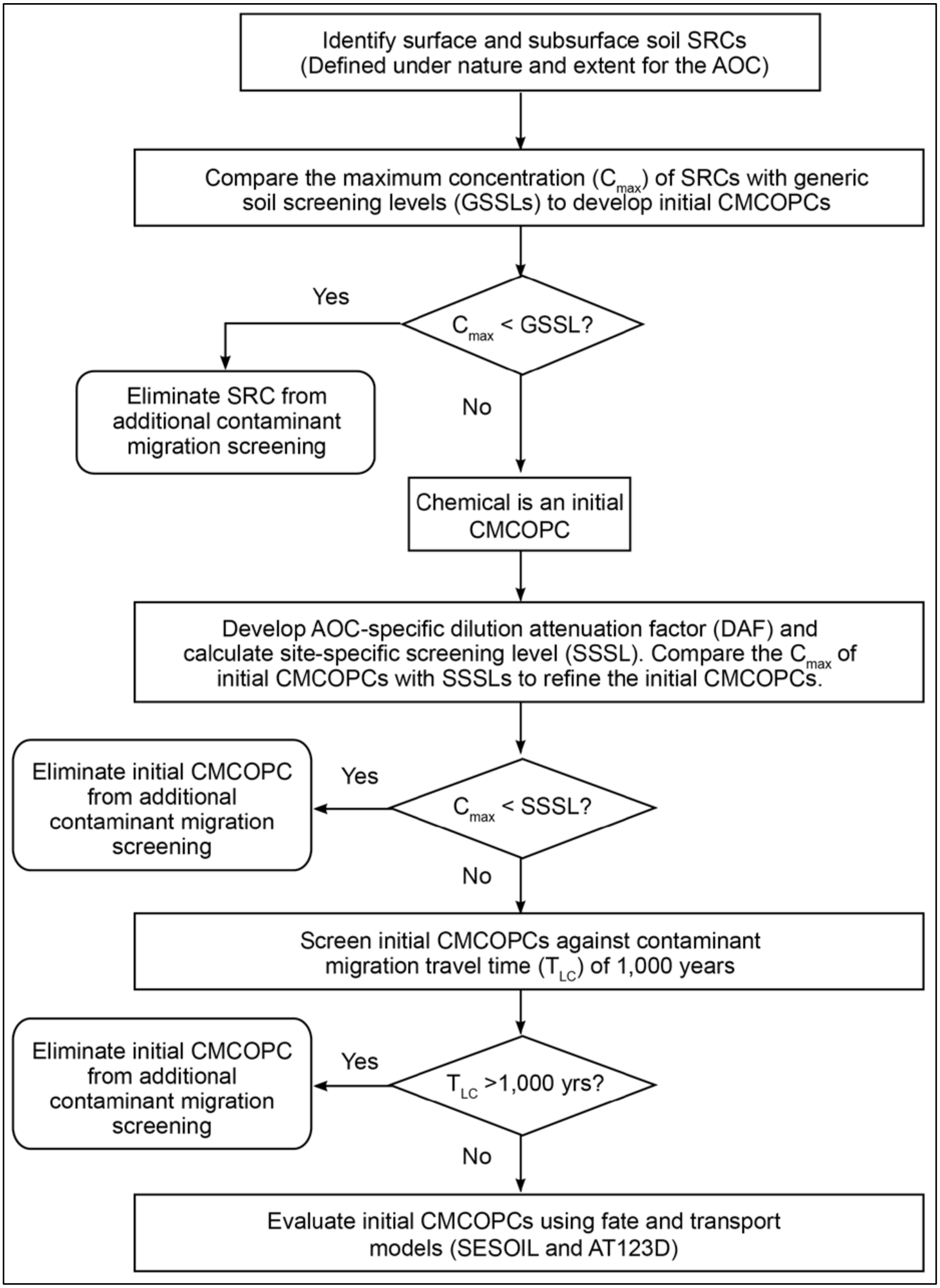


Figure 6–2. Initial CMCOPCs Identified in Soil Screening Analysis for SESOIL Evaluation

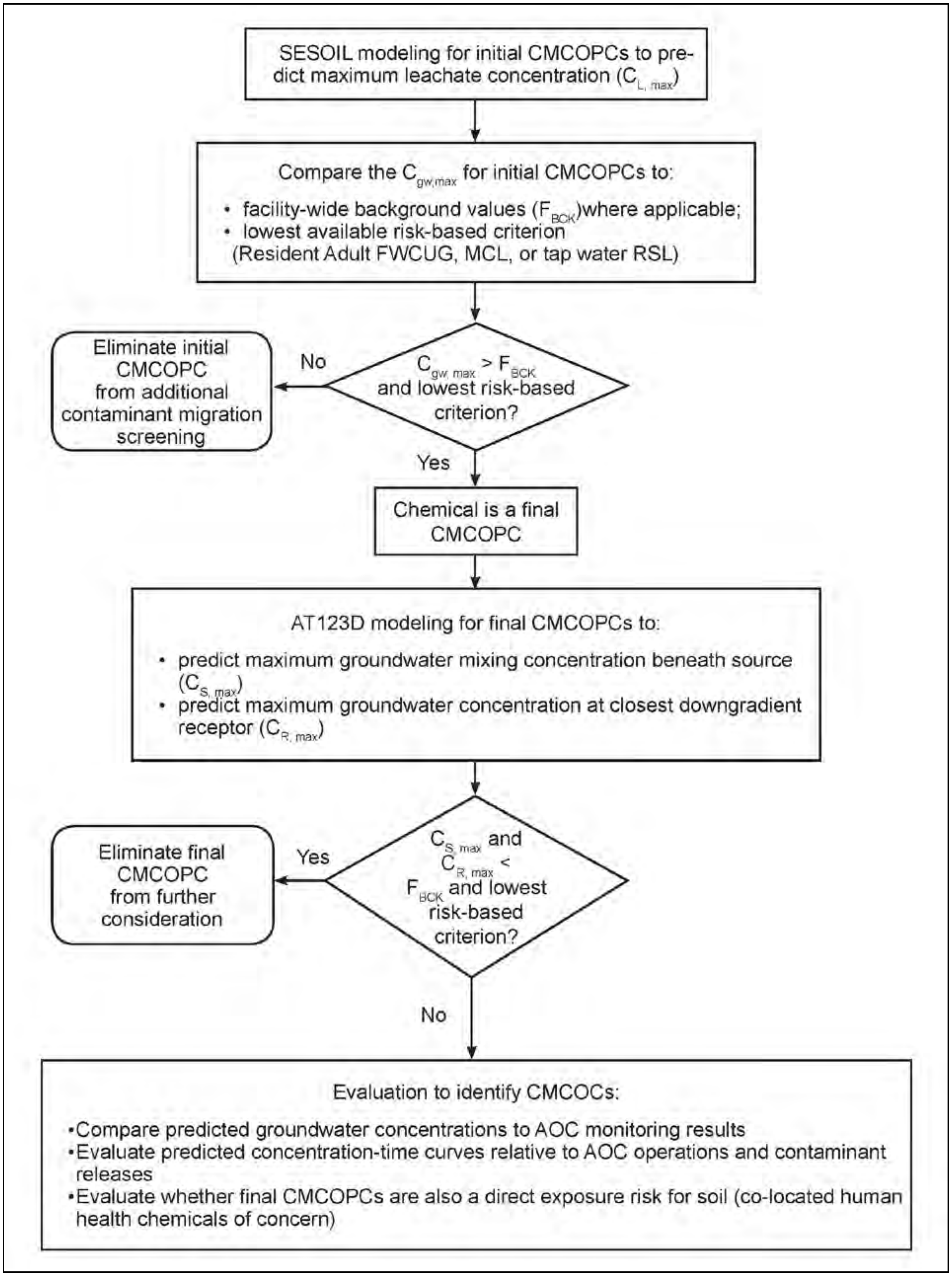


Figure 6–2. Initial CMCOPCs Identified in Soil Screening Analysis for SESOIL Evaluation (continued)

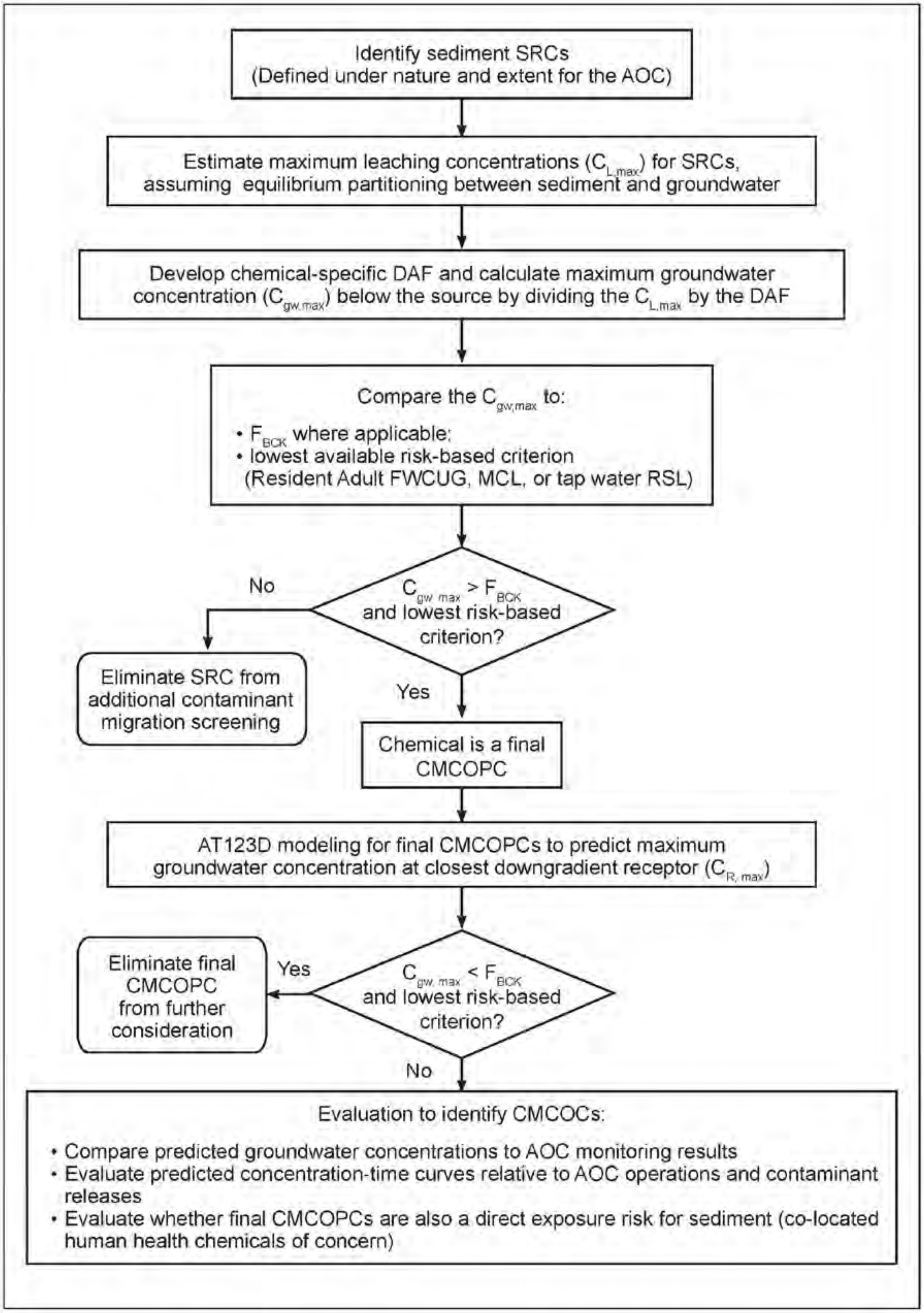
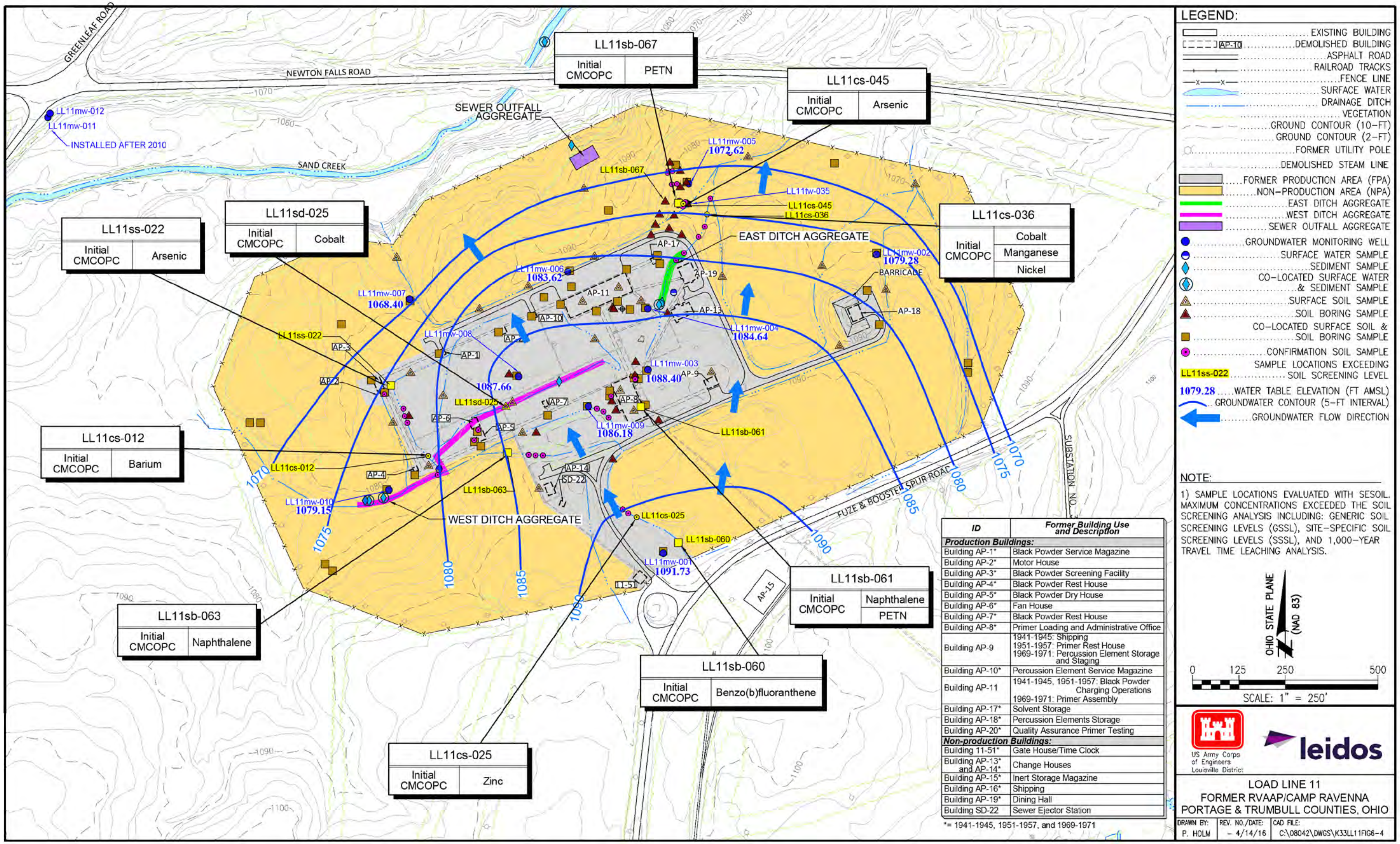


Figure 6–3. AOC Fate and Transport Modeling Approach - Sediment



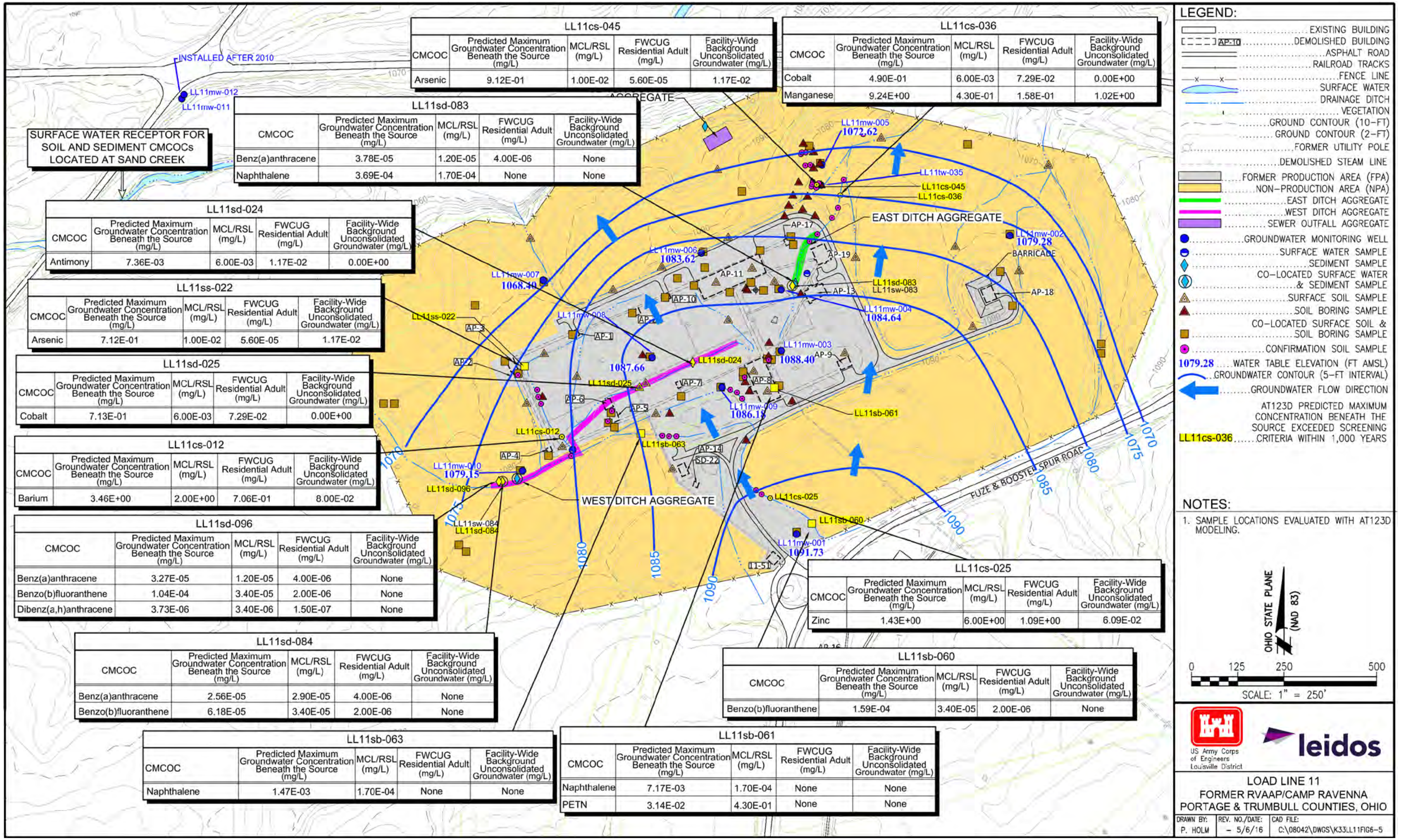
ID	Former Building Use and Description
Production Buildings:	
Building AP-1*	Black Powder Service Magazine
Building AP-2*	Motor House
Building AP-3*	Black Powder Screening Facility
Building AP-4*	Black Powder Rest House
Building AP-5*	Black Powder Dry House
Building AP-6*	Fan House
Building AP-7*	Black Powder Rest House
Building AP-8*	Primer Loading and Administrative Office
Building AP-9	1941-1945: Shipping 1951-1957: Primer Rest House 1969-1971: Percussion Element Storage and Staging
Building AP-10*	Percussion Element Service Magazine
Building AP-11	1941-1945, 1951-1957: Black Powder Charging Operations 1969-1971: Primer Assembly
Building AP-17*	Solvent Storage
Building AP-18*	Percussion Elements Storage
Building AP-20*	Quality Assurance Primer Testing
Non-production Buildings:	
Building 11-51*	Gate House/Time Clock
Building AP-13* and AP-14*	Change Houses
Building AP-15*	Inert Storage Magazine
Building AP-16*	Shipping
Building AP-19*	Dining Hall
Building SD-22	Sewer Ejector Station

*= 1941-1945, 1951-1957, and 1969-1971

NOTE:

1) SAMPLE LOCATIONS EVALUATED WITH SESOIL. MAXIMUM CONCENTRATIONS EXCEEDED THE SOIL SCREENING ANALYSIS INCLUDING: GENERIC SOIL SCREENING LEVELS (GSSL), SITE-SPECIFIC SOIL SCREENING LEVELS (SSSL), AND 1,000-YEAR TRAVEL TIME LEACHING ANALYSIS.

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



NOTES:

1. SAMPLE LOCATIONS EVALUATED WITH AT123D MODELING.

LOAD LINE 11
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
P. HOLM	- 5/6/16	C:\08042\DWGS\K33LL11FIG6-5

LL11cs-045

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Residential Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Arsenic	9.12E-01	1.00E-02	5.60E-05	1.17E-02

LL11cs-036

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Residential Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Cobalt	4.90E-01	6.00E-03	7.29E-02	0.00E+00
Manganese	9.24E+00	4.30E-01	1.58E-01	1.02E+00

LL11sd-083

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Residential Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Benz(a)anthracene	3.78E-05	1.20E-05	4.00E-06	None
Naphthalene	3.69E-04	1.70E-04	None	None

LL11sd-024

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Residential Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Antimony	7.36E-03	6.00E-03	1.17E-02	0.00E+00

LL11ss-022

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Residential Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Arsenic	7.12E-01	1.00E-02	5.60E-05	1.17E-02

LL11sd-025

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Residential Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Cobalt	7.13E-01	6.00E-03	7.29E-02	0.00E+00

LL11cs-012

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Residential Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Barium	3.46E+00	2.00E+00	7.06E-01	8.00E-02

LL11sd-096

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Residential Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Benz(a)anthracene	3.27E-05	1.20E-05	4.00E-06	None
Benzo(b)fluoranthene	1.04E-04	3.40E-05	2.00E-06	None
Dibenz(a,h)anthracene	3.73E-06	3.40E-06	1.50E-07	None

LL11cs-025

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Residential Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Zinc	1.43E+00	6.00E+00	1.09E+00	6.09E-02

LL11sd-084

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Residential Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Benz(a)anthracene	2.56E-05	2.90E-05	4.00E-06	None
Benzo(b)fluoranthene	6.18E-05	3.40E-05	2.00E-06	None

LL11sb-060

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Residential Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Benzo(b)fluoranthene	1.59E-04	3.40E-05	2.00E-06	None

LL11sb-063

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Residential Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Naphthalene	1.47E-03	1.70E-04	None	None

LL11sb-061

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Residential Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Naphthalene	7.17E-03	1.70E-04	None	None
PETN	3.14E-02	4.30E-01	None	None

Figure 6–5. CMCOCs Identified for further WOE 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 and representative of current conditions for use in the HHRA and ERA. As indicated in Section 4.2, an IRA was performed as an early response to contamination in primary pathways at Load Line 11. This IRA was conducted in unison with the Phase I RI. This IRA included removing sumps, 230 yd^3 of contaminated media in drainage ditches, and a hot spot of petroleum-contaminated soil (MKM 2004a). The older sample locations removed during these source removal activities are not included in the data set; however, the numerous confirmation samples collected after source removals are included in these risk assessments.

Load Line 11 data were evaluated to establish data aggregates and to identify a list of SRCs.

7.1.1 Data Aggregates

This section describes the data aggregates for the media for which human and ecological receptors are potentially exposed, followed by a summary of SRCs in Section 7.1.2. Section 4.0 includes a summary of available data. Data collected at Load Line 11 were aggregated by environmental medium, exposure depth (e.g., surface soil), and EU. Samples included in the risk assessment data sets for soil are listed in Tables 7-1 and 7-2. Samples included in the risk assessment data sets for sediment and surface water are listed in Tables 7-3 and 7-4.

7.1.1.1 <u>Soil Data</u>

EUs were established at Load Line 11 as part of the data aggregation prior to the risk assessment evaluations conducted for this Phase II RI Report. 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 11, 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, discrete surface soil (0–1 ft bgs) samples collected in August 2000 through March 2001 as part of the IRA (MKM 2004a) and Phase I RI (MKM 2005a) and March through April 2010 for the PBA08 RI were used to characterize surface soil. The buildings at Load Line 11 were demolished and removed in 2004 and 2005 after the fieldwork associated with the Phase I RI Report (MKM 2005a) was completed. Soil in the vicinity of former production buildings was extensively disturbed during building demolition activities. It is likely that some of the areas sampled in 2000 and 2001 as part of the Phase I RI Report (MKM 2005a) were disturbed during demolition activities.

- 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 2000, 2001, and 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 Surface Water and Sediment Data

No perennial surface water features are present within the AOC or in the immediate vicinity. Intermittent surface water flows in small drainage ditches bordering roads and within the FPA (Figure 3-1). These ditches contain water for short periods of time only during precipitation events or periods of snow melt. On-site surface water and sediment samples were collected at Load Line 11 from the East Ditch that flows north and the West Ditch that flows west/northwest and eventually to Sand Creek. Each of these locations represents separate, isolated drainage and were evaluated as a separate EU.

In addition to these ditches, a sediment sample was collected from sewer outfall location LL11sd-021, and sediment, and surface water samples were collected at off-AOC location LL11sd/sw-082. Risk assessments for these locations were not conducted for this report; rather, these locations were only included as part of the nature and extent evaluation for this Phase II RI. The sewer outfall location (LL11sd-021) will be evaluated as part of the RVAAP-67 Facility-wide Sewers AOC.

Discrete surface water and sediment samples collected in February 2010 per the PBA08 SAP were used to characterize risks from exposure to chemicals in these EUs. Five older surface water and two older sediment samples collected in 2000 (MKM 2005a) were not used in the risk assessment because more recent (2010) data were collected from these sample locations and are more representative of current AOC conditions. Older data not included in the risk assessment were used in characterizing nature and extent of contamination (Section 5.0) to evaluate trends over time.

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 reflects the small size of these EUs.

7.1.2 Identification of SRCs

Section 4.5 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 11 include TNT, RDX, HMX, nitroglycerine, nitrocellulose, nitroguanidine, and heavy metals (lead, chromium, mercury, and arsenic) from munitions assembly activities; VOCs and petroleum from former Building AP-17 that was utilized for solvent storage and at former Building AP-11 where lacquer sealing materials were used on finished primers; and PCBs from on-site transformers. 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. Inorganic constituents detected above facility-wide background concentrations or having no background concentrations were retained as SRCs. All detected organic chemicals were retained as SRCs.
- **Screening of essential human nutrients**: Chemicals considered essential nutrients (e.g., calcium, chloride, iodine, iron, magnesium, potassium, phosphorous, and sodium) are an integral part of the human food supply and are often added to foods as supplements. USEPA recommends these chemicals not be evaluated provided they are: (1) present at low concentrations (i.e., only slightly elevated above naturally occurring levels) and (2) toxic at only very high doses (i.e., much higher than those that could be associated with contact at the AOC) (USEPA 1989). Essential nutrients detected near or below their RDA/RDI-based SLs were eliminated as SRCs.
- **Frequency of detection screening:** In accordance with the FWCUG Report and as revised in the *Final (Revised) United States Army Corps of Engineers RVAAP Position Paper for the Application and Use of Facility-Wide Human Health Cleanup Goals* (USACE 2012b) (hereafter referred to as the Position Paper for Human Health CUGs), analytes detected in less than 5% of the samples are screened out from further consideration with the exception of explosives and propellants).

Details of the SRC screening for each exposure medium are provided in Tables G-1 through G-4 of Appendix G. The SRCs identified for Load Line 11 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 11. This HHRA was conducted as part of the PBA08 RI and is based on the methods from the following guidance documents:

- FWHHRAM (USACE 2005b),
- 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 2005b) and follows standard USEPA-approved risk assessment guidance. This includes the process to identify RVAAP COPCs (presented in Figure 4-6), a TR of 1E-06 and HQ of 0.1 to identify COPCs, and a TR of 1E-05 and HQ of 1 to identify COCs.

Other approaches, such as calculating the sum-of-ratios (SOR), were developed in the FWCUG Report (USACE 2010a) and Position Paper for Human Health CUGs (USACE 2012b). The Technical Memorandum (ARNG 2014) amends the risk assessment process to establish future Land Uses and applicable receptors to be evaluated in an RI.

The approach to risk-based decision making is as follows:

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 was 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 11 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 11 to identify SRCs are presented in Section 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 11 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 risk assessment) in a separate document, as explained in Section 1.2.

7.2.2 Identify COPCs

Section 4.5 presents the statistical methods and screening criteria used to identify SRCs. COPCs are a subset of the SRCs in each exposure medium present at concentrations that indicate the potential for impacts to human receptors. The COPC screen follows the approach specified in the FWCUG Report and is summarized in this section.

To identify COPCs, the MDC of all SRCs was screened against the most stringent chemical-specific FWCUG of all RVAAP receptors at a target cancer risk level of 1E-06 and non-carcinogenic target HQ of 0.1 for the Resident Receptor (Adult and Child) and National Guard Trainee. If no FWCUGs existed for an SRC, the USEPA residential RSL (from RSL table dated June 2015) was used for this screen. No reference dose (RfD) or cancer potency factors are available for acenaphthylene, benzo(ghi)perylene, and phenanthrene; therefore, the RSL for pyrene was used for these PAHs (NDEP 2006).

Hexavalent chromium was detected in two of three surface soil samples collected at Load Line 11 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 11 are presented in Table 7-6 and are summarized below.

7.2.2.1 COPCs in Surface Soil

Former Production Area. Of the 48 chemicals detected in surface soil (0-1 ft bgs) samples at the FPA, 39 (17 inorganic chemicals, 16 SVOCs, 1 VOC, 1 PCB, and 4 explosives) were identified as SRCs. Risk-based screening identified seven inorganic chemicals (aluminum, arsenic, chromium, cobalt, cyanide, manganese, and sulfide), one PCB (PCB-1254), 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 (0-1 ft bgs).

Non-Production Area. Of the 45 chemicals detected in surface soil (0-1 ft bgs) samples at the NPA, 35 (16 inorganic chemicals, 3 explosives, 1 PCB, and 15 SVOCs) were identified as SRCs. Risk-based screening identified six inorganic chemicals (arsenic, chromium, cobalt, cyanide, manganese, and sulfide) and four SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] as COPCs in surface soil (0-1 ft bgs).

7.2.2.2 COPCs in Subsurface Soil

Former Production Area. Of the 36 chemicals detected in subsurface soil (1-13 ft bgs) samples at the FPA, 14 (12 inorganic chemicals, 1 explosive, and 1 PCB) were identified as SRCs. Risk-based screening identified four inorganic chemicals (arsenic, cobalt, sulfate, and sulfide), and one PCB (PCB-1254) as COPCs in subsurface soil.

Non-Production Area. Of the 41 chemicals detected in subsurface soil (1-13 ft bgs) samples at the NPA, 25 (16 inorganic chemicals, 2 miscellaneous organic chemicals (TPH-DRO and TPH-GRO), 1 explosive, and 6 SVOCs) were identified as SRCs. Risk-based screening identified eight inorganic chemicals (aluminum, arsenic, barium, cobalt, cyanide, sulfate, sulfide, and thallium), two miscellaneous organic chemicals (TPH-GRO and TPH-DRO), and one PAH [benzo(a)pyrene] as COPCs in subsurface soil at the NPA.

7.2.2.3 COPCs in Sediment

East Ditch. Of the 36 chemicals detected in sediment samples collected at the East Ditch, 25 (10 inorganic chemicals and 15 SVOCs) were identified as SRCs. Risk-based screening identified five COPCs in sediment: four inorganic chemicals (aluminum, arsenic, chromium, and cobalt) and one SVOC [benzo(a)pyrene].

West Ditch. Of the 32 chemicals detected in sediment samples collected at the West Ditch, 18 (8 inorganic chemicals and 10 SVOCs) were identified as SRCs. Risk-based screening identified four inorganic chemicals (aluminum, chromium, cobalt, and sulfide) as COPCs in sediment.

7.2.2.4 COPCs in Surface Water

East Ditch. Of the 18 chemicals detected in surface water samples collected at the East Ditch, 8 (6 inorganic chemicals and 2 pesticides) were identified as SRCs. Risk-based screening identified one inorganic chemical (cobalt) as a COPC in East Ditch surface water.

West Ditch. Of the 30 chemicals detected in surface water samples collected at the West Ditch, 23 (12 inorganic chemicals, 1 pesticide, and 10 SVOCs) were identified as SRCs. Risk-based screening identified two inorganic chemicals (arsenic and cobalt) and four SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene] as COPCs in West Ditch surface water.

7.2.3 Land Use and Representative Receptors

Camp Ravenna is a controlled-access facility. Load Line 11 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, if an AOC fails to meet the Unrestricted (Residential) Land Use, then an FS will be completed that evaluates cleanup options for all three Land Uses [i.e., Unrestricted (Residential) Land Use, Military Training Land Use, and Commercial/Industrial Land Use]. Remedial alternatives for meeting each Land Use are to be evaluated per the current guidelines for selecting a remedy for the AOC. The preferred remedy is one that would meet Unrestricted (Residential) Land Use. RI/FS Reports in progress at the time of the Technical Memorandum's approval on February 11, 2014 will not be revised to include an evaluation of the Commercial/Industrial Land Use as an alternative if it achieves no further action for Unrestricted (Residential) Land Use.

7.2.4 Compare to Appropriate FWCUGs

Previous sections have outlined the process for identifying SRCs and COPCs. Comparing COPC exposure concentrations to FWCUGs and determining COCs follows guidance presented in the Position Paper for Human Health CUGs (USACE 2012b) and Technical Memorandum (ARNG 2014).

The COC determination process is as follows:

- Report all carcinogenic- and non-carcinogenic based FWCUGs corresponding to a TR of 1E-05 and target HQ of 1 using the most stringent of the Resident Receptor (Adult and Child) FWCUGs to evaluate Unrestricted (Residential) Land Use for each COPC. If no FWCUG is available for a COPC, the Residential RSL, adjusted to represent a TR of 1E-05 or target HQ of 1, is used.
- Report critical effect and target organ for each non-carcinogenic based FWCUG.
- Compare the selected FWCUG to the EPC, including an SOR.

    - For non-carcinogens, compare the EPC to the target HQ FWCUG. Sum the ratios of EPC/FWCUG for COPCs that affect similar target organs or do not have an identified target organ.
    - For carcinogens, compare the EPC to the TR FWCUG. Sum the ratios of EPC/FWCUG for all carcinogens.
- Identify the COPC as a COC if:
    - The EPC exceeds the most stringent of the Resident Receptor (Adult and Child) FWCUGs for either the 1E-05 target cancer risk or the 1 target HQ; or
    - The SOR for all carcinogens or non-carcinogens that may affect the same organ is greater than one. Chemicals contributing at least 10% to the SOR are also considered COCs. In accordance with the Position Paper for Human Health CUGs (USACE 2012b), chemicals contributing greater than 5% but less than 10% to the SOR must be further evaluated before being eliminated as COCs.

The process for calculating FWCUGs rearranges cancer risk or non-cancer hazard equations in order to obtain a concentration that will produce a specific risk or hazard level (USEPA 1991, USACE 2010a). For example, the FWCUG for arsenic at the cancer risk level of 1E-05 for the Resident Receptor Adult is the concentration of arsenic that produces a risk of 1E-05 when using the exposure parameters specific to the Resident Receptor Adult.

For carcinogens, risk is expressed as the probability that an individual will develop cancer over a lifetime as a result of exposure to the carcinogen. Cancer risk from exposure to contamination is expressed as the increased chance of cancer above the normal background rate. In the United States, the background chance of contracting cancer is a little more than 3 in 10 for women and a little less than 5 in 10 for men, or 3E-01 to 5E-01 (American Cancer Society 2015). The calculated incremental lifetime cancer risks (ILCRs) are compared to the range specified in the NCP of 10^{-6} to 10^{-4}, or 1 in a million to 1 in 10,000 exposed persons developing cancer (USEPA 1990). Cancer risks below 10^{-6} are considered acceptable; cancer risks above 10^{-4} are considered unacceptable. The range between 10^{-6} and 10^{-4} is of concern, and any decisions to address risks further in this range, either through additional study or engineered control measures, should account for the uncertainty in the risk estimates. The Ohio EPA Division of Environmental Response and Revitalization (DERR) program has adopted a human health cumulative ILCR goal within this range of 1E-05 to be used as the level of acceptable excess cancer risk and for developing remediation goals for the site. The DERR notes that the defined risk goal should be applied as a goal, recognizing the need to retain flexibility during the evaluation and selection of remedial alternatives.

In addition to developing cancer from exposure to chemicals, an individual may experience other adverse effects. The term “adverse effects” is used here to describe a wide variety of systemic effects ranging from minor irritations, such as eye irritation and headaches, to more substantial effects, such as kidney or liver disease and neurological damage. The risk associated with toxic (i.e., non-carcinogenic) chemicals is evaluated by comparing an estimated exposure (i.e., intake or dose) from AOC media to an acceptable exposure expressed as an RfD. The RfD is the threshold level below which no adverse effects are expected to occur in a population, including sensitive subpopulations. The ratio of intake over the RfD is the HQ (USEPA 1989).

The SOR is used to account for the potential additive effects from exposure to multiple chemicals that can cause the same effect (e.g., cancer) or affect the same target organ. Cancer risk is assumed to be additive for all carcinogens. Non-cancer risk is assumed to be additive for chemicals with similar sites of toxicological action (i.e., target organ such as liver or critical effect such as adversely affecting the ability to reproduce). This approach compares the EPC of each COPC to the FWCUG to determine a ratio. The sum of these individual ratios is then compared to one. The SOR method is based on the principle that a ratio greater than one represents unacceptable cumulative exposure (i.e., above FWCUGs if adjusted for exposure to multiple COPCs), and a ratio less than or equal to one represents acceptable cumulative exposure (i.e., below FWCUGs if adjusted for exposure to multiple COPCs). The FWCUGs for some chemical/receptor combinations are less than the background concentration. In these instances the chemical concentrations are compared to background concentrations to identify COCs. Since the background concentration is not risk-based, these chemicals are not included in the SOR calculations. COCs identified by comparing EPCs to FWCUGs are further evaluated in an uncertainty analysis to identify COCs requiring evaluation in the FS.

The selection of FWCUGs, calculation of EPCs for comparison to the FWCUGs, and the resulting risk-based COCs are detailed in the following sections.

7.2.4.1 Selection of Appropriate FWCUGs

As specified in the Technical Memorandum (ARNG 2014), EPCs for each AOC should initially be evaluated using the most stringent of the Resident Receptor (Adult and 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 are provided in Tables 7-7 and 7-8 and 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 these tables.

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 and 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 chromium 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. The implementation of the chromium speciation process per the PBA08 SAP is discussed below.

- **Hexavalent chromium and total chromium sample collection and results** – To determine whether the FWCUGs for trivalent or hexavalent chromium are most applicable to Load Line 11 and to support risk management decisions, three discrete surface soil samples were collected and analyzed for hexavalent chromium and total chromium. Three samples were collected in April 2010 per the PBA08 SAP. Samples were collected from the three sampling areas having the highest, mid-point, and lowest total historical chromium results. No hexavalent chromium was detected in one of the three samples. Hexavalent chromium was detected in two speciation samples at concentrations of 0.44 and 0.71 mg/kg. Total chromium and hexavalent chromium results for these three 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 three chromium speciation samples at Load Line 11 contained no detectable hexavalent chromium in one sample and 4.4% and 4.6% in the remaining two samples, with the highest percent hexavalent chromium associated with the sample having the second highest concentration of total chromium (LL11ss-075). The total chromium concentration (15.4 mg/kg) in sample LL11ss-075 is 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. The Load Line 11 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.
- **Comparison of 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 2010a). 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 (0.44 and 0.71 mg/kg) are less than 3 mg/kg, indicating hexavalent chromium is not present above the residential RSL for hexavalent chromium.
- **Comparison of 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 hexavalent chromium is less than 14% in of the chromium speciation samples. Therefore, hexavalent chromium is not of concern at Load Line 11, 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

Soil EPCs

EPCs were calculated for each depth interval and EU using analytical results from the discrete samples presented in Tables 7-1 and 7-2. Per the FWHHRAM, the EPC is either the 95% upper confidence limit (UCL) of the mean or the MDC, whichever value is lowest. If the 95% UCL could not be determined, the EPC is the MDC.

Sediment and Surface Water EPCs

Two discrete sediment samples and one discrete surface water sample collected from the East Ditch and three discrete sediment samples and one discrete surface water sample collected from the West Ditch were used to characterize risks from exposure to sediment and surface water. Because of the small number of samples, each ditch was evaluated individually, and the EPC was equal to the detected concentration in each sample.

Identification of COCs for Unrestricted (Residential) Land Use

Load Line 11 COCs for Unrestricted (Residential) Land Use, as represented by the Resident Receptor (Adult and Child), are presented below.

COCs for Surface Soil (0-1 ft bgs)

COC screening for surface soil (0-1 ft bgs) for the Resident Receptor (Adult and Child) is detailed in Appendix G, Tables G-5 through G-7. Sulfide and five PAHs 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 aluminum, chromium, cobalt, cyanide, manganese, benz(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and PCB-1254 EPCs are lower than the Resident Receptor (Adult and Child) FWCUG.

COPCs with no FWCUG: Sulfide was detected in surface soil at the FPA and NPA. No FWCUGs or RSLs are available for this anion. The potential impact of the lack of screening values for this anion is discussed in the uncertainty assessment (Section 7.2.5).

COPCs with EPCs exceeding the Resident Receptor (Adult and Child) FWCUG: EPCs of arsenic at the FPA and NPA and benzo(a)pyrene at the NPA exceed the FWCUG.

- The EPCs for arsenic in surface soil (0–1 ft bgs) at the FPA (14.5 mg/kg) and NPA (14.1 mg/kg) exceed the FWCUG of 4.25 mg/kg but are below the surface soil facility-wide background concentration of 15.4 mg/kg. Because the FWCUG is less than the background concentration, the background concentration is used as the cleanup goal for this inorganic chemical. Thus, arsenic is representative of background and is not a COC in surface soil.

- The EPC for benzo(a)pyrene in surface soil at the NPA (0.28 mg/kg) is approximately 1.3 times its FWCUG of 0.221 mg/kg. The EPC for this data aggregate is the MDC (at sample LL11sb-067); benzo(a)pyrene concentrations in the remaining NPA samples ranged from a non-detectable concentration to 0.11 mg/kg. Sample LL11sb-067 was collected in 2010 from the northeastern portion of Load Line 11.

__**SOR Analysis:**__ Four additional PAHs were identified as COCs based on the SOR analysis summarized below:

- Five COPCs (aluminum, arsenic, chromium, cobalt, cyanide, manganese, and PCB-1254) identified in surface soil have FWCUGs for non-cancer endpoints. The EPCs for aluminum, arsenic, chromium, cobalt, and manganese were below the facility-wide background concentrations; therefore, these inorganic chemicals were not included in the SOR. The total SORs (Table G-6), regardless of endpoint, were less than or equal to one; therefore, no additional COCs were identified using this analysis.
- Eight COPCs [arsenic, cobalt, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and PCB-1254] 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 each EU (Table G-7). The EPCs for arsenic and cobalt were below the facility-wide background concentrations; therefore, arsenic and cobalt were not included in the SORs. The SORs for the FPA and NPA are both two, due primarily to benzo(a)pyrene. The EPC for benzo(a)pyrene in the FPA (0.219 mg/kg) was slightly less than the FWCUG (0.221 mg/kg). The benzo(a)pyrene EPC for the NPA (0.28 mg/kg) was slightly above the FWCUG. COPCs contributing at least 5% to these SORs are benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene (Table G-7) in the FPA and NPA and indeno(1,2,3-cd)pyrene in the FPA.

COCs for Subsurface Soil (1-13 ft bgs)

COC screening for subsurface soil (1-13 ft bgs) for the Resident Receptor (Adult and Child) is detailed in Appendix G, Tables G-8 through G-10. No COCs were identified 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, barium, cobalt, cyanide, thallium, PCB-1254, and benzo(a)pyrene EPCs are lower than the Resident Receptor (Adult and Child) FWCUG.

COPCs with no FWCUG: Sulfate, sulfide, TPH-DRO, and TPH-GRO were detected in subsurface soil at the FPA and/or NPA. No FWCUGs or RSLs are available for these constituents. The potential impact of the lack of screening values is discussed in the uncertainty assessment (Section 7.2.5).

COPCs with EPCs exceeding the Resident Receptor (Adult and Child) FWCUG: EPCs of arsenic at the FPA and NPA exceed the FWCUG. The EPCs for arsenic in subsurface soil (1-13 ft bgs) at the FPA (14.3 mg/kg) and NPA (16.3 mg/kg) exceed the FWCUG of 4.25 mg/kg but are below the surface soil facility-wide background concentration of 19.8 mg/kg. Because the FWCUG is less than the background concentration, the background concentration was used as the cleanup goal for this inorganic chemical. Thus, arsenic is representative of background and is not a COC in subsurface soil.

SOR Analysis: No additional COCs were identified based on the SOR analysis summarized below:

- Three COPCs (arsenic, cobalt, and PCB-1254) identified in subsurface soil at the FPA have FWCUGs for non-cancer endpoints. The EPCs for arsenic and cobalt are less than the facility-wide background concentrations for subsurface soil; therefore, no SOR was calculated for the FPA. Six COPCs [aluminum, arsenic, barium, cobalt, cyanide, and thallium] identified in the NPA subsurface soil have FWCUGs for non-cancer endpoints. The EPCs for aluminum, arsenic, cobalt, and thallium are less than the facility-wide background concentrations for subsurface soil. These inorganic chemicals were not included in the SOR. The total SOR (Table G-9), regardless of endpoint, was less than one; therefore, no additional COCs were identified using this analysis.
- Four COPCs [arsenic, cobalt, PCB-1254, and benzo(a)pyrene] identified in subsurface soil have FWCUGs for the cancer endpoint. The EPCs for arsenic and cobalt are less than the facility-wide background concentrations for subsurface soil; therefore, these metals were not included in the SOR. SORs were calculated for the remaining COPCs (Table G-10). The calculated SORs are less than one.

COCs for Sediment

COC screening for sediment for the Resident (Adult and Child) Receptor is detailed in Appendix G, Tables G-11 though G-13. No COCs were identified for the Resident Receptor (Adult and Child), as explained below:

- The detected concentration of arsenic (19.7 mg/kg) in one of two sediment samples from the East Ditch exceeded the FWCUG for the Resident Receptor (Adult and Child) of 4.25 mg/kg. The concentration in this sample is just above the sediment background screening concentration of 19.5 mg/kg. All of the other sediment samples from the East Ditch and West Ditch were below background concentrations. Because the reported concentration in one sediment sample is essentially the same as the background concentration and all other samples are less than background concentrations, arsenic was not identified as a COC in sediment.
- Sulfide was detected in sediment at the West Ditch; however, no FWCUGs or RSLs are available for this anion. The potential impact of the lack of screening value is discussed in the uncertainty assessment (Section 7.2.5).
- The detected concentrations of all other COPCs were less than their respective FWCUGs.

SOR Analysis: No COCs were identified based on the SOR analysis summarized below:

- Four COPCs (aluminum, arsenic, chromium, and cobalt) identified in sediment have FWCUGs for non-cancer endpoints. Detected concentrations of aluminum, chromium, and cobalt less than the facility-wide background concentrations for sediment were not included in the SOR for that sample location. Total SORs (Table G-12), regardless of endpoint, were less than or equal to one; therefore, no additional COCs were identified using this analysis.
- Three COPCs [arsenic, cobalt, and benzo(a)pyrene] identified in sediment have FWCUGs for the cancer endpoint. SORs (Table G-13) were less than or equal to one; therefore, no additional COCs were identified using this analysis.

COCs for Surface Water

COC screening for sediment for the Resident (Adult and Child) Receptor is detailed in Appendix G, Tables G-14 though G-16. No COPCs and, therefore, no COCs were identified in the surface water collected from the East Ditch. Four PAHs were identified as COCs in the West Ditch for the Resident Receptor (Adult and Child), as explained below:

- The detected concentrations of benz(a)anthracene (0.00035 mg/L), benzo(b)fluoranthene (0.00041 mg/L), and indeno(1,2,3-cd)pyrene (0.00021) in surface water collected from the West Ditch range from approximately two to four times their FWCUG of 0.0001 mg/L. The detected concentration of benzo(a)pyrene (0.00033 mg/L) is approximately 41 times the FWCUG of 0.000008 mg/L. As a result, these PAHs were identified as COCs in surface water of the West Ditch.
- The detected concentrations of all other COPCs were less than their respective FWCUGs in the surface water collected from the West Ditch.

No additional COCs were identified based on the SOR analysis as summarized below:

- Two COPCs (arsenic and cobalt) identified in West Ditch surface water have FWCUGs for non-cancer endpoints. The SOR (Table G-15), regardless of endpoint, was less than one; therefore, no additional COCs were identified using this analysis.
- Five COPCs [arsenic, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene] identified in West Ditch surface water have FWCUGs for the cancer endpoint. The SOR (Table G-16) was 51, due primarily to benzo(a)pyrene. COPCs contributing at least 5% to the SOR are benz(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene (Table G-16). These COPCs were detected in the West Ditch surface water at concentrations above their FWCUGs; therefore, no additional COCs were identified using this analysis.

7.2.5 Uncertainty Assessment

The sources of uncertainty, as well as the potential bias they impart to the risk assessment (i.e., whether conservatism is increased or decreased) and approaches for minimizing their impact on the conclusions of the RI, are briefly discussed below.

7.2.5.1 Uncertainty in Estimating Potential Exposure

Sources of uncertainty in estimating potential human exposure include sampling and analysis limitations, comparison to background concentrations to identify SRCs, and estimation of EPCs.

Sampling Limitations. Uncertainties arise from limits on the media sampled, the total number and specific locations that can be sampled, and the parameters chosen for analysis to characterize the AOC. A total of 82 surface (0-1 ft bgs) soil samples were available for the HHRA. Samples were collected from areas biased toward areas anticipated to have the highest level of potential contamination (i.e., around former buildings, ditches, and a former petroleum contamination removal area) to delineate potential sources as well as from areas where excavation was performed to remove contamination during the 2001 IRA. The results of surface soil sampling were used to efficiently guide selection of locations for subsurface soil sampling with a bias toward the areas of highest potential contamination.

Analytical Limitations. Uncertainty is associated with the chemical concentrations detected and reported by the analytical laboratory. The quality of the analytical data used in the risk assessment was maximized and uncertainty was minimized by implementing QA/QC procedures that specify how samples are selected and handled; however, sampling errors, laboratory analysis errors, and data analysis errors can occur. Beyond the potential for errors, there is normal variability in analytical results.

Some current analytical methods are limited in their ability to achieve detection limits at or below risk-based SLs. Under these circumstances, it is uncertain whether the true concentration is above or below the SLs, which are protective of human health. When analytes have a mixture of detected and non-detected concentrations, EPC calculations may be affected by these detection limits. Risks may be overestimated as a result of some sample concentrations being reported as non-detected at the method detection 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 these analyte concentrations are below the MDL but are above the SL, the risk from these analytes would not be included in the risk assessment results.

Identification of SRCs. Part of determining SRCs is to identify chemicals detected above the established RVAAP facility-wide background concentrations. This screen does not account for the potential sources of chemicals, and background values are only available for inorganic chemicals.

Uncertainty associated with screening against background 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 11, 16 inorganic chemicals (aluminum, arsenic, barium, beryllium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, selenium, and vanadium) had MDCs in surface and/or subsurface soil that were above but close to (i.e., less than 2 times) the background concentration. The consequences of carrying most of these inorganic chemicals forward as SRCs, even if they are actually representative of background concentrations, is negligible because they are not toxic at near background concentrations. By contrast, naturally occurring (background) arsenic and manganese in soil exceeds risk-based cleanup goals. Therefore, the consequence of identifying arsenic or manganese as an SRC if it is, in fact, representative of background can significantly impact the conclusions of the risk assessment. The EPCs of these two metals are less than background concentrations in soil.

Other studies indicate arsenic may be naturally occurring in Ohio soils 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).

The MDC of arsenic in sediment in the East Ditch was 19.7 mg/kg. The RVAAP background concentration for arsenic in sediment is 19.5 mg/kg. All of the other sediment samples from the East Ditch and West Ditch were below background concentrations. Because the reported concentration in one sediment sample is essentially the same as the background concentration, and all other samples are less than background concentrations, arsenic in sediment appears to be present at Load Line 11 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 11, PAHs were detected across the entire AOC, as one or more PAHs were detected in 22 of 28 surface soil samples analyzed for SVOCs. PAH concentrations were less than the Resident Receptor (Adult and Child) FWCUGs in all but four sample locations (LL11cs-020, LL11sb-060, LL11sb-061, and LL11sb-067) where concentrations were up to two times the FWCUG of 0.221 mg/kg for benzo(a)pyrene.

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 inorganics, included a characterization of 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 7-10. 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 soils 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 7-11. 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. Generally, the 95% UCL on the arithmetic mean was adopted as the EPC for discrete sample results and was considered to represent a conservative estimate of the average concentration. This imparts a small but intentional conservative bias to the risk assessment, provided the sampling captured the most highly contaminated areas. Representative EPCs for the EU were calculated from discrete data based on the assumption that the samples collected from the EU were truly random samples. This assumption is not true for Load Line 11 where sample locations were biased to identify areas of highest contaminant concentrations. Therefore, EPCs generated from these data are likely to represent an upper bound of potential exposure concentrations.

In addition to calculating EPCs for each EU, individual discrete sample results above FWCUGs were evaluated to identify whether potential hot spots are present as a result of specific source areas.

Arsenic - The EPCs of arsenic range from 14.1–16.3 mg/kg and are less than RVAAP-specific background concentrations but reported concentrations exceed RVAAP-specific background at a few sample locations. The MDCs of arsenic in surface soil at Load Line 11 are 30.2 mg/kg at the FPA and 40.1 mg/kg at the NPA. The MDCs of arsenic in subsurface soil are 25.8 mg/kg at the FPA and 44.1 mg/kg at the NPA. The RVAAP-specific background value for arsenic in subsurface soil is 19.8 mg/kg. The subsurface background value is applicable for comparison to surface and subsurface results at Load Line 11 due to the extensive soil disturbance and mixing during building demolition and IRA activities at the Load Line. As previously described, naturally occurring arsenic concentrations in Ohio soils are often measured at greater than 20 mg/kg 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).

Individual arsenic results greater than 19.8 mg/kg are described below.

- Surface Soil at the FPA – 56 surface soil samples (including field duplicates) were collected at the FPA. Reported concentrations in 49 of these samples range from 2.7–18.7 mg/kg. Reported concentrations in seven samples ranged from 20.2–30.2 mg/kg. Field duplicate results are available for four of these seven samples. Arsenic concentrations in these field duplicates ranged from 13.2–18.7 mg/kg (i.e., less than 19.8 mg/kg). These seven samples are scattered across the FPA and arsenic concentrations in nearby samples are less than background.
- Subsurface Soil at the FPA - 72 subsurface soil samples (including field duplicates) were collected at the FPA. Reported concentrations in 66 of these samples range from non-detect to 19.5 mg/kg. Reported concentrations in six samples collected in 2000 and 2001 ranged from 20–25.8 mg/kg. Four of these six samples (LL11ss-002, LL11sb-043, LL11ss-003, and LL11sb-009) are scattered across the FPA and arsenic concentrations in nearby samples are less than background. Two of these samples (LL11sb-042 and LL11sb-022) are near each other; however, additional samples collected near and adjacent to these two samples, including confirmation samples collected following sump removal performed during the IRA (MKM 2004a), have arsenic concentrations less than 19.8 mg/kg.
- Surface Soil at the NPA - 32 surface soil samples (including field duplicates) were collected at the NPA. Reported concentrations in 31 of these samples range from non-detect to 18.8 mg/kg. The reported concentration in one sample (LL11ss-070) was 40.4 mg/kg. This sample was collected from a drainage ditch at the road leading to Building AP-18.
- Subsurface Soil at the NPA - 51 subsurface soil samples (including field duplicates) were collected at the NPA. Reported concentrations in 43 of these samples range from non-detect to 19.7 mg/kg. Reported concentrations in eight samples ranged from 20.1–44.1 mg/kg. Three of these eight samples (LL11sb-065, LL11ss-028, LL11ss-031) with arsenic concentrations

ranging from 20.1–24.7 mg/kg are scattered across the NPA and arsenic concentrations in nearby samples are less than background. An additional three samples (LL11cs-050, LL11sb-039, LLsb-040) with arsenic concentrations of 22.3–33.6 mg/kg were collected near each other near the site of the hotspot removal of petroleum-contaminated soil north of Building AP-17 conducted during the 2001 IRA. Additional samples collected near and adjacent to these three samples have arsenic concentrations less than 19.8 mg/kg. Two samples (LL11cs-045 and its field duplicate) with arsenic concentrations of 44.1 and 36.4 mg/kg are also surrounded by several samples with arsenic concentrations less than 19.8 mg/kg.

While several discrete soil samples had arsenic concentrations greater than 19.8 mg/kg, these results do not represent hot spots because:

- With the exception of three samples collected from the area near the site of the hotspot removal of petroleum-contaminated soil north of Building AP-17, these samples are scattered widely across the 48-acre AOC (i.e., they are not clustered) and are surrounded by samples with lower (less than 19.8 mg/kg) arsenic concentrations.
- Three samples from the area near site of the hotspot removal are clustered together; however, there are several other samples in this same area with lower concentrations.
- All samples having arsenic concentrations greater than the RVAAP-specific background concentration of 19.8 mg/kg were evaluated; however, several studies indicate arsenic may be naturally occurring in Ohio soils 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 concentrations as high as 34.8 mg/kg 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 11 at naturally occurring concentrations.

The facility-wide background concentrations for arsenic at RVAAP are 15.4 mg/kg for surface soil and 19.8 mg/kg for subsurface soil; however, earthmoving (e.g., building removal, grading, and other building/demolition activities) has blurred the distinction between surface and subsurface soil. Vosnakis and Perry (2009) recently published the results of arsenic background studies that included 313 samples of Ohio soil. Naturally occurring arsenic in these samples ranged from 1.6–71.3 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 and 29.6 mg/kg for surface and subsurface soil, respectively. In other studies, native soil concentrations of arsenic in Ohio have been reported as ranging from 0.5-56 mg/kg (Ohio EPA 1996) and the U.S. Geological Survey's Certificate of Analysis of the Devonian Ohio Shale estimates arsenic concentrations of 68.5 mg/kg are naturally present in bedrock shales (USGS 2004). Based on this evaluation, arsenic does not represent a hot spot and was not identified as a COC.

Benzo(a)pyrene – The EPC of benzo(a)pyrene at the FPA (0.219 mg/kg) is less than the FWCUG of 0.221 mg/kg but the concentrations in three samples exceed the FWCUG. The MDC of benzo(a)pyrene in surface soil at Load Line 11 is 0.45 mg/kg at LL11sb-060 collected in 2010 from the ditch line immediately east of the entry road to Load Line 11, upstream of the FPA. Few samples were collected in this area where no activities took place. No benzo(a)pyrene was detected in the only other sample in this area (LL11sb-001). A benzo(a)pyrene concentration of 0.39 mg/kg was reported in sample LL11cs-020 collected in 2001 from the drainage ditch north of Building AP-14 as a confirmation sample following the IRA for removal of metals, SVOCs, and pesticides. Benzo(a)pyrene concentrations in the other four confirmation samples collected from this IRA area (LL11cs-016, -017, -018, and -019) range from non-detect to 0.2 mg/kg. A benzo(a)pyrene concentration of 0.31 mg/kg was reported in sample LL11sb-061 collected in 2010 the area of the former Building AP-8. Building AP-8 was used for primer loading and as an administrative building. No other samples collected from the footprint of this building were analyzed for SVOCs because they were not previously used at this building. Benzo(a)pyrene was not identified as a COPC in subsurface soil at the FPA.

The EPC of benzo(a)pyrene at the NPA (0.28 mg/kg) is the MDC. The next highest detected concentration was 0.11 mg/kg. The MDC was reported sample LLsb-067 collected North of Building AP-17 in the area of the IRA to remove a hot spot of petroleum-contaminated soil. Benzo(a)pyrene was detected in one of the six confirmation samples collected following this removal action at a concentration of 0.11 mg/kg. Thus, the previously identified petroleum hot spot in this area has been successfully remediated.

7.2.5.2 Uncertainty in Use of FWCUGs

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

Selection of Representative Receptors. Load Line 11 is not currently used for training. While residential Land Use is unlikely, an evaluation using Resident Receptor (Adult and Child) FWCUGs is included to provide an Unrestricted (Residential) Land Use evaluation as required by CERCLA and the Army. As stated in Paragraph 6.d of the Technical Memorandum, if an AOC fails to meet the Unrestricted (Residential) Land Use, then all three Land Uses [i.e., Unrestricted (Residential) Land Use, Military Training Land Use, and Commercial/Industrial Land Use] will be evaluated.

Exposure Parameters and Exposure Models. For each primary exposure pathway included in the FWCUGs, assumptions are made concerning the exposure parameters (e.g., amount of contaminated media a receptor can be exposed to and intake rates for different routes of exposure) and the routes of exposure. Most exposure parameters have been selected so that errors occur on the side of human health protection. When several of these upper-bound values are combined in estimating exposure for any one pathway, the resulting risks can be in excess of the 99th percentile and, therefore, outside of the range that may be reasonably expected. Therefore, the consistent selection of upper-bound parameters generally leads to overestimation of the potential risks.

Toxicity Values. The toxicity of chemicals is under constant study and values change from time to time. The toxicity values used in calculating the FWCUGs were the most recent values available at the time (September 2008). These values are designed to be conservative and provide an upper-bound estimate of risk.

The toxicity and mobility of many inorganic chemicals in the environment is dependent on the chemical species present. Two important examples are arsenic and chromium. The toxicity values used in developing the FWCUGs are for inorganic arsenic and do not distinguish between arsenite and arsenate.

Chromium is generally present in the environment as either the trivalent (Cr+3) or hexavalent (Cr+6) species, with the trivalent form generally being more stable and, therefore, more common. FWCUGs are available for 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, the selection of 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 using the trivalent chromium FWCUGs for evaluating total chromium results. Using speciation samples to identify the appropriate FWCUG minimizes the associated uncertainty.

No FWCUGs or RSLs were available for TPH-DRO, TPH-GRO, sulfate, and sulfide in soil and/or sediment because no toxicity values are available for calculating FWCUGs. These COPCs were evaluated qualitatively based on comparison to SLs available for other chemicals. A qualitative evaluation of these chemicals indicates the lack of screening values does not represent a significant source of uncertainty as described below.

- After removing the 30 by 30 by 8 ft area of the petroleum-contaminated soil hot spot, confirmation samples were collected. Of the six confirmation samples collected from that excavation footprint, only two samples had petroleum hydrocarbon fractions (TPH-DRO and TPH-GRO) detected at low concentrations in deep surface soil. TPH-DRO and TPH-GRO were identified as COPCs at the NPA because no screening values (FWCUG or RSL) are available. TPH is a mixture of compounds. Many of the compounds included in the reported TPH fractions are also measured individually (e.g., VOCs such as benzene and SVOCs such as PAHs). All individual VOCs and SVOCs associated with TPH were either not detected or were detected below FWCUGs. Some states have developed screening values for TPH. Ohio EPA has published toxicity values for TPH using guidance from other states, including Massachusetts and Louisiana (Ohio EPA 2004b). Louisiana Department of Environmental Quality has published risk-based screening values for TPH-DRO (65 mg/kg) and TPH-GRO (65 mg/kg) in soil (LDEQ 2000). The MDCs for TPH-DRO (34 mg/kg) and TPH-GRO (0.054 mg/kg) at Load Line 11 are below the Louisiana risk-based screening values for these fractions. Therefore, TPH-DRO and TPH-GRO are not COCs for soil.

- Sulfide was identified as a COPC in the FPA and NPA surface and subsurface soil and West Ditch sediment as a COPC and sulfate was identified as a COPC in the FPA and NPA subsurface soil because no screening values (FWCUG or RSL) are available. Sulfate and sulfide have low toxicity to humans, and appropriate toxicity data specific to these anions are not available for calculating FWCUGs. Soil RSLs are available for these anions in combination with other inorganic molecules. Specifically, RSLs are available for hydrogen sulfide (2,800,000 mg/kg) and selenium sulfide (390 mg/kg). The sulfate and sulfide EPCs for surface (0-1 ft bgs) and subsurface soil (1-13 ft bgs) range from a non-detectable concentration to 30.6 mg/kg for sulfate and 27.8-65.3 mg/kg for sulfide. The EPC for sulfate in sediment was 43.4 mg/kg. These EPCs are well below the RSLs available for sulfide combined with other inorganic molecules; therefore, sulfide is not a COC in soil or sediment. Although toxicity data do not exist for sulfate, it is present in naturally occurring minerals contained in soils. As sulfate is naturally occurring and there is no source (e.g., history of agriculture, mine drainage, urban runoff, or industrial processes generating sulfate) of sulfate contamination at Load Line 11, sulfate was eliminated from consideration as a COC.

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 as well as the approach for identifying SRCs, COPCs, and ultimately COCs based on the FWCUGs were designed to ensure the over rather than underestimation of potential risk. The uncertainty assessment attempts to put the identified COCs in perspective to facilitate informed risk management decisions for the AOC.

The SOR is used to account for the potential additive effects from exposure to multiple chemicals that can cause the same critical effect or affect the same target organ. Cancer risk is assumed to be additive for all carcinogens. Non-cancer risk is assumed to be additive for chemicals with similar sites of toxicological action. In the event that any combination of COPCs results in synergistic effects, risk might be underestimated. Conversely, the assumption of additivity would overestimate risk if a combination of COPCs acted antagonistically. It is unclear whether the potential for chemical interaction has been inadvertently understated or overstated. It seems unlikely that the potential for chemical interaction contributes significant uncertainty to the conclusions of the risk assessment.

7.2.6 Identification of COCs for Potential Remediation

As indicated in Section 4.2, an IRA was performed in 2001 to remove contamination in primary migration pathways at Load Line 11. The IRA was performed in parallel with the Phase I RI activities described in Section 4.3. This IRA included removing sump water from production buildings, grouting selected sanitary sewer manholes, excavating contaminated drainage ditches, and removing a hot spot petroleum-contaminated soil.

Using data and information that reflects the current status of Load Line 11, COCs were identified in Section 7.2.4 as any COPC having an EPC greater than an applicable FWCUG or contributing more than 5–10% to an SOR greater than one. For inorganic chemicals with FWCUGs or RSLs below background concentrations, the background concentration was used as the point of comparison. The TR for the FWCUGs used to identify COCs is 1E-05 per the Ohio EPA DERR program, which has adopted a human health cumulative ILCR goal of 1E-05 to be used as the level of acceptable excess cancer risk and for developing site remediation goals.

The results of the COC screening (Section 7.2.4) are combined with the results of the uncertainty assessment (Section 7.2.5) to identify COCs to be carried forward for potential remediation.

No COCs were identified in subsurface soil or sediment based on comparison to FWCUGs and the uncertainty assessment (including evaluation of individual data points).

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

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. The EPC for benzo(a)pyrene in surface soil at the NPA (0.28 mg/kg) is approximately 1.3 times its FWCUG of 0.221 mg/kg. The EPC for this data aggregate is the MDC (at sample LL11sb-067); benzo(a)pyrene concentrations in the remaining NPA samples ranged from a non-detectable concentration to 0.11 mg/kg. Sample LL11sb-067 was collected in 2010 from the northeastern portion of Load Line 11. The EPC for benzo(a)pyrene in the FPA (0.219 mg/kg) was slightly less than the FWCUG (0.221 mg/kg). Other PAHs were identified as COCs because they contribute to SORs of two at the FPA and NPA. The EPCs of benzo(a)pyrene (0.28 and 0.221 mg/kg) are slightly above and below the FWCUG of 0.221 and the SORs are two, indicating cumulative cancer risks to a hypothetical future resident on the order of 1E-05. Reported benzo(a)pyrene concentrations above the FWCUG are scattered (i.e., no hot spots were identified); therefore, no COCs are identified for potential remediation.

COCs for Surface Water for Potential Remediation

Four PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene] were identified as COCs for the Resident Receptor (Adult and Child) in surface water collected from the West Ditch. The detected concentrations of benz(a)anthracene (0.00035 mg/L), benzo(b)fluoranthene (0.00041 mg/L), and indeno(1,2,3-cd)pyrene (0.00021) in surface water collected from the West Ditch range from two to four times their FWCUG of 0.0001 mg/L, and the detected concentration of benzo(a)pyrene (0.00033 mg/L) was 41 times the FWCUG of 0.000008 mg/L. All reported concentrations included a "J" qualifier, indicating they were estimated results below the detection limit of the analytical method. PAHs are present in the environment from natural and anthropogenic sources. Since surface runoff is the potential source of contamination to surface water in the West Ditch, the fact that PAH concentrations are not significantly elevated in soil or sediment indicates there is no identifiable source beyond normal levels of these chemicals to surface water due to runoff from roads and other traffic areas. In addition, incidental exposures of the Resident Receptor (Adult and Child) to surface water in the West Ditch that only intermittently holds water are much less than the ingestion of drinking water (i.e., 2 L/day for an adult) and dermal contact while swimming and wading exposures incorporated into developing the FWCUGs. Thus, these low, estimated concentrations of PAHs were not identified as COCs for 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 11. This HHRA was conducted as part of the RI and was based on the streamlined approach described in the FWCUG Report (USACE 2010a), Position Paper for Human Health FWCUGs (USACE 2012b), and Technical Memorandum (ARNG 2014). The components of the risk assessment (receptors, exposure media, EPCs, and results) are summarized below.

Receptors. Camp Ravenna is a controlled access facility. Load Line 11 is located in the south-central portion of the facility and is not currently used for training. An evaluation using Resident Receptor (Adult and Child) FWCUGs is used to provide an Unrestricted (Residential) Land Use evaluation as required by CERCLA and the Army. Unrestricted (Residential) Land Use is considered protective for all categories of Land Use on the former RVAAP/Camp Ravenna.

Exposure Media. Media of concern at Load Line 11 are surface soil, subsurface soil, surface water, and sediment. Soil data associated with Load Line 11 were aggregated into surface and subsurface soil at the FPA and NPA.

Estimation of EPCs. The EPCs for soil were calculated from the results of all of the discrete samples collected from a given depth interval at each EU. The EPC was either the 95% UCL of the mean or the MDC, whichever value is lowest. The limited number of sediment and surface water samples were evaluated individually (i.e., the number of samples was too small to calculate 95% UCLs).

Results of Human Health Risk Assessment. No COCs for evaluation in an FS were identified for soil, sediment, or surface water at Load Line 11.

7.3 ECOLOGICAL RISK ASSESSMENT

7.3.1 Introduction

The ERA presented in this RI Report follows a unified approach of methods integrating Army, Ohio EPA, and USEPA guidance. This ERA approach is consistent with the general approach by these agencies and primarily follows the Level I Scoping ERA, Level II Screening ERA, and Level III Baseline ERA outlined in the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008), with specific application of components from the FWERWP (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 11 contains habitat that supports ecological receptors. The habitat has known chemical contamination (MKM 2005a). Habitat types and an assessment of the ecological resources found at Load Line 11 are presented in subsequent subsections.

Additionally, the conclusions of a historical ERA [SERA performed as part of the Phase I RI (MKM 2005a)] state the following:

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

The historical ERA and the PBA08 RI results were combined for this RI Report to evaluate the conclusion of the historical ERA 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, this indicates 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 11 is approximately 48 acres. The buildings within the Load Line 11 fence line have been removed. The habitat is mostly field and shrubland with some forest and is large enough to completely support cover and food for small birds and mammals that typically require approximately 1 acre of habitat (USEPA 1993). The habitat area at Load Line 11 represents 0.22% of the 21,683 acres at Camp Ravenna.

Future use at Load Line 11 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 11 include black powder, TNT, RDX, HMX, nitroglycerine, nitrocellulose, nitroguanidine, heavy metals (lead, chromium, mercury, and arsenic) from munitions assembly activities, VOCs from storing solvents (Building AP-17) and lacquer sealing materials used on finished primers (Building AP-11), and PCBs from on-site transformers. 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.

As indicated in Section 4.2, in 2001 an IRA was performed as an early response to contamination in primary pathways at Load Line 11. This IRA was conducted in unison with the Phase I RI. This IRA included removing sumps, 230 yd^3 of contaminated media in drainage ditches, and a hot spot of petroleum-contaminated soil (MKM 2004a). Confirmation samples from these source removal activities are included in this risk assessment, as applicable.

The goal of the historical ERA (MKM 2005a) was to identify COPECs in soil, sediment, and surface water for Load Line 11 that existed after the IRA was conducted. Bioaccumulative compounds were identified and HQs based on food chain models were calculated in the Phase I RI (MKM 2005a); this will be discussed if this ERA continues to Level III. The Phase I RI followed instructions presented in the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2003) and included the first two of six steps listed in Figure III of the FWERWP (USACE 2003a). These two steps identified the evaluation procedures, which were used to determine AOC-related COPECs. First, the MDC of each chemical was compared to its respective facility-wide background concentration. Chemicals were not considered COPECs if the MDC was below the background concentration. For all chemicals detected above background concentrations, the MDC was compared to an ESV. The hierarchy of screening values was based on the guidance included in the FWERWP and *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2003). In addition to the ESV comparison, it was determined if the chemical was a persistent, bioaccumulative, and toxic (PBT) compound. For sediment, chemicals were also compared with the Ohio Sediment Reference Value (SRV). Chemicals were retained as COPECs if they exceeded background concentrations and the ESV, if the chemical exceeded background concentrations and had no toxicity information, or if the chemical was considered a PBT compound. Groundwater was not included in the historical ERA.

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,
- Minimum concentration,
- MDC,
- Mean concentration,
- Average of positive detects,
- Sample of maximum detect,

- Background concentration,
- Comparison of MDC to background (SRC determination),
- SRVs (sediment only),
- Screening levels (ESVs),
- HQ (MDC/ESV ratio),
- PBT compound identification (soil and surface water only),
- COPEC determination, and
- COPEC rationale.

Historical COPECs for Soil. The historical ERA conducted as part of the Phase I RI reported 35 chemicals in surface soil (0-1 ft) at Load Line 11 (MKM 2005a). Of the 35 chemicals detected, 5 (aluminum, calcium, magnesium, potassium, and sodium) were essential nutrients and were excluded from the COPEC screen (Appendix H, Table H-1). A total of 16 inorganic chemicals, 2 anions, and 10 organic chemicals were determined to be SRCs because they exceeded background concentrations or did not have an associated background concentration for comparison. Nine inorganic chemicals (arsenic, chromium, cyanide, lead, manganese, mercury, nickel, vanadium, and zinc), one anion (sulfide), and one organic chemical (PCB-1254) exceeded their ESVs and were identified as COPECs (Table 7-12). Three chemicals (iron, nitrate, 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. Appendix H, Table H-1 presents the Phase I RI ecological screening for surface soil at Load Line 11.

Historical COPECs for Sediment. The historical ERA conducted as part of the Phase I RI reported 38 chemicals in sediment at Load Line 11 (MKM 2005a). Of the 38 chemicals detected, 4 chemicals (calcium, magnesium, potassium, and sodium) were essential nutrients and were excluded from the COPEC screen (Appendix H, Table H-2). A total of 6 inorganic chemicals, 3 anions, and 13 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 22 SRCs, 3 inorganic chemicals (copper, lead, and nickel) and 9 organic chemicals [benz(a)anthracene, benzo(a)pyrene, benzo(ghi)perylene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, and total PAHs] exceeded their ESVs and were identified as COPECs (Table 7-12). In addition, two inorganic chemicals (beryllium and manganese), three anions (nitrate, sulfate, and sulfide), and one organic chemical (nitrocellulose) were selected as COPECs because they did not have an ESV for comparison. Two detected chemicals were also PBT compounds (mercury and PCB-1254). Mercury was eliminated as a COPEC because it did not exceed its background concentration. PCB-1254 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 Phase I RI reported 12 chemicals in surface water at Load Line 11 (MKM 2005a). Of the 12 chemicals detected, 4 (calcium, magnesium, potassium, and sodium) were essential nutrients and were excluded from the COPEC screen (Appendix H, Table H-3). Two inorganic chemicals, one anion, and two organic chemicals were determined to be SRCs because they exceeded background concentrations or did not have an associated background concentration for comparison. Of the five SRCs, one inorganic chemical (manganese) and one anion (sulfate) were identified as COPECs (Table 7-12) because they did not have an ESV for comparison. No PBT compounds were detected in surface water.

Summary of Historical ERA. An IRA was performed for sumps, contaminated drainage ditches, and a hot spot of petroleum-contaminated soil at Load Line 11 as an early response to contamination in primary pathways. Using information and data from the IRA and Phase I RI, a historical ERA was performed to determine COPECs at Load Line 11 in surface soil, sediment, and surface water. Table 7-12 summarizes the COPECs by media. Based on the identified COPECs in the historical Level I ERA, ecological risk was predicted (MKM 2005a).

7.3.2.3 Ecological Significance

Sources of data and information about the ecological resources at Load Line 11 include the *Integrated Natural Resources Management Plan* (INRMP; OHARNG 2014), *Facility-Wide Biological and Water Quality Study* (USACE 2005a), previous characterization work (e.g., the Phase I RI), IRA (MKM 2004a), and visits to Load Line 11 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 11. 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 11 with each of the important places and resources listed in Appendix H, Table H-4.

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 relatively clear that the ecological place or resource is either present or absent on the AOC; therefore, the decision process is objective. If no important or significant resource is present at an AOC, the evaluation will not proceed to Level II regardless of the presence of contamination. Instead, the Level I Scoping ERA would acknowledge that there are important ecological places, but that those resources are not ecologically significant, and no further evaluation is required.

Management Goals for the AOC. Regardless of whether the evaluation is concluded at Level I or continues to Level II, there is another level of environmental protection for Load Line 11 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 resource management goals of OHARNG (listed in Appendix H, Table H-5) benefit Load Line 11. 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 utilizes 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 11 varies, all of the management goals are intended to monitor, maintain, or enhance RVAAP natural resources and its ecosystem. While these goals are for managing all types of resources at and near Load Line 11, they do not affect the decisions concerning the presence or absence of important or significant ecological places or resources at Load Line 11.

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 rare species. An important resource becomes significant when found on an AOC and there is contaminant exposure. The wetlands are important/significant ecological resources at Load Line 11 (Appendix H, Table H-4).

Terrestrial Resources. Load Line 11 is dominated by terrestrial resources, as described below.

Habitat Descriptions and Species. The INRMP and AOC visits by SAIC scientists indicated Load Line 11 consists of five vegetation types (Figure 7-1). The habitat area is dominated by dry, mid-successional, cold-deciduous shrubland (Figure 7-1 and Photograph 7-1). Small areas of three forest types are represented along the western, northern, and eastern boundaries. The western boundary runs through a small amount of mixed, cold-deciduous, successional forest and American beech (*Fagus grandifolia)*, oak (*Quercus* spp.), and maple (*Acer* spp.) forest alliance. The northern boundary runs through a small strip of green ash (*Fraxinus pennsylvanica)*, American elm (*Ulmus americana)*, and hackberry (*Celtis occidentalis*) temporarily-flooded forest alliance. The eastern boundary runs through a small amount of mixed, cold-deciduous, successional forest. The southern boundary runs through a small amount of a fourth forest type – American beech (*Fagus grandifolia)*, sugar maple

(*Acer saccharum)*, and American tulip tree (*Liriodendron tulipifera*) forest alliance. This characterization was originally established by a vegetation study using aerial photography and field verification (USACE 1999) and was later used in the INRMP (OHARNG 2008).

SAIC scientists conducted a field survey at Load Line 11 on May 19, 2010 and determined there have been changes in vegetation at the AOC, including (1) the recent development (post 1999) of a dry, early-successional, herbaceous field habitat; (2) a decrease in dry, mid-successional, cold-deciduous shrubland habitat; and (3) small increases in the four forest habitats. The herbaceous habitat has developed since 1999 and is largely located within the loop road around the former load line. The demolition activities associated with removal of the buildings and other infrastructure at Load Line 11 also removed shrubland, which has been replaced by grassland. Dominant plants include an assortment of grasses, forbs, and seedlings of trees and shrubs. Common species include several species of goldenrod (*Solidago* spp.), clasping-leaf dogbane (*Apocynum cannabinum*), yarrow (*Achillea millefolium*), gray dogwood (*Cornus racemosa*), blackberry (*Rubus allegheniensis*), autumn olive (*Elaeagnus umbellata*), and multiflora rose (*Rosa multiflora*).

The decrease in shrubland is attributable to the removal actions and plant succession. In general, the lost shrubland habitat has been replaced by modest increases in the edge forest and central herbaceous field habitat types. The remaining shrubland areas occur along the boundary and the perimeter road that encircles the former load line. Shrubs and small trees remain the dominant habitat type at 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*).

The increase in forested area is attributed primarily to plant succession, as saplings in the 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. There is also a small area of forested habitat near the locations of former Buildings AP-4, AP-7, and AP-8 (Figure 7-1). The forests include small open areas and understory that result in multi-story vegetation. The vegetation provides multiple layers for the various foraging height preferences of birds, mammals, insects, and other organisms.

The habitats at Load Line 11 were assessed to be healthy and functioning based on May 2008 and 2010 observations by SAIC biologists (Photographs 7-1 through 7-3). 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 11 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 terrestrial places and resources (Appendix H, Table H-4), there are other resources at or near Load Line 11 (e.g., vegetation, animals) that interact in their ecosystems and support nutrient cycling and energy flow. For example, wildlife such as wild turkey (*Meleagris gallopavo*) and white-tailed deer (*Odocoileus virginianus*) could use the area. The INRMP provides information about species and habitat surveys at Camp Ravenna (e.g., timber and ecological succession) (OHARNG 2014). There are no other reported surveys of habitats and wildlife at Load Line 11 beyond those summarized in the INRMP (OHARNG 2014).

Photograph 7-1. Herbaceous Growth, Shrubland, and Forest in the Habitat Area (May 20, 2008)

Photograph 7-2. Portion of the East Ditch Network (May 19, 2010)

Photograph 7-3. Portion of the West Ditch Network Facing Northeast Across the Central Part of the AOC (May 19, 2010)

Aquatic Resources. Load Line 11 has few aquatic resources. Although there are no ponds or streams at Load Line 11, there are two shallow drainage ditches and two small wetlands.

Habitat Descriptions and Species. The water features at Load Line 11 include the East and West Ditches (Figures 2-1 and 7-1). The East Ditch drains the northeastern portion of the AOC. The ditch is well-vegetated with shrubs and herbaceous plants, and there is no evidence of erosion. Despite several days of moderately heavy rain at the East and West Ditches, there was only a small amount of water flowing in the East Ditch during a May 19, 2010 site visit. This small amount of water flow was due to a small drainage area and a blocked culvert (or other impediment). Water from the East Ditch eventually discharges onto the Sand Creek floodplain near Newton Falls Road. The West Ditch drains the central portion of the AOC and flows southwest to an unnamed tributary to Sand Creek. The ditch is well-vegetated with a mixture of shrub and herbaceous species, and there is no evidence of erosion. Water in the West Ditch was flowing at the time of the site visit. The West Ditch is fed by a network of small ditches; most of the flow appeared to be coming from a small forested area between former Buildings AP-4, AP-7, and AP-8 rather than the main part of the AOC. Within the central portion of the AOC, water was present in the entire network of smaller ditches that feed into the West Ditch, but very little flow was evident.

Intermittent surface water flows in drainage ditches at Load Line 11. During several inspections and sampling visits over a three year period, SAIC scientists found no water in the West Ditch or East Ditch throughout most of the year. However, due to a blocked culvert or other impediment in the ditch, a very small wetland has developed in part of the East Ditch. Precipitation data from Camp Ravenna are provided in Section 3.5. The storm frequency is 35 days per year, and precipitation occurs 154 days per year; field observations have determined this is not sufficient to create and maintain aquatic habitat in the unblocked portion of the drainage ditches.

The May 19, 2010 site visit also included an inspection of an old sewer outfall in the north-central part of the AOC boundary. The outfall consisted of an 8-inch ceramic tile pipe partially blocked by leaves and other organic debris. There was no evidence that any sediment had been moving recently, because the opening of the pipe was effectively covered with leaves and other debris. Any discharge from the sewer outfall would eventually flow onto the Sand Creek floodplain. The outfall assessment was completed and provided in the *Remedial Investigation/Feasibility Study Report for RVAAP-67 Facility-Wide Sewers* (USACE 2012a).

Wetlands. Important wetland resources exist at the AOC. Wetlands are important habitats with water-saturated soil or sediment and plant life that 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 11 perform these and other related functions.

A planning level survey [i.e., based on desktop surveys conducted for the OHARNG of wetlands data and resources [e.g., National Wetlands Inventory maps, aerials] identified one small wetland (Wetland 1) that straddles the western boundary of the AOC (Figure 7-1) (OHARNG 2014). There is one other wetland (Wetland 2) not previously identified on any wetlands surveys; it is associated with the East Ditch EU. Wetland 2 is not present on any of the wetland maps provided by the OHARNG and was once occupied by a building. No jurisdictional wetlands determination has been conducted 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.

An SAIC Professional Wetland Scientist used the Ohio Rapid Assessment Method (ORAM) (Ohio EPA 2001) in December 2011 to assess the condition of the two wetlands within the habitat area for Load Line 11 and to determine the potential ecological importance to those wetlands (Appendix H, Figure H-1). Using 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 1–29.
- Category 2 includes wetlands of moderate quality and wetlands that are degraded but exhibit reasonable potential for restoration. Scores range from 30–59.
- 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 60–100.

The field sheets detailing the ORAM at Load Line 11 are presented in Appendix H, Figures H-1 and H-2. Figure 7-1 shows the wetland locations. Based on the ORAM, Wetland 1 is classified as Category 1 (with a final score of 28), indicating low wetland quality, with degradation of wetland functions and conditions (Appendix H, Figure H-1). Wetland 2 is classified as Category 1 (with a final score of 21), indicating low wetland quality, with degradation of wetland functions (Appendix H, Figure H-2).

Wetland 1 is a small emergent/scrub-shrub planning level survey wetland that straddles the western boundary of Load Line 11. Wetland 1 is 0.24 acres, with 0.13 acres inside the AOC. The wetland is located on the western boundary of the AOC between the extension of the West Ditch and a small wet weather tributary to Sand Creek. Dominant vegetation includes silky dogwood (*Cornus amomum*), arrowwood (*Viburnum dentatum*), red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), blackberry (*Rubus* spp.), cutgrass (*Leersia* spp.), and cattails (*Typha* spp.).

Wetland 2 is a very small emergent/scrub-shrub wetland (0.02 acres) that has formed in the center of the East Ditch EU. The wetland has likely formed as a result of blocked drainage in the ditch. Dominant vegetation includes silky dogwood, arrowwood, red maple, green ash, softstem bulrush (*Schoenoplectus tabernaemontani*), reed canary grass (*Phalaris arundinacea*), an unidentified bulrush (*Scirpus* spp.), cattails, cutgrass, and primrose willow (*Ludwigia* spp.). Wetland 2 has not been delineated.

Another wetland, located just outside the western and northern boundaries of the AOC is a moderately large, forested wetland, associated with the floodplains of Sand Creek and an unnamed tributary to Sand Creek. The wetland receives runoff from Load Line 11 via the East and West Ditches, some small conveyances/drainageways, and seeps along the northern boundary of the AOC.

Dominant vegetation includes black willow (*Salix nigra*), red maple, cottonwood (*Populus deltoides*), silky dogwood, golden ragwort (*Senecio aureus*), and poison ivy (*Toxicodendron radicans*).

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 11 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 11 (e.g., vegetation, animals). There are no other reported surveys of habitats and wildlife at Load Line 11 beyond those summarized in the INRMP (OHARNG 2014). There are two nearby biological and water quality stations. The following subsections provide a summary of the biological and water quality stations in the vicinity of Load Line 11.

Biological/Water Quality Sampling Stations. Ohio EPA and USACE investigated several streams at RVAAP in a network of various biological/water quality sampling stations (USACE 2005a). The purpose of this investigation was to document ecological effects of AOCs on stream or pond biota and conditions. Two sampling stations were located in the vicinity of Load Line 11. Station S-1 was located upstream of the AOC, and Station S-2 was located downstream of the AOC. The upstream biological/water quality station (S-1) provides information about potential contamination from upstream AOCs and if upstream AOCs may be contributing to adverse biological, chemical, and physical measurements in the vicinity of Load Line 11. The downstream sampling station (S-2) provides information about potential contamination from Load Line 11 and upstream AOCs. A positive rating (e.g., good, excellent, full attainment, and other positive terms reported in the study) at a downstream sampling station suggests Load Line 11 and other upstream AOCs are not adversely impacting the quality of Sand Creek.

According to the *Facility-Wide Biological and Water Quality Study* (USACE 2005a), each sampling location included a sediment sampling/assessment, surface water sampling/assessment, fish and macroinvertebrate community assessment, and habitat assessment. The sampling reach for stream sampling stations ranged 395-690 ft.

Sediment evaluations were conducted in June 2003 using guidelines established in *Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald et al. 2000), SRVs for inorganic chemicals (Ohio EPA 2003), and USEPA Region 5 ecological screening levels (ESLs) (USEPA 2003a). Sediment samples were analyzed for SVOCs, pesticides, PCBs, TAL metals, explosives, percent solids, cyanide, ammonia, nitrate, and phosphorus. Surface water grab samples collected in June and September 2003 were evaluated using comparisons to Ohio Water Quality Standards criteria, reference conditions, or cited in the *Facility-Wide Biological and Water Quality Study*. Surface water samples were analyzed for TAL metals, pesticides, PCBs, explosives, SVOCs, and several nutrients.

Fish and macroinvertebrate sampling and assessments occurred in August and September 2003. Fish were sampled using electrofishing methods. Macroinvertebrate communities were assessed using artificial substrates (quantitative sampling), supplemented with a composite natural substrate sample (qualitative sampling). The fish and macroinvertebrate community assessments followed the methods contained in *Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities* (Ohio EPA 1989).

The physical habitat assessment was conducted in June 2003 and used the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA (Rankin 1989, 1995). The types(s) and quality of substrates, amount and quality of in-stream cover, channel morphology, extent and quality of riparian vegetation, pool, run, riffle development and quality, and gradient are some of the habitat characteristics used to determine the QHEI score.

Sampling Station Locations. Station S-1 [River Mile (RM) 7.0] is located at the first and eastern intersection of Sand Creek and Newton-Falls Road, approximately 4,500 ft west of Load Line 11. Station S-1 provides the closest upstream reference point for the AOC. Station S-2 (RM 5.9) is located at the second and western intersection of Sand Creek and Newton Falls Road, approximately 300 ft directly north of Load Line 11 (Figure 7-1). The station is immediately downstream from Load Line 11 and provides the closest downstream sampling point to the AOC.

Summary of Sampling/Assessment Results. Table 7-13 shows the ratings of the attributes for sampling stations S-1 and S-2. Review of the *Facility-Wide Biological and Water Quality Study* (USACE 2005a) data from the two stations showed many positive attribute ratings (e.g., good, excellent, full attainment) and no sign of aquatic impairment. Each station was rated at Full Use Attainment Status, which indicated that all indices met the Ohio EPA biological criteria.

At S-1, all inorganic chemicals tested in sediment were below Ohio SRVs and threshold effects concentration (TEC) levels. All tested explosives, pesticides, and PCBs were not detected in sediment samples collected from S-1. The few SVOCs were measured at low levels, with all concentrations below TEC or ESL guidelines. Ammonia and total phosphorus levels were measured below screening guidelines. None of the surface water chemical concentrations at S-1 exceeded Ohio Water Quality Standards aquatic life maximum or average water quality criteria (WQC), and none of the chemicals measured exceeded criteria protective of the Warm Water Habitat aquatic life use (USACE 2005a). Overall, the sediment quality and water quality at S-1 was rated “excellent.” The fish community at S-1 was rated “good.” The Index of Biotic Integrity score was 41; 15 species were reported. The macroinvertebrate community at S-1 was rated “exceptional.” Based on the fish and macroinvertebrate community assessment, no biological impairment associated with chemical contaminants was observed at S-1. The physical habitat was also evaluated at S-1, and the QHEI score was 74.0, indicating “good” stream habitat capable of supporting Warm Water Habitat biological communities.

At S-2, all inorganic chemicals tested in sediment were below Ohio SRVs and TEC levels. All tested explosives, pesticides, and PCBs were not detected in sediment samples collected from S-2. The few

SVOCs were measured at low levels, with all concentrations below TEC or ESL guidelines. Ammonia and total phosphorus levels were measured below screening guidelines. None of the surface water chemical concentrations at S-2 exceeded Ohio Water Quality Standards aquatic life maximum or average WQC, and none of the chemicals measured exceeded criteria protective of the Warm Water Habitat aquatic life use (USACE 2005a). Overall, the sediment quality and water quality at S-2 was rated "excellent." The fish community at S-2 was rated "good." The Index of Biotic Integrity score was 40, and 15 species were reported. The macroinvertebrate community at S-2 was rated "exceptional." The physical habitat was also evaluated at S-2, and the QHEI score was 78.5, indicating "excellent" stream habitat capable of supporting Warm Water Habitat biological communities. These favorable sediment/water quality findings at S-2 support the observation that Load Line 11 is not contributing contamination to Sand Creek.

Ecosystem and Landscape Roles and Relationships. Four spatial areas were evaluated to assess the ecosystem and landscape roles and relationships at Load Line 11: the actual AOC, vicinity of the AOC, entire Camp Ravenna, and ecoregion of northeastern Ohio. Information about the first spatial area (AOC) was provided in the section above on terrestrial and aquatic resources.

Vicinity of the AOC. Four forest communities border Load Line 11 (Figure 7-1). 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.

Figure 7-1 shows there is one wetland along the western border of the AOC and one in the vicinity of the East Ditch. Other wetlands are located outside of Load Line 11, to the north along Sand Creek, southeast of Fuze & Booster Spur Road, and southwest of the AOC boundary. No perennial surface water features exist in AOC boundary. Sand Creek is located at least 125 ft north of the AOC (Figure 7-1).

The closest recorded rare species [caddisfly (*Psilotreta indecisa*)] is located approximately 900 ft west of the AOC (Table 7-14). It is a state threatened species. The next closest rare species [pale sedge (*Carex pallescens*)] is located approximately 1,100 ft west of the AOC. It is a state potentially threatened species.

No beaver dams are in or near the AOC. There is a 100-year floodplain along Sand Creek that reaches the northern boundary of the AOC. There is a biological and water quality station (stream sample station) within 300 ft of the AOC.

The Entire Camp Ravenna. Load Line 11 is approximately 48 acres, which represents 0.22% 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); FL1 represents 10.7% of the habitat at Camp Ravenna. There are approximately 1,440 acres of forest type FU1 (American beech/sugar maple/American tulip tree) at Camp Ravenna (OHARNG 2014); FU1 represents 6.6% of the habitat at Camp Ravenna. There are approximately 2,290 acres of forest type FU2 (American beech/oak/maple) (OHARNG 2014); FU2 represents 0.6% of the habitat at Camp Ravenna. There are approximately 1,650 acres of forest type FU5 (white ash/black cherry/red maple) (OHARNG 2014); FU5 represents 7.6% of the habitat at Camp Ravenna. There are approximately 2,050 acres of vegetation type HU1 (goldenrod/clasping-leaf dogbane) (OHARNG 2014); HU1 represents 9.5% of the habitat at Camp Ravenna. There are approximately 2,900 acres of vegetation type SU1 (gray dogwood/northern arrowwood) (OHARNG 2014); SU1 represents 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); wetlands represent about 9% of the habitat at Camp Ravenna. These types of resources are abundant and are not unique to Load Line 11 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 (USGS 1998) is located in the northeastern part of Ohio, and both contain the communities of temporarily flooded forest alliance (e.g., green ash and American elm), American beech/sugar maple/American tulip tree forest alliance and American beech/oak/maple forest alliance, and mixed cold-deciduous successional forest (e.g., white ash and 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 (USGS 1998). 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, 171,380 acres of forest type FU1, 621,100 acres of forest type FU2, and 210,340 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 (SU1) are common across the ecoregion (USDA 2011). Wetlands across the ecoregion make up 207,800 acres (USEPA 1999a). The vegetation and wetland communities at Load Line 11 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 and American elm); (2) American beech/sugar maple/American tulip tree forest alliance; (3) American beech/oak/maple forest alliance; (4) mixed, cold-deciduous, successional forest; (5) dry, early-successional, herbaceous field; (6) dry, mid-successional, cold-deciduous shrubland; and (7) wetlands are found in the vicinity of Load Line 11. The forest types, herbaceous field, shrubland, and wetlands are abundant at Camp Ravenna and the larger surrounding local ecoregion. There is no known unique resource at Load Line 11 that cannot be found in the immediate vicinity of the AOC, Camp Ravenna, and in a 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, 14 soil, 19 sediment, and 2 surface water COPECs were identified at Load Line 11. These COPECs are listed on Table 7-12.

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 only resource on this list present at Load Line 11 is wetlands. Environmental management goals and objectives of OHARNG are applicable to Load Line 11, 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 11 is made up of approximately 48 acres of herbaceous field, shrubland, and forest communities. Two wetlands are found at the AOC. The vegetation types and wetlands at Load Line 11 are found nearby at RVAAP and in the ecoregion.

Because there is contamination at Load Line 11 and important or significant resources (i.e., wetlands) are present, this ERA continues to a Level II Screening Level ERA.

7.3.3 Level II: Screening Level Ecological Risk Assessment

The Level II method follows the guidance documents listed in Section 7.3.1. The Level II method identifies evaluation procedures used for problem formulation and ecological effects evaluation to determine AOC-related COPECs. This work includes defining habitats/environmental setting, suspected contaminants, possible pathways, and mechanisms for ecotoxicity and contaminant transport. Level II also includes establishing screening values.

In addition, technical and refinement factors can be used to assess outcomes of the above procedures. The factors include using mean exposure concentrations and discussing 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 identifies the interconnections of contaminant sources and transport mechanisms for contaminant migration through the environment to the receptors. The conceptual site exposure model provides an understanding of the relationships of all sources, release and transport pathways, potential exposure media, and receptors and includes:

- **Source Media.** Based on historical AOC information, operations associated with various former buildings at Load Line 11 are the contaminant source. The operations contributed chemicals to the surrounding soil, sediment, and surface water. Some contaminated source media was removed during the 2001 IRA: sumps, 230 yd^3 of contaminated media in drainage ditches, and a hot spot of petroleum-contaminated soil (MKM 2004a).
- **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, although parts of the land are relatively sloped, the slopes have a high percentage of vegetative ground cover that will further help to increase infiltration and

decrease erosion. This extensive vegetative cover includes 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 drainages (East Ditch and West Ditch) that provide a likely flow pathway from the location of the former buildings to the small wetlands or Sand Creek. The ditches also provide a possible pathway to transport leachate from the soil to the wetlands or Sand Creek.

- **Exposure Media.** These are media where contaminants are available for exposure to ecological receptors. Potential exposure media at Load Line 11 are soil, sediment, surface water, vegetation, and animals.
- **Exposure Pathways.** A main exposure pathway is ingestion of contaminated food. Other exposure pathways may include ingesting 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 11 were defined in the Level I ERA (Section 7.3.2). Five types of habitats were described. Habitats, species, and other resources were analyzed, and it was determined that important or significant ecological resources are present at Load Line 11. One small planning level survey wetland and one emergent wetland (e.g., marsh) associated with the East Ditch are located at Load Line 11. 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 5.3 details chemical concentration data. The PBA08 RI included collecting discrete surface soil (0-1 ft bgs), sediment, and surface water samples. Some locations were different from the historical sample locations, and some were co-located with previous samples (Figures 5-2 through 5-11).

As discussed in Section 7.1.1, the soil data within the geographic area of Load Line 11 were subdivided into two EUs: FPA and NPA. The FPA includes the area inside the gravel perimeter road and all former buildings and operational areas. The NPA includes the area outside the production area to the fence line. The FPA contains all known or potential primary contaminant sources, such as the former operational buildings. The former buildings located within the NPA were limited to administrative and storage functions. The sediment and surface water samples were divided into two EUs: East Ditch and West Ditch. This ERA uses updated SRVs (Appendix H, Table H-6) and ESVs that follow the revised *Ecological Risk Assessment Guidance* (Ohio EPA 2008), as provided in Appendix H, Tables H-7 through H-9.

The hierarchy of ESVs is based on the information found in the Ohio EPA risk assessment guidance (Ohio EPA 2008) and FWERWP (USACE 2003a). The MDC of each chemical is compared to its respective facility-wide background concentration. Sediment concentrations are also compared to the SRV. Chemicals are not considered site-related if the MDC is below the background concentration. For all chemicals detected above background concentrations, the MDC is compared to the chemical-specific ESV. In addition to the ESV comparison, it was determined if the chemical is a PBT compound. 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 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 average concentration also be compared to the Ohio EPA outside mixing zone average (OMZA) ESV when available (Appendix H, Table H-9). However, there is only one surface water sample for each surface water EU at Load Line 11, so average concentrations were not available to compare against the OMZA. As a result, the MDC was compared against the OMZA and OMZM at the East and West Ditches.

Maximum Detected Concentrations. The MDCs were compared to the background concentrations and ESVs (Appendix H, Tables H-10 through H-15) for detected chemicals. These comparisons are provided for soil in the FPA (Appendix H, Table H-10), soil in the NPA (Appendix H, Table H-11), sediment in the East Ditch (Appendix H, Table H-12), sediment in the West Ditch (Appendix H, Table H-13), surface water in the East Ditch (Appendix H, Table H-14), and surface water in the West Ditch (Appendix H, Table H-15).

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. The hierarchy for soil is ecological soil screening levels (EcoSSLs), PRGs, and ESLs. The hierarchy for sediment is the Sediment Quality Guidelines, followed by ESLs. The hierarchy for surface water is the Ohio EPA WQC, National Recommended WQC, and ESLs. Appendix H provides for values and sources for ESVs in Tables H-7 through H-9.

7.3.3.4 Integrated COPECs for Surface Soil (0-1 ft bgs)

As discussed in Section 7.1.1, the soil data within the geographic area of Load Line 11 were subdivided into two EUs: FPA and NPA. A summary of the integrated COPECs identified in soil at the FPA and NPA follows.

Integrated COPECs for Surface Soil (0-1 ft) at the Former Production Area. During the PBA08 RI, 48 chemicals were detected in surface soil at the FPA. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. A total of 16inorganic chemicals, 2 anions, and 22 organic chemicals were determined to be SRCs because they exceeded background concentrations or did not have an associated background concentration for comparison. Of the 40 SRCs, 12 inorganic chemicals (aluminum, arsenic, cadmium, chromium, cobalt, copper, cyanide, lead, manganese, mercury, vanadium, and zinc), 1 anion (sulfide), and 1 organic chemical (PCB-1254) exceeded their ESVs and were identified as integrated COPECs (Table 7-15). In addition, one anion (nitrate) and four organic chemicals (nitrocellulose, nitroguanidine, PETN, and tetryl) were selected as integrated COPECs because they do not have an ESV for comparison. Two of the integrated COPECs (mercury and PCB-1254) were also PBT compounds. Table 7-15 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 at the FPA.

Most inorganic COPECs reported in the historical ERA (Table 7-12) for soil are also identified in this ERA. The historical ERA (MKM 2005a) identified two inorganic COPECs (iron and nickel) that are not integrated COPECs for the FPA. Nickel at the FPA was below the new, less conservative ESV (Ohio EPA 2008) (Appendix H, Table H-10), and iron was considered an essential nutrient in the new data set. Seven new integrated COPECs (aluminum, cadmium, cobalt, copper, nitroguanidine, PETN, and tetryl) were identified in this ERA. Aluminum was considered an essential nutrient in the historical ERA; however, aluminum is not considered an essential nutrient in the PBA08 ERA and is identified as an integrated COPEC. Three other inorganic COPECs (cadmium, cobalt, and copper) were identified in the FPA due to detections above new, more conservative ESVs (Ohio EPA 2008). Four new integrated COPECs (nitroguanidine, PETN, tetryl, and PCB-1254) were identified due to detections of these organic chemicals in samples collected during the PBA08 RI.

Integrated COPECs for Surface Soil (0-1 ft) at the Non-Production Area. During the PBA08 RI, 45 chemicals were detected in surface soil at the NPA. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. A total of 14 inorganic chemicals, 2 anions, and 19 organic chemicals were determined to be SRCs because they either exceeded their background concentrations or did not have an associated background concentration for comparison. Of the 35 SRCs, 7 inorganic chemicals (arsenic, cadmium, cobalt, lead, manganese, mercury, and zinc) and 1 anion (sulfide) exceeded the ESVs and were identified as integrated COPECs (Table 7-16). In addition, one anion (nitrate) and three organic chemicals (HMX, nitrocellulose, and PETN) were selected as integrated COPECs because they do not have an ESV for comparison. One PBT compound (PCB-1254) was also identified as a COPEC, even though it did not exceed its ESV. One integrated COPEC (mercury) was also a PBT compound. Table 7-16 shows the calculated ratio of MDC to ESV for each integrated COPEC. Appendix H, Table H-11 presents the details of the ESV comparisons for surface soil at the NPA.

Some inorganic COPECs reported in the historical ERA (Table 7-12) for soil are also identified in this ERA. The historical ERA (MKM 2005a) identified five COPECs (chromium, cyanide, iron, nickel, and vanadium) that are not integrated COPECs for the NPA. Iron was considered an essential nutrient in the new data set (Appendix H, Table H-11); chromium and nickel were below their new, less conservative ESVs (Ohio EPA 2008); and vanadium was below its background concentration. Cyanide was not detected in NPA soil above its ESV. Four new integrated COPECs (cadmium, cobalt, HMX, and PETN) were identified in this ERA. Cadmium and cobalt were identified in the NPA due to detections above new, more conservative ESVs (Ohio EPA 2008). Two new integrated COPECs (HMX and PETN) were identified due to detections of these organic chemicals in samples collected during the PBA08 RI.

7.3.3.5 Integrated COPECs for Sediment

As discussed in Section 7.1.1, the sediment data collected within the geographic area of Load Line 11 were subdivided into two EUs: East Ditch and West Ditch. A summary of the integrated COPECs identified in sediment at the East Ditch and West Ditch is presented below.

Integrated COPECs for Sediment at the East Ditch. During the PBA08 RI, 36 chemicals were detected in sediment at the East Ditch. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. A total of 3 inorganic chemicals and 15 organic chemicals were determined to be SRCs because they either exceeded their background concentrations or did not have an associated background concentration for comparison. Of the 18 SRCs, 1 organic chemical [benz(a)anthracene] exceeded its ESV and was identified as an integrated COPEC (Table 7-17). In addition, two inorganic chemicals (beryllium and selenium) were selected as integrated COPECs because they do not have an ESV for comparison. No PBT compounds were identified in the East Ditch sediment. Table 7-17 shows the calculated ratio of MDC to ESV for each integrated COPEC. Appendix H, Table H-12 presents the details of the ESV comparisons for sediment at the East Ditch.

Two COPECs [beryllium and benz(a)anthracene] reported in the historical ERA (Table 7-12) for sediment are also identified in this ERA for the East Ditch. The historical ERA (MKM 2005a) identified 4 inorganic COPECs (copper, lead, manganese, and nickel), 3 anions (nitrate, sulfate, and sulfide), and 10 organic COPECs [benzo(a)pyrene, benzo(ghi)perylene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, total PAHs, PCB-1254, and nitrocellulose] that are not integrated COPECs for East Ditch sediment because concentrations of these chemicals in the East Ditch did not exceed their ESVs, SRVs, or background concentrations (Appendix H, Table H-12). One new integrated COPEC (selenium) was identified for East Ditch sediment in the PBA08 RI. The addition of selenium was due to a detection above its background concentration.

Integrated COPECs for Sediment at the West Ditch. During the PBA08 RI, 32 chemicals were detected in sediment at the West Ditch. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. A total of 3 inorganic chemicals, 1 anion, and 10 organic chemicals were determined to be SRCs because they exceeded their background concentrations, did not have an associated background concentration for comparison, or were PBT compounds. Of the 14 SRCs, 2 chemicals (beryllium and sulfide) were selected as integrated COPECs because they do not have an ESV for comparison. Mercury did not exceed its ESV; however, it was selected as an integrated COPEC because it is a PBT compound. Table 7-18 shows the calculated ratio of MDC to ESV for each integrated COPEC. Appendix H, Table H-13 presents the details of the ESV comparisons for sediment at the West Ditch.

Two COPECs (beryllium and sulfide) reported in the historical ERA (Table 7-12) for sediment are also identified in this ERA for the West Ditch. The historical ERA (MKM 2005a) identified 4 inorganic COPECs (copper, lead, manganese, and nickel), 2 anions (nitrate and sulfate), and 11 organic COPECs [benz(a)anthracene, benzo(a)pyrene, benzo(ghi)perylene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, total PAHs, PCB-1254, and nitrocellulose] that are not integrated COPECs for West Ditch sediment because concentrations of these chemicals in the West Ditch did not exceed their ESVs, SRVs, or background concentrations (Appendix H, Table H-13). One PBT compound (mercury) was also identified as an integrated COPEC for the West Ditch, even though it did not exceed its ESV.

7.3.3.6 Integrated COPECs for Surface Water

As discussed in Section 7.1.1, the surface water data within the geographic area of Load Line 11 were subdivided into two EUs: East Ditch and West Ditch. A summary of the integrated COPECs identified in surface water at the East Ditch and West Ditch is presented below.

Integrated COPECs for Surface Water at the East Ditch. During the PBA08 RI, 18 chemicals were detected in surface water at the East Ditch. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. Six inorganic chemicals and two organic chemicals were determined to be SRCs because they exceeded their background concentrations, did not have an associated background concentration for comparison, or were PBT compounds. Of the eight SRCs, two PBT compounds (beta-BHC and gamma-chlordane) were identified as integrated COPECs (Table 7-19), even though they did not exceed their ESVs. No other SRCs exceeded their ESVs. Table 7-19 shows the calculated ratio of MDC to ESV for each integrated COPEC. Appendix H, Table H-14 presents the details of the MDC to OMZM ESV comparisons and Appendix H, Table H-16 presents the details of the MDC to OMZA ESV comparisons for surface water at the East Ditch. These comparisons used the OMZM and OMZA from Ohio EPA WQC, when available, as the ESV; when the OMZM or OMZA were not available, the hierarchy of preferred sources was followed, as presented in Section 7.3.3.3.

The historical ERA (MKM 2005a) identified two COPECs (manganese and sulfate) that are not integrated COPECs for surface water in the East Ditch. Manganese was below its background concentration (Appendix H, Table H-14), and sulfate was not detected in East Ditch surface water.

Integrated COPECs for Surface Water at the West Ditch. During the PBA08 RI, 30 chemicals were detected in surface water at the West Ditch. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. A total of 12 inorganic chemicals and 11 organic chemicals were determined to be SRCs because they exceeded their background concentrations, did not have an associated background concentration for comparison, or were PBT compounds. Of the 23 SRCs, 1 inorganic chemical (manganese) and 1 organic chemical [benzo(a)pyrene] exceeded their ESVs and were identified as integrated COPECs (Table 7-20). In addition, one organic chemical [benzo(k)fluoranthene] was selected as an integrated COPEC because it does not have an ESV for comparison. Beta-BHC did not exceed its ESV; however, it was selected as an integrated COPEC because it is a PBT compound. Table 7-20 shows the calculated ratio of MDC to ESV for each integrated COPEC. Appendix H, Table H-15 presents the details of the MDC to OMZM ESV comparisons and Appendix H, Table H-17 presents the details of the MDC to OMZA ESV comparisons for surface water at the West Ditch. These comparisons used the OMZM and OMZA from Ohio EPA WQC, when available, as the ESV; when the OMZM or OMZA were not available, the hierarchy of preferred sources was followed, as presented in Section 7.3.3.3.

One of the COPECs (manganese) reported in the historical ERA (Table 7-12) for surface water is also identified in this ERA for the West Ditch. The historical ERA (MKM 2005a) identified one other COPEC (sulfate) that was not detected in West Ditch surface water. Three new integrated COPECs [benzo(a)pyrene, benzo(k)fluoranthene and beta-BHC] were identified in this ERA.

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, as 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 ecological risk assessment should be initiated.”

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

- Comparing average (i.e., mean) concentration to ESV,
- Comparing mean concentration to background concentration,
- Comparing background concentration to ESV,
- Determining frequency of chemical occurrence relative to ESV,
- Observing magnitude of ESV exceedance (ratio of ESV to chemical concentrations),

- Discussing Ohio EPA approved and preferred ESVs,
- Evaluating qualitative relationship of exposure area to general home range,
- Categorizing wetland quality inside the AOC,
- Evaluating geographical relationship of on-site wetlands to AOC exceedance area,
- Obtaining information about on-site migration of chemicals to on-site wetlands, and
- Evaluating off-site migration of chemicals at biological/water quality stations.

Surface soil at Load Line 11 is divided into two EUs: FPA and NPA. For the FPA, there are 19 integrated COPECs in surface soil. Aluminum, arsenic, cadmium, chromium, cobalt, copper, cyanide, lead, manganese, mercury, vanadium, zinc, sulfide, and PCB-1254 are the 14 integrated COPECs that exceeded their background concentrations and ESVs. Mercury and PCB-1254 are also PBT compounds. Five additional chemicals (nitrate, nitrocellulose, nitroguanidine, PETN, and tetryl) are integrated COPECs because they do not have an ESV. For the NPA, there are 13 integrated COPECs in surface soil. Arsenic, cadmium, cobalt, lead, manganese, mercury, zinc, and sulfide are the eight integrated COPECs that exceeded their background concentrations and ESVs. PCB-1254 did not exceed its ESV but was identified as a COPEC because it is a PBT compound. One other COPEC (mercury) was also identified as a PBT compound. Four additional chemicals (nitrate, HMX, nitrocellulose, and PETN) are integrated COPECs because they do not have an ESV.

Sediment at Load Line 11 is divided into two EUs: East Ditch and West Ditch. In the East Ditch, there are three integrated COPECs in sediment [beryllium, selenium, and benz(a)anthracene]. Benz(a)anthracene exceeded its ESV, and beryllium and selenium were integrated COPECs by default (i.e., the chemical does not have an ESV). In the West Ditch, there are three integrated COPECs in sediment (beryllium, mercury, and sulfide). Beryllium and sulfide were integrated COPECs because they do not have an ESV, and mercury is a PBT compound.

Surface water at Load Line 11 is divided into two EUs: East Ditch and West Ditch. In the East Ditch, there are two integrated COPECs in surface water (beta-BHC and gamma-chlordane). Beta-BHC and gamma-chlordane did not exceed their ESVs but were identified as COPECs because they are PBT compounds. In the West Ditch, there are four integrated COPECs in surface water [manganese, benzo(a)pyrene, benzo(k)fluoranthene, and beta-BHC]. Manganese and benzo(a)pyrene are the only integrated COPECs that exceeded their background concentrations and ESVs [benzo(a)pyrene has no background value available], benzo(k)fluoranthene was an integrated surface water COPEC because it does not have an ESV, and beta-BHC is a PBT compound that did not exceed its ESV.

Chemicals with no ESVs are discussed later in Step 3A and in Section 7.3.3.9. PBT compounds are discussed later in Step 3A. All integrated COPECs that have an MDC to ESV ratio greater than one 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 and are listed below.

- Comparing average (i.e., mean) concentration to ESV,
- Comparing mean concentration to background concentration,
- Comparing background concentration to ESV, and
- Determining 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).

Comparing background concentration to an 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 applying additional evaluation and refinement factors, when necessary. The COPECs for each soil EU are defined separately.

Former Production Area – Comparison of Mean Concentration to ESV. Seven integrated COPECs (arsenic, cadmium, chromium, cobalt, copper, cyanide, and PCB-1254) in soil are eliminated in this step because the mean concentration is smaller than the ESV (Appendix H, Table H-16). 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.

Arsenic. Arsenic was detected in all 47 discrete samples analyzed for inorganic chemicals at the FPA. Only 11 samples had detections above the background concentration, and 8 samples had arsenic concentrations exceeding the ESV (Table 7-22). Although the MDC for arsenic in surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and background concentration. Therefore, arsenic was eliminated from further consideration and will not be a final COPEC.

Cadmium. Cadmium was detected in 26 of 47 discrete soil samples analyzed for inorganic chemicals at the FPA, but only 7 samples had cadmium concentrations exceeding the ESV (Table 7-22). Although the MDC for cadmium in surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV. Therefore, cadmium was eliminated from further consideration and will not be a final COPEC.

Chromium. Chromium was detected in all 47 discrete samples analyzed for inorganic chemicals at the FPA. A total of 10 samples exceeded the background concentration, and only 2 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 and background concentration. Therefore, chromium was eliminated from further consideration and will not be a final COPEC.

Cobalt. Cobalt was detected in all 47 discrete samples analyzed for inorganic chemicals at the FPA. Six samples had detections above the background concentration, but only two of these samples had cobalt concentrations exceeding the ESV (Table 7-22). Although the MDC for cobalt in surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and background concentration. Therefore, cobalt was eliminated from further consideration and will not be a final COPEC.

Copper. Copper was detected in all 47 discrete samples analyzed for inorganic chemicals at the FPA. Nineteen samples were above the background concentration, and only three 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 was eliminated from further consideration and will not be a final COPEC.

Cyanide. Cyanide was detected in 3 of 34 discrete soil samples analyzed for inorganic chemicals at the FPA, but only 1 sample had a cyanide concentration exceeding the ESV (Table 7-22). Although the MDC for cyanide in surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV. Therefore, cyanide was eliminated from further consideration and will not be a final COPEC.

PCB-1254. PCB-1254 was detected in 4 of 12 discrete samples analyzed for PCBs at the FPA. There is no background concentration for comparison, but only one sample had a concentration exceeding the ESV (Table 7-22). Although the MDC for PCB-1254 in surface soil exceeds the ESV, the mean concentration is less than the ESV. While PCB-1254 is a PBT compound, the ESV accounted for bioaccumulation (DOE 1997); therefore, PCB-1254 was eliminated from further consideration and will not be a final COPEC. Additional information about PBT compounds is provided later in Step 3A.

Of the 14 integrated FPA surface soil COPECs with MDCs exceeding the ESV, 7 COPECs (arsenic, cadmium, chromium, cobalt, copper, cyanide, and PCB-1254) were eliminated from further consideration. Seven remaining integrated COPECs with MDCs greater than the ESV (aluminum, lead, manganese, mercury, vanadium, zinc, and sulfide) in FPA surface soil have mean concentrations larger than the ESV.

Non-Production Area – Comparison of Mean Concentration to ESV. Four integrated COPECs (arsenic, cadmium, cobalt, and PCB-1254) in soil are eliminated in this step because the mean concentration is smaller than the ESV (Appendix H, Table H-17). Each eliminated integrated COPEC is discussed relative to the mean concentration being smaller than the ESV and the related evaluation and refinement factors. Table 7-23 shows the relevant data and various comparisons.

Arsenic. Arsenic was detected in 29 of 30 discrete samples analyzed for inorganic chemicals at the NPA. Only five samples had detections above the background concentration, and only three samples had arsenic concentrations exceeding the ESV (Table 7-23). Although the MDC for arsenic in surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and background concentration. Therefore, arsenic was eliminated from further consideration and will not be a final COPEC.

Cadmium. Cadmium was detected in 17 of 30 discrete soil samples analyzed for inorganic chemicals at the NPA. All 17 detections were above the background concentrations, but only 4 samples had cadmium concentrations exceeding the ESV (Table 7-23). Although the MDC for cadmium in surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV. Therefore, cadmium was eliminated from further consideration and will not be a final COPEC.

Cobalt. Cobalt was detected in all 30 discrete samples analyzed for inorganic chemicals at the NPA. Seven samples had detections above the background concentration, but only one of these samples had a cobalt concentration exceeding the ESV (Table 7-23). Although the MDC for cobalt in surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and background concentration. Therefore, cobalt was eliminated from further consideration and will not be a final COPEC.

PCB-1254. PCB-1254 was detected in 1 of 14 discrete samples analyzed for PCBs at the NPA. The detected PCB-1254 concentration did not exceed its ESV in surface soil in the NPA but was retained as a COPEC because it is a PBT compound (Table 7-23). While PCB-1254 is a PBT compound, the ESV accounted for bioaccumulation (DOE 1997); therefore, PCB-1254 was eliminated from further consideration and will not be a final COPEC. Additional information about PBT compounds is provided later in Step 3A.

Of the nine integrated NPA surface soil COPECs with MDCs exceeding the ESV, four COPECs (arsenic, cadmium, cobalt, and PCB-1254) were eliminated from further consideration. Five remaining integrated COPECs with MDCs greater than the ESV (lead, manganese, mercury, zinc, and sulfide) in NPA surface soil have mean concentrations larger than the ESV.

Former Production Area – Comparison of Mean Concentration Above ESV to Background Concentration. Three integrated COPECs (aluminum, manganese, and vanadium) in surface soil at the FPA have mean concentrations larger than the ESV but are eliminated in this step because the mean concentration is smaller than the background concentration. Each eliminated integrated COPEC is discussed relative to the various evaluation and refinement factors.

Aluminum. Aluminum in surface soil at the FPA has a mean concentration less than the background concentration (Table 7-22). The background concentration is more than 350 times greater than the ESV, so the ESV can be considered conservative. Although aluminum was detected in all 47 discrete samples at concentrations above the ESV, only 3 samples had detections exceeding the background concentration. Having only three samples exceed the background concentration suggests the concentration of aluminum in surface soil is not likely a concern. Additionally, aluminum is not a concern because the soil pH is too high to dissociate the chemical. A typical soil pH is 6-7 at one of the nearby load lines at RVAAP (USACE 2004). Regarding aluminum chemistry and ecological risk in soil, the USEPA states, “aluminum is identified as a COPC only for soil with a pH less than 5.5” (USEPA 1999a). Therefore, because the mean concentration is less than the background concentration, the ESV is conservative, and the soil pH at RVAAP is higher than the USEPA dissociation limit, aluminum was eliminated from further consideration and will not be a final COPEC.

Manganese. Manganese in surface soil in the FPA has a mean concentration less than the background concentration, and the background concentration is more than six times greater than the ESV

(Table 7-22). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Manganese was detected in 42 of 47 discrete samples at concentrations above the ESV; however, only 2 samples had detections which (slightly) exceeded the background concentration. Although the MDC for manganese in surface soil exceeds the background concentration and the ESV, the MDC is just slightly greater than background concentration, the mean concentration is below background concentration, and the ESV is conservative. Therefore, manganese was eliminated from further consideration and will not be a final COPEC.

Vanadium. Vanadium in surface soil in the FPA has a mean concentration less than the background concentration, and the background concentration is approximately four times greater than the ESV (Table 7-22). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Vanadium was detected in 46 of 47 discrete samples at concentrations above the ESV; however, only 2 samples had detections which (slightly) exceeded the background concentration. Although the MDC for vanadium in surface soil exceeds the background concentration and the ESV, the MDC is slightly greater than background concentration, the mean concentration is below background concentration, and the ESV is conservative. Therefore, vanadium was eliminated from further consideration and will not be a final COPEC.

Non-Production Area – Comparison of Mean Concentration Above ESV to Background Concentration. Three integrated COPECs (lead, manganese, and mercury) in surface soil at the NPA are eliminated in this step because the mean concentration is larger than the ESV but smaller than the background concentration. Each eliminated integrated COPEC is discussed relative to the various evaluation and refinement factors.

Lead. Lead in surface soil in the NPA has a mean concentration less than the background concentration, and the background concentration is more than twice the ESV (Table 7-23). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Lead was detected in 27 of 29 discrete samples at concentrations above the ESV; however, only 4 samples had detections exceeding the background concentration. Although the MDC for lead in surface soil exceeds the background concentration and the ESV, the mean concentration is below the background concentration, and the ESV is conservative. Therefore, lead was eliminated from further consideration and will not be a final COPEC.

Manganese. Manganese in surface soil in the NPA has a mean concentration less than the background concentration, and the background concentration is more than six times greater than the ESV (Table 7-23). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Manganese was detected in 29 of 30 discrete samples at concentrations above the ESV; however, only 2 samples had detections exceeding the background concentration. Although the MDC for manganese in surface soil exceeds the background concentration and the ESV, the mean concentration is below the background concentration, and the ESV is conservative. Therefore, manganese was eliminated from further consideration and will not be a final COPEC.

Mercury. Mercury in surface soil in the NPA has a mean concentration less than the background concentration, and the background concentration is 70 times greater than the ESV (Table 7-23).

Because the ESV is lower than the background concentration, the ESV can be considered conservative. Mercury was detected in 14 of 30 discrete samples, with all detections above the ESV; 11 of 30 samples had detections exceeding the background concentration. Although the MDC for mercury in surface soil exceeds the background concentration and the ESV, the mean concentration is below the background concentration, and the ESV is conservative. Therefore, mercury was eliminated from further consideration and will not be a final COPEC.

Former Production Area – Continued Evaluations. The remaining four integrated COPECs (lead, mercury, zinc, and sulfide) at the FPA in surface soil have mean concentrations greater than the ESV and the background concentration (Table 7-24). Each remaining integrated COPEC is discussed below relative to the first four and related evaluation and refinement factors.

Lead. Lead in FPA surface soil has a mean concentration greater than the background concentration and ESV. It was detected above the background concentration in 21 of 47 discrete samples and above the ESV in 44 of 47 samples (Table 7-24). 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 the background concentration and ESV. Lead requires further evaluation as a COPEC.

Mercury. Mercury in FPA surface soil has a mean concentration greater than the background concentration and ESV. Mercury was detected above the background concentration in 13 of 17 discrete samples and above the ESV in all 17 samples (Table 7-24). 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 the background concentration and ESV. Mercury requires further evaluation as a COPEC.

Zinc. Zinc in FPA surface soil has a mean concentration greater than the background concentration and ESV. It was detected above the background concentration in 22 of 47 discrete samples and at concentrations above the ESV in 42 of 47 samples (Table 7-24). 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 the background concentration and the ESV, zinc requires further evaluation as a COPEC.

Sulfide. Sulfide in FPA surface soil has a mean concentration greater than the ESV. There is no background concentration for comparison. Sulfide was detected above the ESV in all 22 samples (Table 7-24). Because the mean concentration in surface soil exceeds the ESV and there is not a background concentration for comparison, sulfide requires further evaluation as a COPEC.

Non-Production Area – Continued Evaluations. The remaining two integrated COPECs (zinc and sulfide) at the NPA in surface soil have mean concentrations greater than the ESV and the background concentration (Table 7-24). Each remaining integrated COPEC is discussed below and discussed relative to the first four and related evaluation and refinement factors.

Zinc. Zinc in NPA surface soil has a mean concentration greater than the background concentration and ESV. It was detected above the background concentration in 12 of 30 discrete samples and at concentrations above the ESV in 25 of 30 samples (Table 7-24). 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 the background concentration and the ESV, zinc requires further evaluation as a COPEC.

Sulfide. Sulfide in NPA surface soil has a mean concentration greater than the ESV. There is no background concentration for comparison. It was detected above the ESV in all 11 samples (Table 7-24). Because the mean concentration in surface soil exceeds the ESV and there is not a background concentration for comparison, sulfide 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 (lead, mercury, zinc, and sulfide at the FPA and zinc and sulfide at the NPA) have mean concentrations higher than their background concentrations. If the degree of difference between the mean concentration and the background concentration is small, the integrated COPEC will not be considered a final COPEC. Table 7-24 shows that while the mean concentration exceeds the background concentration, the exceedance is often relatively small. For example, the mean concentration for lead at the FPA is 29.6 mg/kg, while the background concentration is 26.1 mg/kg. Sulfide does not have an established background concentration at RVAAP; therefore, a comparison of mean concentration to background concentration is not available.

Additional Technical and Refinement Factors. The next three evaluation and refinement factors include:

- Observing magnitude of ESV exceedance (ratio of ESV to chemical concentrations),
- Discussing Ohio EPA approved and preferred ESVs, and
- Evaluating qualitative relationship of exposure area to general home range.

Former Production Area – Magnitude of ESV Exceedance. Although the mean concentration to ESV ratios for lead (2.7), mercury (77.8), zinc (1.7), and sulfide (13,770) indicate a possibility of risk, the ratio for zinc is relatively small (Appendix H, Table H-16). The small ratio for zinc indicates the potential for toxicity is relatively low, and this likely supports eliminating zinc as an integrated COPEC. The *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008) states:

> "If only minor exceedances are detected and other evidence can substantiate, a claim may be made that some or all of the site-associated soils have not been impacted and no additional ecological investigation of the soils is warranted."

Non-Production Area – Magnitude of ESV Exceedance. Although the mean concentration to ESV ratios for zinc (1.7) and sulfide (11,620) indicate a possibility of risk, the ratio for zinc is relatively small (Appendix H, Table H-17). The small ratio for zinc indicates the potential for toxicity is relatively low, and this supports eliminating zinc as an integrated COPEC.

Comparison of Ohio EPA Approved and Preferred ESVs. The *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008) gives specific guidance on selecting 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 2003a). 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 at the FPA and two integrated COPECs at the NPA.

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 2005). The ESV of 11 mg/kg is about four times lower than the ESV (40.5 mg/kg) from the next source of ESVs preferred by Ohio EPA (Appendix H, Table H-7) (DOE 1997). The preferred ESV used for lead is also lower than the background concentration of 26.1 mg/kg (Appendix H, Table H-10), while all of the other EcoSSLs and the alternate ESV are above the background concentration. This information indicates the Ohio EPA approved and preferred ESV for lead, and 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 2003b) (Appendix H, Table H-7), and the background concentration (0.036 mg/kg) (Appendix H, Table H-10). The *Preliminary Remediation Goals for Ecological Endpoints* labels the form of mercury as an "inorganic chemical" and notes 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 2007a). The ESV of 46 mg/kg is about five times greater than the ESV (8.5 mg/kg) from the next source of ESVs preferred by Ohio EPA (Appendix H, Table H-7) (DOE 1997). The preferred ESV used for zinc is also lower than the background concentration of 61.8 mg/kg (Appendix H, Table H-10), while all of the other EcoSSLs are above the background concentration. These factors indicate the Ohio EPA approved and preferred ESV for zinc is somewhat conservative; thus, the selection of zinc as a COPEC is somewhat conservative.

The Ohio EPA approved and preferred sulfide ESV used in this ERA is 0.00358 mg/kg. This value is from the USEPA Region 5 ESLs (USEPA 2003a) (Appendix H, Table H-7). Sulfide does not have any known alternative ESVs.

The above information about alternative ESVs shows there are less conservative ESVs that could be chosen for the Level II work. Table 7-25 shows the ratio of ESV-to-mean concentration for the preferred ESV and an alternative ESV. This alternative ESV is the ESV with the closest concentration to the preferred ESV that is above the background concentration. For the four remaining integrated COPECs at the FPA, using the alternative ESV would decrease ratios to less than one for lead, mercury, and zinc. Using the alternative ESV for mercury would decrease the ratio to 0.4. For the two remaining integrated COPECs at the NPA, using the alternative ESV would decrease the ratio to less than one for zinc. If the alternative ESVs were used, lead, mercury, and zinc would be eliminated from further consideration and would not be final COPECs. However, sulfide still needs further evaluation.

Qualitative Relationship of Exposure Area to General Home Range. A majority of the highest lead, mercury, zinc, and sulfide concentrations in surface soil (0-1 ft bgs) are scattered near the former buildings and roads at Load Line 11 (Figures 5-2 and 5-4). The highest concentrations are as follows:

- Lead at the FPA: 102 mg/kg at LL11cs-006 and 97.1 mg/kg at LL11ss-016.
- Mercury at the FPA: 0.34 mg/kg at LL11ss-013 and 0.08 mg/kg at LL11cs-025 and LL11ss-003.
- Zinc at the FPA: 465 mg/kg at LL11cs-025 and 219 mg/kg at LL11cs-021.
- Zinc at the NPA: 478 mg/kg at LL11ss-078 and 176 mg/kg at LL11cs-039.
- Sulfide at the FPA: 244 mg/kg at LL11ss-001 and 226 mg/kg at LL11ss-014.
- Sulfide at the NPA: 85.5 mg/kg at LL11ss-030 and 79.7 mg/kg at LL11sd-014.

Wildlife receptors, especially those with small one-acre home ranges (e.g., small birds and mammals such as robins and field mice), could be exposed to the highest detected concentrations of lead, mercury, zinc, or sulfide at the FPA and zinc or sulfide at the NPA. The highest concentrations of integrated COPECs are interspersed with large areas of lower concentrations over many acres. For example, the two highest mercury concentrations are about 600 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 would be exposed is small.

An examination of the number of concentrations detected above the alternative ESVs (discussed in the previous section) indicates receptor exposures would be limited to these elevated concentrations. Specifically, in the FPA, only 1 of the 47 mercury results is above the alternative ESV. Lead (8 of 47 detections) and zinc (11 of 47 detections) at the FPA, and zinc (4 of 30 detections) at the NPA also have relatively limited exceedances of the alternative ESVs compared to the overall number of detections. Thus, COPEC exposure to receptors would be relatively small, suggesting that lead, mercury, and zinc can be eliminated from further consideration and would not be final COPECs.

Sulfide needs to be further evaluated because all detections exceeded the only available ESV of 0.00358 mg/kg.

Other Considerations. Sulfide was only measured to better characterize the soil and not for risk purposes in the Phase I RI (MKM 2005a). However, once the measurements were available, a risk assessment was conducted by MKM Engineers, Inc. (MKM). Sulfide became a historical COPEC because the MDC (244 mg/kg) exceeded the ESV (0.00358 mg/kg). Given the absence of background concentrations for sulfide at RVAAP and in Ohio, it was not possible to determine if AOC concentrations were similar to background concentrations. To provide perspective, sulfide was detected at a maximum of 928 mg/kg and a median of 117 mg/kg in background samples in Massachusetts (BBL 2002). In Kentucky, soil background concentrations for sulphur were used as a proxy for sulfide; background soil concentrations ranged between 260 and 1,600 mg/kg (DOE 1995). Thus, the MDC for sulfide at Load Line 11 is within the range of these background concentrations. Although there is no other known ESV for sulfide, there are other protective values for sulfides in soil. For example, human health values, often based on animal studies, are greater than 1,000,000 mg/kg for hydrogen sulfide, according to USEPA (2010b). This is several orders of magnitude higher than the 0.00358 mg/kg ESV.

Sulphur and sulfides are naturally occurring in soil and sediment, and sulfides can help reduce toxicity of contaminants. Sulfides bind with metals and make them less bioavailable than their oxide, hydroxide, carbonate, and sulfate forms. Metals in soil and sediment would also show reduced toxicity when they are bound to the sulfides. The above information suggests that sulfide can be eliminated from further consideration and would not be a final COPEC.

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. Evaluating sediment and surface water includes chemical-specific evaluation and refinement factors and the qualitative relationship of exposure area to general home range.

Sediment. The three integrated COPECs in sediment at the East Ditch are beryllium, selenium, and benz(a)anthracene (Table 7-17), and the three integrated COPECs in sediment at the West Ditch are beryllium, mercury, and sulfide (Table 7-18). Beryllium, selenium, and sulfide were identified as integrated COPECs by default (i.e., the chemicals did not have an ESV) and are discussed later in Step 3A and in Section 7.3.3.9. Mercury did not exceed its ESV but was retained as a COPEC because it is a PBT compound. Mercury is discussed later in Step 3A. One COPEC [benz(a)anthracene] had an MDC that exceeded the ESV and is discussed below.

Benz(a)anthracene. Benz(a)anthracene was detected in the one discrete sediment sample collected in the East Ditch, and the single detection slightly exceeded the ESV (Table 7-17; Appendix H, Table H-12). Benz(a)anthracene does not have a background concentration for comparison; therefore, it was evaluated further. The magnitude of ESV exceedance was very low; the MDC to ESV ratio was 1.02

(Appendix H, Table H-12). The small ratio indicates risk to ecological receptors is small and this supports eliminating benz(a)anthracene as an integrated COPEC for sediment in the East Ditch.

Surface Water. The two integrated COPECs in surface water at the East Ditch are beta-BHC and gamma-chlordane (Table 7-19) and the four integrated COPECs in surface water at the West Ditch are manganese, benzo(a)pyrene, benzo(k)fluoranthene, and beta-BHC (Table 7-20). Benzo(k)fluoranthene was identified as an integrated COPEC because it did not have an ESV and is discussed later in Step 3A and in Section 7.3.3.9. Beta-BHC and gamma-chlordane did not exceed their ESVs but were retained as COPECs because they are PBT compounds. Beta-BHC and gamma-chlordane are discussed later in Step 3A. Two COPECs (manganese and benzo(a)pyrene) had MDCs that exceeded the ESVs and are discussed below.

Manganese. Manganese (0.559 mg/L) was detected above its background concentration (0.39 mg/L) and the ESV (0.12 mg/L) in the single West Ditch surface water sample included in the PBA08 RI. Although the MDC to ESV ratio for manganese (4.7) in surface water at the West Ditch indicates a possibility of risk, manganese had a concentration less than the background concentration for manganese in the West Ditch sediment, and mean concentrations in both soil EUs were below the background concentration. This information suggests limited source material for the elevated detections in the surface water, and this chemical may not become a final COPEC; however, manganese will undergo further evaluation.

Benzo(a)pyrene. Benzo(a)pyrene (0.00033 mg/L) was detected above its OMZA ESV (0.00006 mg/L) in the single West Ditch surface water sample included in the PBA08 RI. Benzo(a)pyrene does not have a background concentration for comparison. Benzo(a)pyrene was below its OMZM ESV and became a COPEC when compared to the OMZA. Although the MDC to ESV ratio for benzo(a)pyrene (5.5) in surface water at the West Ditch indicates a possibility of risk, the MDC for benzo(a)pyrene was below its ESV in the sediment of the West Ditch and in both soil EUs. This information suggests limited source material for the elevated detection in the surface water, and this chemical may not become a final COPEC; however, benzo(a)pyrene will undergo further evaluation.

Summary. In summary, no sediment COPECs required further evaluation. The only integrated COPECs retained for further evaluation in surface water are manganese and benzo(a)pyrene in the West Ditch.

Comparison of Ohio EPA Approved and Preferred ESVs. The *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008) gives guidance on selecting media screening values (ESVs) for Level II evaluation. For surface water, five possible sources of ESV values are listed in order of preference: (1) Ohio EPA Administrative Code OMZAs, (2) Ohio EPA Administrative Code OMZMs, (3) National Ambient WQC, (4) Tier II values (Suter & Tsao 1996), and (5) *Region 5 Ecological Screening Levels* (USEPA 2003a). It is possible that the chosen ESV is too conservative. Consequently, alternative ESVs are presented below for the remaining two integrated COPECs in surface water at the West Ditch.

The Ohio EPA approved and preferred manganese ESV used in this ERA is 0.12 mg/L. This value is from Tier II (Suter & Tsao 1996) (Appendix H, Table H-9). Manganese does not have any known alternative surface water ESVs.

The Ohio EPA approved and preferred benzo(a)pyrene ESV used in this ERA is 0.00006 mg/L. This ESV is from the Ohio EPA Administrative Code OMZAs (Appendix H, Table H-9). The benzo(a)pyrene OMZA ESV used in this ERA is about 10 times lower than the OMZM ESV (0.00054 mg/L) and about 4 times higher than the other available surface water ESV for benzo(a)pyrene (0.000014 mg/L, USEPA 2003a).

Qualitative Relationship of Exposure Area to General Home Range. The West Ditch drains the central portion of the AOC and flows southwest through Wetland 1 to an unnamed tributary to Sand Creek. The West Ditch receives surface water from a network of small ditches. Intermittent surface water flows in drainage ditches at Load Line 11. SAIC scientists have observed no water in the West Ditch during repeated visits to the area during sampling and other activities. The intermittent surface water in the West Ditch is not sufficient to create and maintain aquatic habitat. Any ecological receptor that uses Load Line 11 as part of its home range would have only incidental contact with the West Ditch. The relatively low exposure supports removing manganese and benzo(a)pyrene as integrated COPECs in surface water in the West Ditch.

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:

- Categorizing wetland quality inside the AOC,
- Evaluating geographical relationship of on-site wetlands to AOC exceedance area, and
- Obtaining 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 [lead, mercury, zinc, sulfide, manganese, and benzo(a)pyrene] will not be of ecological concern to wetlands and do not need to be evaluated as final COPECs.

There are two small wetlands at Load Line 11. Wetland 1 is a planning level survey wetland that straddles the western boundary of the AOC (Figure 7-1) (OHARNG 2014). It is a Category 1 wetland (with an ORAM score of 28). Wetland 2 was not previously identified on any wetland surveys and has likely formed as a result of blocked drainage in the East Ditch. It is a Category 1 wetland (with an ORAM score of 21). Category 1 indicates low wetland quality, with degradation of wetland functions.

Wetland 1 is small in size, with 0.13 acres inside the AOC (Figure 7-1). Wetland 2 is about 0.02 acres. RVAAP contains about 1,970 acres of wetlands, and the 0.15 acres of wetlands inside the habitat boundary at Load Line 11 represent 0.008% of the total wetland area of RVAAP (OHARNG 2014). The relatively small area and availability of many more wetland acres at RVAAP lowers the importance of the wetlands at Load Line 11.

The main mechanism for migration of on-site COPECs to the wetlands is via the ditches. Chemicals in soil that migrate into the ditches are then transported to the wetlands in ditch sediment and surface water. The West Ditch drains toward Wetland 1 and becomes less channelized approximately 200 ft southeast of Wetland 1. However, it is possible that contaminants in the ditch or in the soil immediately adjacent to Wetland 1 could migrate into and potentially impact the wetland. Similarly, the East Ditch drains directly into Wetland 2, which has likely formed around a blocked or obstructed culvert in the ditch (Photograph 7-2).

Any COPECs impacting Wetland 1 most likely originate from the West Ditch sediment and surface water. In the West Ditch, the COPECs are beryllium, mercury, and sulfide in sediment and manganese, benzo(a)pyrene, benzo(k)fluoranthene, and beta-BHC in surface water. No direct chemical concentration measurements were taken in the wetland, but adjacent soil samples were taken at LL11sb-066 and LL11ss-028. Manganese, mercury, and sulfide were found in the adjacent soil samples, but only sulfide was at high concentrations (i.e., average and maximum concentrations above the background concentration and ESV). In the West Ditch sediment closest to the wetland, mercury was at a lower concentration than in the soil, and sulfide was not reported. Mercury was also below its background concentration, SRV, and ESV. Manganese and benzo(a)pyrene were not COPECs in either soil or sediment near Wetland 1. This suggests that the remaining integrated COPECs in soil, sediment, and surface water are unlikely to impact Wetland 1. Importantly, there is a biological/water quality station downstream of Wetland 1 where the five assessment attributes exhibit such rankings as excellent, good, and exceptional (Table 7-13).

Any COPECs impacting Wetland 2 most likely originate from the East Ditch sediment and surface water. In the East Ditch, the COPECs are beryllium, selenium, and benz(a)anthracene in sediment and beta-BHC and gamma-chlordane in surface water. No chemical concentration measurements were taken directly in the small 0.02 acre area. However, samples LL11sd/sw-083, LL11sd-017, and LL11sw-012 were taken directly adjacent to the wetland. The most recent sample (LL11sd/sw-083) was included in the East Ditch data set, but the two older samples it replaced (LL11sd-017 and LL11sw-012) had similar or lower concentrations of sediment and surface water COPECs. None of the East Ditch sediment and surface water COPECs were of ecological concern in the FPA soil (i.e., soil COPECs). Further, although some soil COPECs (arsenic, cadmium, cobalt, lead, manganese, and zinc) were detected in the East Ditch, concentrations in sediment were lower, and none were at levels of ecological concern (i.e., above background concentrations, SRVs, and/or ESVs) in the ditch. Thus, no nearby soil, sediment, or surface water COPECs are likely to adversely affect the small wetland. Importantly, vegetation appears healthy at Wetland 2, and the downstream biological/water quality station exhibits rankings of excellent, good, and exceptional for the five assessment attributes (Table 7-13).

Evaluation of Biological and Water Quality Sampling Stations. The last evaluation and refinement factor is:

- Evaluating off-site migration of chemicals at biological/water quality stations.

Various biological measurements of macroinvertebrates and fish, as well as chemical and physical measurements of surface water and sediment, were taken and assessed for evidence of upgradient and downgradient contamination. These studies were published in the *Facility-wide Biological and Water Quality Study* (USACE 2005a). Monitoring stations are positioned in streams and ponds downgradient of several AOCs. One sampling station (S-1) is upstream of Load Line 11, and one station (S-2) is downstream of the AOC. When the assessment attributes are positively rated (e.g., “good,” “excellent,” “full attainment status”), this is evidence the downstream sampling station has not been impaired by upstream chemical conditions at the AOC.

The measurements taken at each station are sediment chemistry and conditions, surface water chemistry and conditions, fish community, benthic macroinvertebrate community, and habitat conditions. Also, a statement about attainment status is provided. Table 7-13 shows the results of the attributes for both sampling stations (S-1 and S-2). Review of the *Facility-Wide Biology and Water Quality Study* (USACE 2005a) data from the two sampling stations showed many positive metrics and no sign of aquatic impairment.

Table 7-13 shows the biological, sediment, and water quality attributes at the downstream location (S-2) indicate little to no impairment (i.e., Full Attainment Status). No inorganic or organic chemicals were detected above their screening criteria; therefore, chemicals at Load Line 11 have not adversely affected downstream ecological conditions. This greatly reduces concern for the remaining COPECs (in soil, sediment, and water) at Load Line 11.

Evaluation of PBT Compounds and COPECs Without ESVs. As discussed in Level II, there are two chemicals that are PBT compounds in surface soil (mercury and PCB-1254), one chemical that is a PBT compound in sediment (mercury), and two chemicals that are PBT compounds in surface water (beta-BHC and gamma-chlordane). Six chemicals (nitrate, HMX, nitrocellulose, nitroguanidine, PETN, and tetryl) are integrated COPECs by default (i.e., the chemicals did not have ESVs) in surface soil, three (beryllium, selenium, and sulfide) are COPECs by default in sediment, and one [benzo(k)fluoranthene] is a COPEC by default in surface water at Load Line 11. 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 ingesting 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 2007b). Deriving EcoSSL values includes uptake equations that account for direct ingestion and food chain bioaccumulation (USEPA 2007b). 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.

The USEPA Region 5 ESLs (USEPA 2003a) are an Ohio EPA-approved source for soil, sediment, and surface water ESVs (see Appendix H, Tables H-7 to H-9 for hierarchies); they are a source of screening values for some PBT compounds not covered by the EcoSSLs or PRGs. The ESLs also account for bioaccumulation in the food chain, as "development of ESLs focused on mammalian or avian species and identified those chemicals that have the potential for significant bioaccumulation or biomagnification" (USEPA 1999b). Thus, development of ESLs included bioaccumulation in higher tropic levels as a standard component in the equations, and PBT compounds with ESVs in soil, sediment, and surface water from this source that have ratios less than one can be dismissed as final COPECs. For this ERA, this includes PCB-1254 in surface soil at the NPA and beta-BHC in surface water in the East Ditch and West Ditch. PCB-1254 in FPA surface soil was previously evaluated in Step 3A, and it will not be a final COPEC because the MDC (0.42 mg/kg) is just slightly greater than the ESV (0.371 mg/kg) and the mean concentration (0.0562 mg/kg) is less than the ESV.

Mercury was detected in both soil EUs above the ESV, which accounts for bioaccumulation (DOE 1997). These exceedances are not surprising considering the background concentration is 70 times greater than the ESV. At the NPA, the mean concentration of mercury (0.034 mg/kg) is below the background concentration (0.036 mg/kg) (Table 7-23); therefore, mercury was eliminated from further consideration and will not be a final COPEC at NPA. While the mean concentration of mercury (0.0397 mg/kg) at the FPA is slightly above the background concentration (0.036 mg/kg) (Table 7-22), the similarity between the concentrations suggests exposures to mercury at Load Line 11 are no different from background concentrations. Thus, mercury at the FPA was eliminated from further consideration and will not be a final COPEC.

In the West Ditch, mercury is the only chemical in sediment identified as an integrated COPEC because it is a PBT compound. While the mean concentration and MDC are below the ESV, the sediment ESV does not account for bioaccumulation. However, the MDC (0.049 mg/kg) is below the background concentration (0.059 mg/kg) (Appendix H, Table H-13). Mercury was found in 1 of 5 samples in the ditches. Thus, the frequency is low. These facts support the view that mercury does not need to be retained as a final COPEC. Therefore, mercury was eliminated from further consideration and will not be a final COPEC in sediment.

In the East Ditch, gamma-chlordane was identified as an integrated COPEC for surface water because it is a PBT compound. The MDC (0.000015 mg/kg) is below the ESV (0.0043 mg/kg) (Appendix H, Table H-14); therefore, gamma-chlordane was eliminated from further consideration and will not be a final COPEC.

PBT compounds at Load Line 11 are mercury and PCB-1254 in surface soil, mercury in sediment, and beta-BHC and gamma-chlordane in surface water. As discussed above, all PBT compounds are dismissed and will not be final COPECs.

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 prior to submitting the report. For Load Line 11, a search for (and subsequent approval of) additional values was not deemed necessary. Rather, to mitigate concern for the uncertainties associated with COPECs that lack ESVs, a limited additional evaluation was conducted for each medium, focusing on frequency of detection, relationship to background concentration, and other chemical-specific refinement factors.

For soil at the FPA, the integrated COPECs without ESVs are nitrate, nitrocellulose, nitroguanidine, PETN, and tetryl. Nitrate was detected in 7 of 34 samples, nitroguanidine was detected in 1 of 4 samples, PETN was detected in 1 of 7 samples, and tetryl was detected in 1 of 41 samples. Thus, exposure to these chemicals would be limited. While nitrocellulose was detected in 4 of 4 samples, it is essentially non-toxic (USEPA 1987), and this chemical is also not expected to be an ecological concern. For soil at the NPA, the integrated COPECs without ESVs are nitrate, HMX, nitrocellulose, and PETN. Nitrate was detected in 6 of 17 samples, HMX was detected in 1 of 29 samples, and PETN was detected in 1 of 12 samples. Thus, exposure to these chemicals would be limited. While nitrocellulose was detected in 3 of 5 samples, it is essentially non-toxic (USEPA 1987), and this chemical is also not expected to be an ecological concern. In addition, nitrate is unlikely to be of ecological concern. As discussed in the Phase I RI (MKM 2005a), nitrate analysis was conducted primarily for gross characterization of AOC soil conditions and not for risk assessment purposes. Although it is possible that nitrate is related to the AOC, nitrates in soil are not typically considered to be toxic and are often added to soil as fertilizer.

For sediment in the East Ditch, beryllium and selenium were the only identified integrated COPECs without ESVs. Beryllium was detected in two of two sediment samples; however, the mean concentration (0.81 mg/kg) is essentially the same as the SRV (0.8 mg/kg). Selenium was detected in two of two sediment samples; however, the mean concentration (2.6 mg/kg) is similar to the SRV (1.7 mg/kg). Beryllium and selenium are not considered of ecological concern in sediment.

For sediment in the West Ditch, beryllium and sulfide were the only identified integrated COPECs without ESVs. Beryllium was detected in three of three sediment samples; however, the mean concentration (0.81 mg/kg) is essentially the same as the SRV (0.8 mg/kg). Sulfide was detected in one of one sediment sample. Sulfide toxicity varies as a function of its binding with metals. Binding with metals lowers toxicity. Given the number of detected metals in the sediment and the principle of binding by sulfides, it is likely that sulfide toxicity is relatively low. As discussed in the Phase I RI (MKM 2005a), sulfide analysis was conducted primarily for gross characterization of AOC conditions and not for risk assessment purposes. Beryllium and sulfide are not considered of ecological concern in sediment.

Surface water in the East Ditch did not have integrated COPECs without ESVs. For surface water in the West Ditch, one PAH [benzo(k)fluoranthene] was the only identified integrated COPEC without an ESV for comparison. Benzo(k)fluoranthene was detected in one surface water sample at a low concentration of 0.00024 mg/L. While benzo(k)fluoranthene does not have an ESV, it is detected below all ESVs for other detected PAHs in surface water [e.g., 0.023 mg/L ESV for benzo(b)fluoranthene]. In addition, benzo(k)fluoranthene was detected below its ESV in all soil and sediment samples at Load Line 11. As a result, benzo(k)fluoranthene is not likely an ecological concern for surface water.

Summary of Findings in Step 3A. Of the 20 integrated COPECs in surface soil at Load Line 11, the six that did not have ESVs – nitrate, HMX, nitrocellulose, nitroguanidine, PETN, and tetryl – 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 (arsenic, cadmium, chromium, cobalt, copper, cyanide, and PCB-1254) or the mean concentration is smaller than the background concentration (aluminum, manganese, and vanadium). One PBT compound (PCB-1254) was eliminated because it had a ratio less than one, using an ESV that accounted for bioaccumulation.

The remaining four integrated COPECs in soil (lead, mercury, zinc, and sulfide) have a combination of factors that together eliminated them from further consideration as presented below.

1. Most mean concentrations are only slightly higher than background concentrations.
2. Many mean concentration-to-ESV ratios of exceedance are near one.
3. Ohio EPA guidance allows alternative ESVs that are less conservative than the ESVs used in this ERA. These alternate ESVs (unlike the preferred ESV) are above background concentrations. If these alternate ESVs were used in lieu of current ESVs, ratios for lead, mercury, and zinc would be below one.
4. Samples with highly elevated concentrations are scattered widely, and few ecological receptors are exposed to soil with detected concentrations above the alternative ESVs.
5. The wetlands are relatively small and of low quality, and on-site migration is possible.
6. Off-site downstream sampling station indicates a healthy environment.

No final COPECs were identified for Load Line 11 surface soil.

Of the five integrated COPECs in sediment, beryllium, selenium, and sulfide have no ESVs. They were eliminated as COPECs because the mean concentration is essentially the same as the SRV for beryllium and selenium. Sulfide was collected for gross soil characterization reasons, concentrations were similar to available background concentrations, and it is often bound with metals; these points helped to eliminate sulfide as a COPEC. Benz(a)anthracene was eliminated because the MDC was similar to the ESV. Despite mercury being a PBT compound with an ESV that did not recognize bioaccumulation, mercury was eliminated due to the similarity of mean concentration and background concentration, low mean-to-ESV ratio, and the positive conditions in the downstream station in nearby Sand Creek. No final COPECs were identified for Load Line 11 sediment.

Of the five integrated COPECs in surface water, benzo(a)fluoranthene had no ESV. PBT compounds beta-BHC and gamma-chlordane were eliminated because the MDCs are considerably lower than the ESVs. Manganese and benzo(a)pyrene lack sources in soil and sediment media that contribute to surface water; mean concentrations in soil and maximum concentrations in sediment for manganese are below background, and maximum concentrations for benzo(a)pyrene in both media are below ESVs. No final COPECs were identified for Load Line 11 surface water.

7.3.3.8 Consideration of Human Health Driven Remediation

After the 2001 IRA was conducted [i.e., removing sumps, 230 yd^3 of contaminated media in drainage ditches, and a hot spot of petroleum-contaminated soil (MKM 2004a)], the HHRA did not identify any additional COCs for remediation and recommends no further action for surface soil, sediment, and surface water at Load Line 11. Thus, there will be no remediation implemented to further protect human health that would also protect ecological resources at Load Line 11.

7.3.3.9 Uncertainties and Mitigations

Uncertainties or unknowns are present in both exposure 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. To mitigate uncertainty in effects information, a site visit for habitat condition was conducted, and the latest INRMP of rare species sightings and jurisdictional wetlands was used (OHARNG 2014). 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. There are some COPECs by default (i.e., the chemicals 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. Using ESVs that are lower than background concentrations indicates the conservative nature of the evaluation. Conservative ESVs are appropriate for use as screening thresholds in Level I and II (i.e., soil constituents with an MDC below the ESV need no further consideration in Level II).

7.3.3.10 Summary and Recommendations of Screening Level Ecological Risk Assessment

Integrated COPECs were identified in surface soil, sediment, and surface water at Load Line 11. Most of the soil COPECs identified in the historical ERA were also identified during screening of PBA08 RI data. Three historical COPECs were not identified during the PBA08 RI, and a few new COPECs were identified due to additional sampling data. Some comparable historical sediment and surface water data were available and were considered. Those chemicals retained after screening historical and PBA08 RI data were termed integrated COPECs.

Twenty integrated soil COPECs, five integrated sediment, and five integrated surface water COPECs were further evaluated in Step 3A with technical and refinement factors. All integrated soil, sediment, and surface water COPECs were determined to be of no ecological concern. None require remediation or further evaluation. Consequently, the ERA for Load Line 11 can conclude with a Level II ERA that no further action is necessary to be protective of important ecological receptors.

7.3.4 Conclusions

As indicated in Section 4.2, in 2001 an IRA was performed as an early response to contamination in primary pathways at Load Line 11. This IRA included removing sumps, 230 yd^3 of contaminated media in drainage ditches, and a hot spot of petroleum-contaminated soil (MKM 2004a). This ERA concludes that there is chemical contamination currently present in surface soil, sediment, and surface water at Load Line 11. This contamination was identified using historical and PBA08 RI data. Dry, mid-successional, cold-deciduous shrubland (dominant vegetation type); dry, mid-successional, herbaceous field; and four types of forests were observed on the 48 acres of the AOC. Wetlands 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 factors in Step 3A showed there is no further evaluation necessary for integrated COPECs, and there is no ecological concern requiring additional remediation. Consequently, the ERA for Load Line 11 can conclude with Level II ERA that no further action is necessary to be protective of important ecological receptors. This supports the conclusion from the Phase I RI, which stated:

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

Table 7–1. Risk Assessment Data Set for Surface Soil (0-1 ft bgs) Discrete Samples

Location	Sample ID	Date	Depth (ft bgs)
Former Production Area			
LL11cs-006	LL11cs-006-0001-SD	3/21/2001	0 - 1
LL11cs-010	LL11cs-010-0001-SD	3/21/2001	0 - 1
LL11cs-011	LL11cs-011-0001-SD	3/23/2001	0 - 1
LL11cs-016	LL11cs-016-0001-SD	3/23/2001	0 - 1
LL11cs-020	LL11cs-020-0001-SO	3/23/2001	0 - 1
LL11cs-021	LL11cs-021-0001-SD	3/21/2001	0 - 1
LL11cs-025	LL11cs-025-0001-SD	3/21/2001	0 - 1
LL11cs-030	LL11cs-030-0001-SD	3/21/2001	0 - 1
LL11sb-001	LL11sb-001-0001-SO	10/31/2000	0 - 1
LL11sb-003	LL11sb-003-0001-SO	10/30/2000	0 - 1
LL11sb-004	LL11sb-004-0001-SO	10/31/2000	0 - 1
LL11sb-008	LL11sb-008-0001-SO	10/31/2000	0 - 1
LL11sb-009	LL11sb-009-0001-SO	10/30/2000	0 - 1
LL11sb-019	LL11sb-019-0001-SO	8/21/2000	0 - 1
LL11sb-020	LL11sb-020-0001-SO	8/21/2000	0 - 1
LL11sb-021	LL11sb-021-0001-SO	8/21/2000	0 - 1
LL11sb-022	LL11sb-022-0001-SO	8/22/2000	0 - 1
LL11sb-023	LL11sb-023-0001-SO	8/22/2000	0 - 1
LL11sb-060	LL11sb-060-5551-SO	3/18/2010	0 - 1
LL11sb-061	LL11sb-061-5555-SO	3/17/2010	0 - 1
LL11sb-062	LL11sb-062-5559-SO	3/18/2010	0 - 1
LL11sb-064	LL11sb-064-5569-SO	3/18/2010	0 - 1
LL11sd-023	LL11sd-023-0001-SD	11/15/2000	0 - 1
LL11sd-025	LL11sd-025-0001-SD	11/16/2000	0 - 1
LL11sd-026	LL11sd-026-0001-SD	11/16/2000	0 - 1
LL11sd-031	LL11sd-031-0001-SD	11/16/2000	0 - 1
LL11ss-001	LL11ss-001-0001-SO	11/7/2000	0 - 1
LL11ss-002	LL11ss-002-0001-SO	11/6/2000	0 - 1
LL11ss-003	LL11ss-003-0001-SO	11/7/2000	0 - 1
LL11ss-004	LL11ss-004-0001-SO	11/7/2000	0 - 1
LL11ss-008	LL11ss-008-0001-SO	11/7/2000	0 - 1
LL11ss-009	LL11ss-009-0001-SO	11/8/2000	0 - 1
LL11ss-010	LL11ss-010-0001-SO	11/13/2000	0 - 1
LL11ss-013	LL11ss-013-0001-SO	11/8/2000	0 - 1
LL11ss-014	LL11ss-014-0001-SO	11/6/2000	0 - 1
LL11ss-015	LL11ss-015-0001-SO	11/8/2000	0 - 1
LL11ss-016	LL11ss-016-0001-SO	11/13/2000	0 - 1
LL11ss-017	LL11ss-017-0001-SO	11/8/2000	0 - 1
LL11ss-018	LL11ss-018-0001-SO	11/9/2000	0 - 1
LL11ss-019	LL11ss-019-0001-SO	11/10/2000	0 - 1
LL11ss-020	LL11ss-020-0001-SO	11/10/2000	0 - 1
LL11ss-021	LL11ss-021-0001-SO	11/9/2000	0 - 1
LL11ss-022	LL11ss-022-0001-SO	11/9/2000	0 - 1
LL11ss-023	LL11ss-023-0001-SO	11/9/2000	0 - 1
LL11ss-024	LL11ss-024-0001-SO	11/9/2000	0 - 1
LL11ss-025	LL11ss-025-0001-SO	11/9/2000	0 - 1
LL11ss-071	LL11ss-071-5597-SO	4/12/2010	0 - 1

Table 7-1. Risk Assessment Data Set for Surface Soil (0-1 ft bgs) Discrete Samples (continued)

Location	Sample ID	Date	Depth (ft bgs)
LL11ss-074	LL11ss-074-5600-SO	4/12/2010	0 - 1
LL11ss-076	LL11ss-076-5602-SO	4/12/2010	0 - 1
LL11ss-072[a]	LL11ss-072-5598-SO	4/12/2010	0 - 1
LL11ss-073[a]	LL11ss-073-5599-SO	4/12/2010	0 - 1
LL11ss-075[a]	LL11ss-075-5601-SO	4/12/2010	0 - 1
Non-Production Area			
LL11cs-039	LL11cs-039-0001-SD	3/20/2001	0 - 1
LL11sb-002	LL11sb-002-0001-SO	10/30/2000	0 - 1
LL11sb-005	LL11sb-005-0001-SO	10/31/2000	0 - 1
LL11sb-006	LL11sb-006-0001-SO	10/31/2000	0 - 1
LL11sb-007	LL11sb-007-0001-SO	10/31/2000	0 - 1
LL11sb-010	LL11sb-010-0001-SO	10/31/2000	0 - 1
LL11sb-063	LL11sb-063-5563-SO	3/22/2010	0 - 1
LL11sb-065	LL11sb-065-5573-SO	3/22/2010	0 - 1
LL11sb-066	LL11sb-066-5577-SO	3/22/2010	0 - 1
LL11sb-067	LL11sb-067-5581-SO	3/18/2010	0 - 1
LL11sb-068	LL11sb-068-5585-SO	3/18/2010	0 - 1
LL11sb-069	LL11sb-069-5589-SO	3/22/2010	0 - 1
LL11sd-014	LL11sd-014-0001-SD	11/14/2000	0 - 1
LL11sd-015	LL11sd-015-0001-SD	11/14/2000	0 - 1
LL11sd-016	LL11sd-016-0001-SD	11/14/2000	0 - 1
LL11sd-020	LL11sd-020-0001-SD	11/15/2000	0 - 1
LL11sd-022	LL11sd-022-0001-SD	11/15/2000	0 - 1
LL11sd-029	LL11sd-029-0001-SD	11/16/2000	0 - 1
LL11ss-026	LL11ss-026-0001-SO	11/10/2000	0 - 1
LL11ss-027	LL11ss-027-0001-SO	11/10/2000	0 - 1
LL11ss-028	LL11ss-028-0001-SO	11/10/2000	0 - 1
LL11ss-029	LL11ss-029-0001-SO	11/14/2000	0 - 1
LL11ss-030	LL11ss-030-0001-SO	11/14/2000	0 - 1
LL11ss-031	LL11ss-031-0001-SO	11/10/2000	0 - 1
LL11ss-070	LL11ss-070-5596-SO	4/12/2010	0 - 1
LL11ss-077	LL11ss-077-5603-SO	4/12/2010	0 - 1
LL11ss-078	LL11ss-078-5604-SO	4/12/2010	0 - 1
LL11ss-079	LL11ss-079-5605-SO	4/12/2010	0 - 1
LL11ss-080	LL11ss-080-5606-SO	4/12/2010	0 - 1
LL11ss-081	LL11ss-081-5607-SO	4/12/2010	0 - 1

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

Table 7–2. Risk Assessment Data Set for Subsurface Soil (1-13 ft bgs): Discrete Samples

Location	Sample ID	Date	Depth (ft bgs)
Former Production Area			
LL11cs-007	LL11cs-007-0001-SO	3/21/2001	1 - 2
LL11cs-008	LL11cs-008-0001-SO	3/21/2001	1 - 2
LL11cs-009	LL11cs-009-0001-SO	3/21/2001	1 - 2
LL11cs-012	LL11cs-012-0001-SO	3/23/2001	1 - 2
LL11cs-017	LL11cs-017-0001-SO	3/23/2001	1 - 2
LL11cs-018	LL11cs-018-0001-SO	3/23/2001	1 - 2
LL11cs-019	LL11cs-019-0001-SO	3/23/2001	1 - 2
LL11cs-022	LL11cs-022-0001-SO	3/21/2001	1 - 2
LL11cs-023	LL11cs-023-0001-SO	3/21/2001	1 - 2
LL11cs-024	LL11cs-024-0001-SO	3/21/2001	1 - 2
LL11cs-026	LL11cs-026-0001-SD	3/21/2001	1 - 2
LL11cs-027	LL11cs-027-0001-SO	3/21/2001	1 - 2
LL11cs-028	LL11cs-028-0001-SO	3/21/2001	1 - 2
LL11cs-029	LL11cs-029-0001-SO	3/21/2001	1 - 2
LL11cs-032	LL11cs-032-0001-SO	3/20/2001	1 - 2
LL11cs-033	LL11cs-033-0001-SO	3/20/2001	1 - 2
LL11sb-060	LL11sb-060-5552-SO	3/18/2010	1 - 4
LL11sb-061	LL11sb-061-5556-SO	3/17/2010	1 - 4
LL11sb-062	LL11sb-062-5560-SO	3/18/2010	1 - 4
LL11sb-064	LL11sb-064-5570-SO	3/18/2010	1 - 4
LL11ss-001	LL11ss-001-0002-SO	11/7/2000	1 - 3
LL11ss-002	LL11ss-002-0002-SO	11/6/2000	1 - 3
LL11ss-003	LL11ss-003-0002-SO	11/6/2000	1 - 3
LL11ss-004	LL11ss-004-0002-SO	11/7/2000	1 - 3
LL11ss-007	LL11ss-007-0002-SO	11/13/2000	1 - 3
LL11ss-008	LL11ss-008-0002-SO	11/7/2000	1 - 3
LL11ss-009	LL11ss-009-0002-SO	11/8/2000	1 - 3
LL11ss-010	LL11ss-010-0002-SO	11/13/2000	1 - 3
LL11ss-013	LL11ss-013-0002-SO	11/8/2000	1 - 3
LL11ss-014	LL11ss-014-0002-SO	11/7/2000	1 - 3
LL11ss-015	LL11ss-015-0002-SO	11/8/2000	1 - 3
LL11ss-016	LL11ss-016-0002-SO	11/13/2000	1 - 3
LL11ss-017	LL11ss-017-0002-SO	11/8/2000	1 - 3
LL11ss-018	LL11ss-018-0002-SO	11/9/2000	1 - 3
LL11ss-019	LL11ss-019-0002-SO	11/10/2000	1 - 3
LL11ss-020	LL11ss-020-0002-SO	11/10/2000	1 - 3
LL11ss-021	LL11ss-021-0002-SO	11/9/2000	1 - 3
LL11ss-022	LL11ss-022-0002-SO	11/9/2000	1 - 3
LL11ss-023	LL11ss-023-0002-SO	11/9/2000	1 - 3
LL11ss-024	LL11ss-024-0002-SO	11/9/2000	1 - 3
LL11ss-025	LL11ss-025-0002-SO	11/9/2000	1 - 3
LL11cs-001	LL11cs-001-0001-SO	1/24/2001	5 - 6
LL11cs-002	LL11cs-002-0001-SO	1/26/2001	5 - 6
LL11cs-003	LL11cs-003-0001-SO	1/26/2001	5 - 6
LL11cs-004	LL11cs-004-0001-SO	2/21/2001	5 - 6
LL11cs-005	LL11cs-005-0001-SO	2/21/2001	5 - 6
LL11sb-009	LL11sb-009-0002-SO	11/13/2000	4 - 6
LL11sb-011	LL11sb-011-0001-SO	8/21/2000	4 - 6
LL11sb-017	LL11sb-017-0001-SO	8/22/2000	4 - 6
LL11sb-018	LL11sb-018-0001-SO	8/22/2000	4 - 6
LL11sb-019	LL11sb-019-0002-SO	8/21/2000	6 - 8

Table 7-2. Risk Assessment Data Set for Subsurface Soil (1-13 ft bgs): Discrete Samples (continued)

Location	Sample ID	Date	Depth (ft bgs)
LL11sb-020	LL11sb-020-0002-SO	8/21/2000	6 - 8
LL11sb-021	LL11sb-021-0002-SO	8/21/2000	6 - 8
LL11sb-022	LL11sb-022-0002-SO	8/22/2000	6 - 8
LL11sb-023	LL11sb-023-0002-SO	8/22/2000	6 - 8
LL11sb-041	LL11sb-041-0001-SO	3/13/2001	6 - 8
LL11sb-042	LL11sb-042-0001-SO	3/13/2001	6 - 8
LL11sb-043	LL11sb-043-0001-SO	3/13/2001	6 - 8
LL11sb-060	LL11sb-060-5553-SO	3/18/2010	4 - 7
LL11sb-061	LL11sb-061-5557-SO	3/17/2010	4 - 7
LL11sb-062	LL11sb-062-5561-SO	3/18/2010	4 - 7
LL11sb-064	LL11sb-064-5571-SO	3/18/2010	4 - 7
LL11sb-004	LL11sb-004-0002-SO	11/8/2000	10 - 12
LL11sb-008	LL11sb-008-0002-SO	11/8/2000	12 - 13
LL11sb-012	LL11sb-012-0001-SO	8/22/2000	8 - 10
LL11sb-013	LL11sb-013-0001-SO	8/22/2000	8 - 10
LL11sb-014	LL11sb-014-0001-SO	8/22/2000	11 - 13
LL11sb-015	LL11sb-015-0001-SO	8/22/2000	10 - 12
LL11sb-016	LL11sb-016-0001-SO	8/22/2000	8.5 - 11.5
LL11sb-064	LL11sb-064-5572-SO	3/18/2010	7 - 13
Non-Production Area			
LL11cs-013	LL11cs-013-0001-SO	3/23/2001	1 - 2
LL11cs-014	LL11cs-014-0001-SO	3/23/2001	1 - 2
LL11cs-034	LL11cs-034-0001-SO	3/20/2001	1 - 2
LL11cs-035	LL11cs-035-0001-SO	3/20/2001	1 - 2
LL11cs-036	LL11cs-036-0001-SO	3/20/2001	1 - 2
LL11cs-037	LL11cs-037-0001-SO	3/20/2001	1 - 2
LL11cs-038	LL11cs-038-0001-SO	3/20/2001	1 - 2
LL11cs-040	LL11cs-040-0001-SO	3/22/2001	3 - 7
LL11cs-041	LL11cs-041-0001-SO	3/22/2001	3 - 7
LL11cs-042	LL11cs-042-0001-SO	3/22/2001	3 - 7
LL11cs-043	LL11cs-043-0001-SO	3/22/2001	3 - 7
LL11cs-046	LL11cs-046-0001-SO	3/22/2001	3 - 4
LL11cs-047	LL11cs-047-0001-SO	3/22/2001	3 - 4
LL11cs-048	LL11cs-048-0001-SO	3/22/2001	3 - 4
LL11cs-049	LL11cs-049-0001-SO	3/22/2001	3 - 4
LL11cs-050	LL11cs-050-0001-SO	3/22/2001	3 - 4
LL11sb-006	LL11sb-006-0002-SO	11/13/2000	2 - 4
LL11sb-063	LL11sb-063-5564-SO	3/22/2010	1 - 4
LL11sb-065	LL11sb-065-5574-SO	3/22/2010	1 - 4
LL11sb-066	LL11sb-066-5578-SO	3/22/2010	1 - 4
LL11sb-067	LL11sb-067-5582-SO	3/18/2010	1 - 4
LL11sb-068	LL11sb-068-5586-SO	3/18/2010	1 - 4
LL11sb-069	LL11sb-069-5590-SO	3/22/2010	1 - 4
LL11ss-026	LL11ss-026-0002-SO	11/10/2000	1 - 3
LL11ss-027	LL11ss-027-0002-SO	11/10/2000	1 - 3
LL11ss-028	LL11ss-028-0002-SO	11/10/2000	1 - 3
LL11ss-029	LL11ss-029-0002-SO	11/14/2000	1 - 3
LL11ss-030	LL11ss-030-0002-SO	11/14/2000	1 - 3
LL11ss-031	LL11ss-031-0002-SO	11/10/2000	1 - 3
LL11sb-002	LL11sb-002-0002-SO	11/10/2000	6 - 8
LL11sb-005	LL11sb-005-0002-SO	11/9/2000	6 - 8
LL11sb-025	LL11sb-025-0001-SO	11/17/2000	5 - 7

Table 7-2. Risk Assessment Data Set for Subsurface Soil (1-13 ft bgs): Discrete Samples (continued)

Location	Sample ID	Date	Depth (ft bgs)
LL11sb-026	LL11sb-026-0001-SO	11/16/2000	4 - 6
LL11sb-027	LL11sb-027-0001-SO	11/16/2000	6 - 8
LL11sb-028	LL11sb-028-0001-SO	11/16/2000	4 - 6
LL11sb-029	LL11sb-029-0001-SO	11/16/2000	6 - 8
LL11sb-035	LL11sb-035-0001-SO	11/17/2000	4 - 6
LL11sb-037	LL11sb-037-0001-SO	3/13/2001	6 - 8
LL11sb-038	LL11sb-038-0001-SO	3/13/2001	6 - 8
LL11sb-039	LL11sb-039-0001-SO	3/13/2001	6 - 8
LL11sb-040	LL11sb-040-0001-SO	3/13/2001	6 - 8
LL11sb-063	LL11sb-063-5565-SO	3/22/2010	4 - 5
LL11sb-065	LL11sb-065-5575-SO	3/22/2010	4 - 7
LL11sb-066	LL11sb-066-5579-SO	3/22/2010	4 - 7
LL11sb-067	LL11sb-067-5583-SO	3/18/2010	4 - 7
LL11sb-068	LL11sb-068-5587-SO	3/18/2010	4 - 7
LL11sb-069	LL11sb-069-5591-SO	3/22/2010	4 - 5
LL11cs-044	LL11cs-044-0001-SO	3/22/2001	7 - 8
LL11cs-045	LL11cs-045-0001-SO	3/22/2001	7 - 8
LL11sb-024	LL11sb-024-0001-SO	11/16/2000	7 - 9
LL11sb-030	LL11sb-030-0001-SO	11/17/2000	8 - 10
LL11sb-065	LL11sb-065-5576-SO	3/22/2010	7 - 13

bgs = Below ground surface.
Ft = Feet.
ID = Identification.

Table 7–3. Risk Assessment Data Set for Surface Water

Location	Sample ID	Date
East Ditch		
LL11sw-083	LL11sw-083-5609-SW	2/25/2010
West Ditch		
LL11sw-084	LL11sw-084-5610-SW	2/25/2010

ID = Identification.

Table 7–4. Risk Assessment Data Set for Sediment

Location	Sample ID	Date	Depth (ft bgs)
East Ditch			
LL11cs-031	LL11cs-031-0001-SD	3/20/2001	0 - 1
LL11sd-083	LL11sd-083-5594-SD	2/25/2010	0 - 0.5
West Ditch			
LL11cs-015	LL11cs-015-0001-SD	3/23/2001	0 - 1
LL11sd-024	LL11sd-024-0001-SD	11/16/2000	0 - 1
LL11sd-084	LL11sd-084-5595-SD	2/25/2010	0 - 0.5

ID = Identification.
bgs = Below ground surface.

Table 7–5. Summary of SRCs

SRC	Surface Soil (0-1 ft bgs)		Subsurface Soil (1-13 ft bgs)		Sediment		Surface Water	
	FPA	**NPA**	**FPA**	**NPA**	**ED**	**WD**	**ED**	**WD**
Inorganic Chemicals								
Aluminum	X	--	--	X	X	X	--	--
Antimony	--	--	--	--	X	X	--	X
Arsenic	X	X	X	X	X	--	--	X
Barium	X	X	X	X	--	--	--	X
Beryllium	X	--	X	X	X	X	--	X
Cadmium	X	X	X	X	X	--	--	X
Chromium	X	X	--	--	X	X	X	X
Cobalt	X	X	X	X	X	X	X	X
Copper	X	X	--	X	X	--	--	--
Cyanide	X	X	--	X	--	--	--	--
Lead	X	X	X	X	--	--	X	X
Manganese	X	X	--	--	--	--	--	X
Mercury	X	X	X	X	--	--	--	--
Nickel	X	X	--	--	X	X	X	X
Nitrate	X	X	X	X	--	--	--	--
Selenium	--	--	--	--	X	--	X	X
Silver	--	X	X	X	--	--	--	--
Sulfate	--	--	X	X	--	--	--	--
Sulfide	X	X	X	X	--	X	--	--
Thallium	X	X	--	X	--	--	--	--
Vanadium	X	--	--	--	--	X	X	X
Zinc	X	X	--	X	--	--	--	--
Explosives								
HMX	--	X	--	--	--	--	--	--
Nitrocellulose	X	X	X	X	--	--	--	--
Nitroguanidine	X	--	--	--	--	--	--	--
PETN	X	X	--	--	--	--	--	--
Tetryl	X	--	--	--	--	--	--	--
Pesticide/PCB								
beta-BHC	--	--	--	--	--	--	X	X
gamma-Chlordane	--	--	--	--	--	--	X	--
PCB-1254	X	X	X	--	--	--	--	--
Semi-volatile Organic Compounds								
2-Methylnaphthalene	--	--	--	--	X	--	--	--
Acenaphthene	X	X	--	--	--	--	--	--
Acenaphthylene	X	--	--	--	--	--	--	--
Anthracene	X	X	--	--	X	--	--	--
Benz(a)anthracene	X	X	--	--	X	X	--	X
Benzo(a)pyrene	X	X	--	X	X	X	--	X
Benzo(b)fluoranthene	X	X	--	X	X	X	--	X
Benzo(ghi)perylene	X	X	--	--	X	X	--	X
Benzo(k)fluoranthene	X	X	--	--	X	X	--	X
Chrysene	X	X	--	X	X	X	--	X
Dibenz(a,h)anthracene	X	X	--	--	X	--	--	--
Fluoranthene	X	X	--	X	X	X	--	X
Fluorene	X	X	--	--	X	--	--	--
Indeno(1,2,3-cd)pyrene	X	X	--	--	X	X	--	X

Table 7-5. Summary of SRCs (continued)

	Surface Soil (0-1 ft bgs)		Subsurface Soil (1-13 ft bgs)		Sediment		Surface Water	
SRC	**FPA**	**NPA**	**FPA**	**NPA**	**ED**	**WD**	**ED**	**WD**
Naphthalene	X	X	--	--	X	--	--	--
Phenanthrene	X	X	--	X	X	X	--	X
Pyrene	X	X	--	X	X	X	--	X
Volatile Organic Compounds								
Acetone	X	--	--	--	--	--	--	--
Miscellaneous								
TPH - DRO	--	--	--	X	--	--	--	--
TPH - GRO	--	--	--	X	--	--	--	--

bgs = Below ground surface.
BHC = Hexachlorocyclohexane.
DRO = Diesel range organics.
ED = East Ditch.
FPA = Former Production Area.
Ft = Feet.
GRO = Gasoline range organics.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane.
NPA = Non-Production Area.
PCB = Polychlorinated biphenyl.
PETN = Pentaerythritol tetranitrate.
SRC = Site-related contaminant.
TPH = Total petroleum hydrocarbon.
WD = West Ditch.
X = Chemical is an SRC at this depth interval.
-- = Chemical is not an SRC at this depth interval.

Table 7–6. Summary of COPCs

COPC	**Surface Soil (0-1 ft bgs)**		**Subsurface Soil (1-13 ft bgs)**		**Sediment**		**Surface Water**	
	FPA	**NPA**	**FPA**	**NPA**	**ED**	**WD**	**ED**	**WD**
Inorganic Chemicals								
Aluminum	X	--	--	X	X	X	--	--
Arsenic	X	X	X	X	X	--	--	X
Barium	--	--	--	X	--	--	--	--
Chromium	X	X	--	--	X	X	--	--
Cobalt	X	X	X	X	X	X	--	X
Cyanide	X	X	--	X	--	--	--	--
Manganese	X	X	--	--	--	--	--	--
Sulfate[a]	--	--	X	X	--	--	--	--
Sulfide[a]	X	X	X	X	--	X	--	--
Thallium	--	--	--	X	--	--	--	--
Pesticide/PCB								
PCB-1254	X	--	X	--	--	--	--	--
Semi-volatile Organic Compounds								
Benz(a)anthracene	X	X	--	--	--	--	--	X
Benzo(a)pyrene	X	X	--	X	X	--	--	X
Benzo(b)fluoranthene	X	X	--	--	--	--	--	X
Dibenz(a,h)anthracene	X	X	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	X	--	--	--	--	--	--	X
Miscellaneous								
TPH - DRO[a]	--	--	--	X	--	--	--	--
TPH - GRO[a]	--	--	--	X	--	--	--	--

[a] Chemical identified as a COPC because no screening value is available.

bgs = Below ground surface.
COPC = Chemical of potential concern.
DRO = Diesel range organics.
ED = East Ditch.
FPA = Former Production Area.
ft = Feet.
GRO = Gasoline Range Organics.
NPA = Non-Production Area.
PCB = Polychlorinated biphenyl.
TPH = Total petroleum hydrocarbon.
WD = West Ditch.
X = Chemical is a COPC in this medium.
-- = Chemical is not a COPC in this medium.

Table 7–7. FWCUGs Corresponding to an HQ of 1 and TR of 1E-05 for COPCs in Soil and/or Sediment

COPC	Critical Effect or Target Organ	FWCUG (mg/kg) Resident (Adult and Child)[a] HQ = 1	FWCUG (mg/kg) Resident (Adult and Child)[a] TR=1E-05
Inorganic Chemicals			
Aluminum	Neurotoxicity in offspring	73,798	--
Arsenic	Skin	20.2	4.25[b]
Barium	Nephropathy	14,129	--
Chromium, trivalent	NOAEL	81,473	--
Cobalt	Not specified	1,313	8,030
Cyanide	Decreased caudal epididymis weight	2.7[c]	
Manganese	CNS	2,927[b]	--
Sulfate	--	--	--
Sulfide	--	--	--
Thallium	Multiple systems[d]	6.12	--
Organic Chemicals-Pesticide/PCB			
PCB-1254	Eyes[e]	1.2	2.03
Organic Chemicals-Semi-volatile			
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
Miscellaneous			
TPH – DRO	NA	--	--
TPH – GRO	NA	--	--

[a] Resident FWCUGs are the smaller of the 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), subsurface soil (19.8 mg/kg), and sediment (19.5 mg/kg) and for manganese in subsurface soil (3,030 mg/kg).

[c] No FWCUG is available for cyanide. Value is the U.S. Environmental Protection Agency regional screening level.

[d] Vomiting, diarrhea, temporary hair loss, and effects on the nervous system, lungs, heart, liver, and kidneys.

[e] Ocular exudate, inflamed and prominent meibomian glands.

-- FWCUG could not be quantified based on lack of approved toxicity value.

CNS = Central nervous system.
COPC = Chemical of potential concern.
DRO = Diesel Range Organics.
FWCUG = Facility-wide cleanup goal.
GRO = Gasoline Range Organics.
HQ = Hazard quotient.
mg/kg = Milligrams per kilogram.
NA = Not available.
NOAEL = No observed adverse effect level.
PCB = Polychlorinated biphenyl.
TPH = Total petroleum hydrocarbon
TR = Target risk.

Table 7–8. FWCUGs Corresponding to an HQ of 1 and TR of 1E-05 for COPCs in Surface Water

COPC	Critical Effect or Target Organ	Resident FWCUG (mg/L)	
		HQ=1	TR=1E-05
Inorganic Chemicals			
Arsenic	Skin	0.0463	0.011
Cobalt	Not specified	0.006[b]	--
Organic chemical-Semi-volatile			
Benz(a)anthracene	NA	--	0.0001
Benzo(a)pyrene	NA	--	8.00E-06
Benzo(b)fluoranthene	NA	--	0.0001
Indeno(1,2,3-cd)pyrene	NA	--	0.0001

[a]Resident Receptor FWCUGs are the smaller of the Adult or Child values for each COPC.

[b]No FWCUG is available for cobalt. Value is the U.S. Environmental Protection Agency tap water regional screening level.

COPC = Chemical of potential concern.
FWCUG = Facility-wide cleanup goal.
HQ = Hazard quotient.
mg/L – Milligrams per liter.
NA = Not applicable.
TR = Target risk.
-- = No value available.

Table 7–9. Total and Hexavalent Chromium Soil Sample Results

Discrete Sample Location[a]	Total Chromium (mg/kg)	Hexavalent Chromium (mg/kg)	Percent Hexavalent Chromium (%)
LL11ss-072	10.1	0.44J	4.4
LL11ss-073	17.1	ND	NA
LL11ss-075	15.4	0.71J	4.6

J = Estimated concentration.
mg/kg = Milligrams per kilogram.
NA = Not applicable; hexavalent chromium not detected in sample.
ND = Not detected.

Table 7–10. 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 7–11. Baseline Levels of Benz(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenz(a,h)anthracene, and Indeno(1,2,3-cd)pyrene in Soil from Various Data Sets

Study	Number of Samples	Geometric Mean or Median	Minimum	95th Percentile[a]	Maximum
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
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	--
ATSDR[e]	--	--	--	--	--
NYSDEC Rural Near Roads[f]	28	--	--	--	--
NYSDEC Rural Distant Roads[f]	118	--	ND	ND	0.23

Table 7–11. Baseline Levels of Benz(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenz(a,h)anthracene, and Indeno(1,2,3-cd)pyrene in Soil from Various Data Sets (continued)

Study	Number of Samples	Geometric Mean or Median	Minimum	95th Percentile[a]	Maximum
Indeno(1,2,3-cd)pyrene					
CA/T Project[b]	871	0.2	0.022	7	100
LSPA Project[b]	475	--	ND	--	130
Watertown[b]	17	1.752	1.2	6.2	7.2
Worcester[b]	68	--	ND	2	6
New England[b]	62	0.532	ND	1.29	6
Illinois[c] Urban	--	--	--	1.6	--
Illinois[c] Rural	--	--	--	0.51	--
ATSDR[d] Urban	--	--	8	--	61
ATSDR[d] Rural	--	--	0.01	--	0.015
ATSDR[d] Agricultural	--	--	0.063	--	0.1
NYSDEC Rural Near Roads[f]	28	--	ND	0.62	0.66
NYSDEC Rural Distant Roads[f]	118	--	ND	0.076	1.4

[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)

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 background data submitted by its members in 2001.Water Town and Worcester Site-specific background samples.

[c] Data from 3 New England locations from Bradley et al. 1994.

[d] Background concentrations of polycyclic aromatic hydrocarbons in Illinois metropolitan statistical areas (urban) and non-metropolitan statistical areas (rural) as reported by Illinois EPA (IEPA 2005)

[e] Generic background data published by the Agency for Toxic Substances and Disease Registry in Polycyclic Aromatic Hydrocarbons 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 7–12. Summary of Historical COPECs per the Phase I RI

Soil	Sediment	Surface Water
Arsenic Chromium Iron Lead Manganese Mercury Nickel Vanadium Zinc Nitrate Sulfide Cyanide PCB-1254 Nitrocellulose	Beryllium Copper Lead Manganese Nickel Nitrate Sulfate Sulfide Benz(a)anthracene Benzo(a)pyrene Benzo(ghi)perylene Chrysene Fluoranthene Indeno(1,2,3-cd)pyrene Phenanthrene Pyrene Total PAHs PCB-1254 Nitrocellulose	Manganese Sulfate

Adapted from the *Report for the Remedial Investigation at Load Line 11 (AOC 44)* (MKM 2005a).
COPEC = Chemical of potential ecological concern.
PAH = Polycyclic aromatic hydrocarbon.
PCB = Polychlorinated biphenyl.

Table 7–13. Comparison of Five Assessment Attributes at Sampling Stations near Load Line 11

Attributes	S-1 (RM 7.0) (upstream)	S-2 (RM 5.9) (downstream)	Comments
Sediment quality	Excellent	Excellent	Downstream station rating is equivalent to upstream station, suggesting no negative impacts from the AOC.
Water quality	Excellent	Excellent	Downstream station rating is equivalent to upstream station, suggesting no negative impacts from the AOC.
Fish community (IBI)[a]	Good	Good	Downstream station rating is equivalent to upstream station, suggesting no negative impacts from the AOC.
Macroinvertebrate community (ICI)[b]	Exceptional	Exceptional	Downstream station rating is equivalent to upstream station, suggesting no negative impacts from the AOC.
Habitat (QHEI)[c]	Good	Excellent	Downstream station rating is better than upstream station, suggesting no negative impacts from the AOC.
Use Attainment Status [d]	Full	Full	Downstream station rating is equivalent to upstream station, suggesting no negative impacts from the AOC.

[a] Fish communities range from 0-60, with <18 being “very poor,” 18-27 being “poor,” 28-35 being “fair,” 36-39 being “marginally good,” 40-45 being “good,” 46-49 being “very good,” and 50-60 being “excellent” (Ohio EPA 2009).

[b] Macroinvertebrate communities range from 0-60, with <2 being “very poor,” 2-12 being “poor,” 14-32 being “fair,” 34-46 being “good,” and 48-60 being “exceptional” (Ohio EPA 1988).

[c] Habitat ranges from 30 to <100, with <30 being “very poor,” 30-44 being “poor,” 45-59 being “fair,” 60-74 being “good,” and 75-100 being “excellent” (Ohio EPA 2009).

[d] Full-attainment means all of the applicable indices meet the Ohio Environmental Protection Agency biocriteria (USACE 2005a).

AOC = Area of concern.
IBI = Index of Biotic Integrity.
ICI = Invertebrate Community Index.
QHEI = Qualitative Habitat Evaluation Index.

Table 7–14. Survey of Proximity to the AOC of Various Ecological Resources

Natural Resource	Natural Resources Inside Habitat Area	Proximity Within or Near the AOC	Distances to Nearest Resource of the AOC[a]
Wetlands (Planning Level Survey and Jurisdictional)	Two small Category 1 wetlands – one located along the western boundary of the AOC and one in the vicinity of the East Ditch	Wetlands associated with Sand Creek to the north and other small wetlands located to the south	Other wetlands are in vicinity of AOC (Figure 7-1)
Rare species	No known sightings	None	900 ft west and 1,100 ft west (See text for species names)
Beaver dams	None	None	1,300 ft southeast and 2,100 ft south
100-year floodplain	None	Sand Creek Floodplain to the north	100-year Floodplain to Sand Creek located immediately north
Stream sampling[b]	None	Sampling station S-2 is approximately 300 ft north (downgradient) on Sand Creek	Sampling station S-1 is approximately 4,500 ft west (upgradient) on Sand Creek
Pond sampling[b]	None	None	Approximately 3,400 ft southwest (Fuze/Booster Ponds)

[a] Measurements of distance and direction are taken from the nearest boundary of the AOC to the resource being measured.

[b] Stream and pond sampling refers to *Facility-Wide Biological and Water Quality Study 2003* (USACE 2005a).

AOC = Area of concern.

ft = Feet.

Table 7–15. Summary of Integrated COPECs for Surface Soil at the FPA

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Aluminum	23,800	50	476	None
Arsenic	30.2	18	1.7	None
Cadmium	1.3	0.36	3.6	None
Chromium	28.4	26	1.1	None
Cobalt	33.8	13	2.6	None
Copper	45.7	28	1.6	None
Cyanide	1.6	1.33	1.2	None
Lead	102	11	9.3	None
Manganese	1,540	220	7	None
Mercury	0.34	0.00051	667	Second highest ratio at 667x, PBT compound
Vanadium	38.8	7.8	5	None
Zinc	465	46	10.1	None
Nitrate	3.2	No ESV	--	None
Sulfide	244	0.00358	68,156	Highest ratio at 68,156x
Nitrocellulose	1.1	No ESV	--	None
Nitroguanidine	0.077	No ESV	--	None
PETN	0.049	No ESV	--	None
Tetryl	0.02	No ESV	--	None
PCB-1254	0.42	0.371	1.13	PBT compound

Table excludes nutrients.

COPEC = Chemical of potential ecological concern.

ESV = Ecological screening value.

MDC = Maximum detected concentration.

mg/kg = Milligrams per kilogram.

PBT = Persistent, bioaccumulative, and toxic.

PCB = Polychlorinated biphenyl.

PETN = Pentaerythritol tetranitrate.

x = Multiplier.

-- = Not applicable, no ESV is available for comparison.

Table 7–16. Summary of Integrated COPECs for Surface Soil at the NPA

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Arsenic	40.4	18	2.2	None
Cadmium	0.92	0.36	2.6	None
Cobalt	13.9	13	1.1	None
Lead	33.9	11	3.1	None
Manganese	1,930	220	8.8	None
Mercury	0.08	0.00051	157	Second highest ratio at 157x, PBT compound
Zinc	478	46	10.4	None
Nitrate	3	No ESV	--	None
Sulfide	85.5	0.00358	23,883	Highest ratio at 23,883x
HMX	0.013	No ESV	--	None
Nitrocellulose	1.2	No ESV	--	None
PETN	0.036	No ESV	--	None
PCB-1254	0.035	0.371	0.09	PBT Compound

Table excludes nutrients.
COPEC = Chemical of potential ecological concern.
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.
PETN = Pentaerythritol tetranitrate.
x = Multiplier.
-- = not applicable, no ESV is available for comparison.

Table 7–17. Summary of Integrated COPECs in Sediment at the East Ditch

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of Maximum to ESV	Comments
Beryllium	1	No ESV	--	None
Selenium	3.2	No ESV	--	None
Benz(a)anthracene	0.11	0.108	1.02	None

Table excludes nutrients.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
mg/kg = Milligrams per kilogram.
-- = not applicable, no ESV available.

Table 7–18. Summary of Integrated COPECs in Sediment at the West Ditch

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of Maximum to ESV	Comments
Beryllium	1	No ESV	--	None
Mercury	0.049	0.18	0.27	PBT Compound
Sulfide	43.4	No ESV	--	None

Table excludes nutrients.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
mg/kg = Milligrams per kilogram.
PBT = Persistent, bioaccumulative, and toxic.
-- = Not applicable, no ESV available.

Table 7–19. Summary of Integrated COPECs in Surface Water at the East Ditch

COPEC	MDC (mg/L)	ESV (mg/L)	Ratio of Maximum to ESV	Comments
beta-BHC	0.000013	0.000495	0.03	ESV is USEPA Region 5; PBT compound
gamma-Chlordane	0.000015	0.0043	0.003	ESV is NAWQC; PBT compound

Table excludes nutrients.
BHC = Hexachlorocyclohexane.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
mg/L = Milligrams per liter.
NAWQC = National Ambient Water Quality Criteria.
PBT = Persistent, bioaccumulative, and toxic.
USEPA = U.S. Environmental Protection Agency.

Table 7–20. Summary of Integrated COPECs in Surface Water at the West Ditch

COPEC	MDC (mg/L)	ESV (mg/L)	Ratio of Maximum to ESV	Comments
Manganese	0.559	0.12	4.66	ESV is Tier II
Benzo(a)pyrene	0.00033	0.00006	5.50	ESV is OMZA
Benzo(k)fluoranthene	0.00024	No ESV	--	None
beta-BHC	0.0000096	0.000495	0.02	ESV is USEPA Region 5; PBT compound

Table excludes nutrients.
BHC = Hexachlorocyclohexane.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
mg/L = Milligrams per liter.
OMZA = Ohio Environmental Protection Agency outside mixing zone average.
PBT = Persistent, bioaccumulative, and toxic.
USEPA = U.S. Environmental Protection Agency.
-- = Not applicable, no ESV available.

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	COPEC is not a candidate to be a final COPEC. Evaluation ceased.
Compare mean concentration above ESV to background concentration	(A) Mean concentration smaller than the background concentration	COPEC is not a candidate to be a final COPEC. Evaluation ceased.
	(B) Mean concentration larger than background concentration	Continue evaluation of chemical.

COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.

Table 7–22. Summary of Data for Step 3A Refinement of Integrated COPECs in Surface Soil at Load Line 11 FPA

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										
Arsenic	13.2	18	No	15.4	No	Yes	47 / 47	8 / 47	11 / 47	No
Cadmium	0.215	0.36	No	0	Yes	Yes	26 / 47	7 / 26	26 / 26	No
Chromium	14.6	26	No	17.4	No	Yes	47 / 47	2 / 47	10 / 47	No
Cobalt	8.54	13	No	10.4	No	Yes	47 / 47	2 / 47	6 / 47	No
Copper	18	28	No	17.7	Yes	Yes	47 / 47	3 / 47	19 / 47	No
Cyanide	0.301	1.33	No	0	Yes	Yes	3 / 34	1 / 3	3 / 3	No
PCB-1254	0.0562	0.371	No	0	Yes	Yes	4 / 12	1 / 4	4 / 4	No
COPEC with Mean Concentration > ESV and Mean Concentration < Background Concentration										
Aluminum	11400	50	Yes	17700	No	No	47 / 47	47 / 47	3 / 47	No
Manganese	511	220	Yes	1450	No	No	47 / 47	42 / 47	2 / 47	No
Vanadium	20.1	7.8	Yes	31.1	No	No	47 / 47	46 / 47	2 / 47	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration										
Lead	29.6	11	Yes	26.1	Yes	No	47 / 47	44 / 47	21 / 47	Yes
Mercury	0.0397	0.00051	Yes	0.036	Yes	No	17 / 47	17 / 17	13 / 17	Yes
Zinc	77.3	46	Yes	61.8	Yes	No	47 / 47	42 / 47	22 / 47	Yes
Sulfide	49.3	0.00358	Yes	0	Yes	Yes	22 / 34	22 / 22	22 / 22	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.
ESV = Ecological screening value.
mg/kg = Milligrams per kilogram.
PCB = Polychlorinated biphenyl.

Table 7–23. Summary of Data for Step 3A Refinement of Integrated COPECs in Surface Soil at Load Line 11 NPA

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										
Arsenic	12	18	No	15.4	No	Yes	29 / 30	3 / 29	5 / 29	No
Cadmium	0.191	0.36	No	0	Yes	Yes	17 / 30	4 / 17	17 / 17	No
Cobalt	8.46	13	No	10.4	No	Yes	30 / 30	1 / 30	7 / 30	No
PCB-1254	0.0206	0.371	No	0	Yes	Yes	1 / 14	0 / 1	1 /1	No
COPEC with Mean Concentration > ESV and Mean Concentration < Background Concentration										
Lead	18.1	11	Yes	26.1	No	No	29 / 30	27 / 29	4 / 29	No
Manganese	550	220	Yes	1450	No	No	30 / 30	29 / 30	2 / 30	No
Mercury	0.034	0.00051	Yes	0.036	No	No	14 / 30	14 / 14	11 / 14	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration										
Zinc	78.2	46	Yes	61.8	Yes	No	30 / 30	25 / 30	12 / 30	Yes
Sulfide	41.6	0.00358	Yes	0	Yes	Yes	11 / 17	11 / 11	11 / 11	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.
ESV = Ecological screening value.
mg/kg = Milligrams per kilogram.
PCB = Polychlorinated biphenyl.

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Table 7–24. 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
Former Production Area				
Lead	29.6	26.1	1.13	Concentrations are similar
Mercury	0.0397	0.036	1.10	Concentrations are similar
Zinc	77.3	61.8	1.25	Concentrations are somewhat similar
Sulfide	49.3	0	NA	Sulfide does not have an established background concentration at RVAAP
Non-Production Area				
Zinc	78.2	61.8	1.27	Concentrations are somewhat similar
Sulfide	41.6	0	NA	Sulfide does not have an established background concentration at RVAAP

COPEC = Chemical of potential ecological concern.
mg/kg = Milligrams per kilogram.
NA = Not available, ratio could not be calculated.
RVAAP = Ravenna Army Ammunition Plant.

Table 7–25. Comparison of Mean Concentration to Alternative ESV for Remaining Integrated 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
Former Production Area					
Lead	29.6	11	40.5	2.7	0.7
Mercury	0.0397	0.00051	0.1	77.8	0.4
Zinc	77.3	46	79	1.7	0.98
Sulfide	49.3	0.00358	None	13,771	NA
Non-Production Area					
Zinc	78.3	46	79	1.7	0.99
Sulfide	41.6	0.00358	None	11,620	NA

[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.
NA = Not available or ratio could not be calculated.

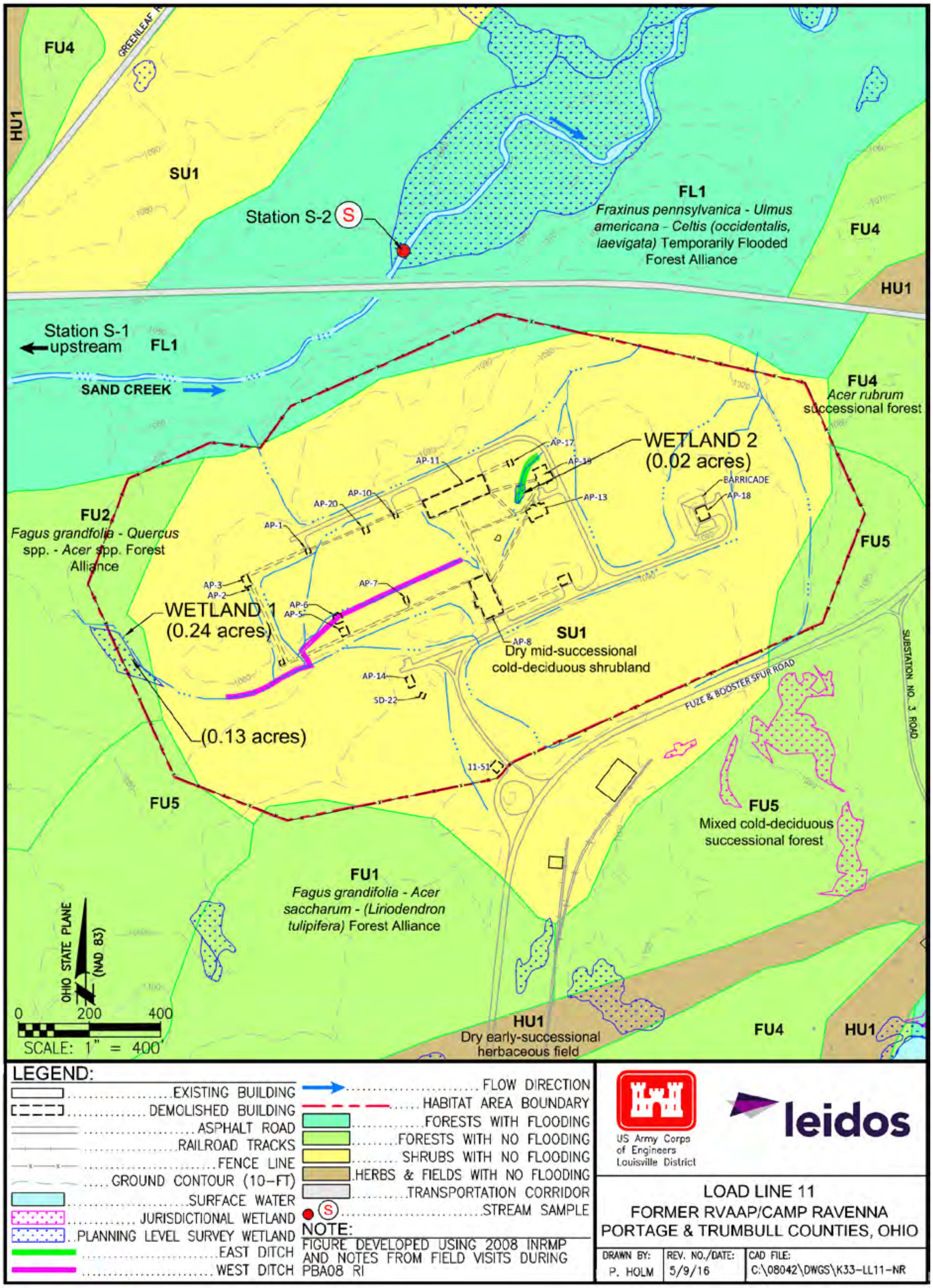

Figure 7–1. Important Ecological Resources Inside and Near Load Line 11

8.0 REMEDIAL INVESTIGATION CONCLUSIONS AND RECOMMENDATIONS

8.1 INTRODUCTION

This Phase II RI Report for Load Line 11 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, contaminant fate and transport modeling, 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 INTERIM REMOVAL ACTION

In 2001, an IRA was completed at Load Line 11. The IRA was initiated following the Phase I RI activities as an early response action to remove the primary pathways for off-AOC contaminant migration. The IRA included removing sump water from production buildings, grouting selected sanitary sewer manholes, and performing limited excavations from open ditch systems draining the AOC (MKM 2004a).

Sumps located adjacent to Buildings AP-3, AP-5, AP-6, and AP-8 were excavated, removed, and disposed during the 2001 IRA. Approximately 15,000 gal of water were removed from sumps and sewer manholes downgradient of each sump and were filled with bentonite cement to prevent water from infiltrating back into the sumps during excavation and removal operations. Once the water was removed, effluent sewer lines were cut and plugged with mechanical packers and cement grout, which prepared the sumps for removal.

Six drainage ditch locations were excavated based on Phase I RI analytical data showing exceedances of background concentrations and/or Region 9 PRGs for residential soil. Elevated contaminant concentrations in the six ditch locations included metals in all six ditches, VOCs in two ditches, and SVOCs and/or pesticides in only one ditch. A total of 230 yd^3 of contaminated soil was removed during the ditch excavation operations. Confirmation samples were collected to verify that the contaminated soil and sediment were removed.

One 30 by 30 by 8 ft hot spot area, located in an open field north of Building AP-17, was excavated due to petroleum contamination encountered during RI soil boring activities (MKM 2004a). A total of 130 yd^3 of petroleum-contaminated soil were excavated. Confirmation samples were used to verify that the petroleum-contaminated soil was removed and the excavations were backfilled with approved off-site soil. During the excavation of the hot spot, it was determined that the area needed to be assessed for UXO. Upon excavating test trenches, cable, scrap metal, bolts, and magnetite containing rock were found. Confirmation samples were then collected from the test trenches. After the excavation was complete and it was determined no UXO was present, the test trenches were backfilled and leveled to the original ground surface elevation.

8.3 SUMMARY OF DATA USED IN THE REMEDIAL INVESTIGATION

Quality-assured sample data from the Phase I RI (MKM 2005a), confirmation results from the IRA (MKM 2004a), and 2010 and 2012 PBA08 RI were used to evaluate nature and extent of contamination at Load Line 11. These investigations used discrete sampling methods.

All available sample data collected at the locations were evaluated to determine suitability for use in various key RI data screens and evaluations (i.e., nature and extent, fate and transport, risk assessment). 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 Phase I RI and IRA data sets were evaluated to determine if conditions had changed substantively between earlier characterization efforts and the 2010 and 2012 PBA08 RI, as building demolition activities occurred in 2004-2005 after the 2000 and 2001 Phase I RI and IRA confirmation sampling. The samples collected in 2000-2001 were collected within ditch lines adjacent to former buildings and in areas encompassing, but also extending substantially beyond the footprint of the former buildings. The 2001 confirmation sampling was conducted within the footprints of the removal areas after the contaminated soil was removed. Therefore, both data sets were considered representative of current conditions within and surrounding the footprints of the former buildings and removal areas at Load Line 11.

Data collected in 2010 and 2012 as part of the PBA08 RI focused on delineating the extent of contaminants identified in surface soil (0-1 ft bgs), subsurface soil (1-13 ft bgs), sediment, and surface water. The PBA08 RI sampled locations with the greatest likelihood of contamination (e.g., adjacent to production buildings or within sediment accumulation areas, such as ditches) and analyzed for chemicals identified in historical investigations. Additionally, sediment and surface water samples were collected from drainage ditches exiting the AOC.

8.4 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 subsequent to the 2001 IRA was evaluated in this Phase II RI. Data from the Phase I RI, IRA, and 2010 and 2012 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 11.

8.4.1 Soil

Locations where explosives were identified as potential contaminants from previous use were thoroughly evaluated, including around former process buildings and across the AOC as a whole. The maximum concentrations of the explosives and propellants were all below their respective SLs and were not considered COPCs in the surface and subsurface soil at the FPA and NPA.

Arsenic, chromium, lead, and mercury were identified as potential SRCs and as potentially related to the previous site use. When evaluating these chemicals against their SLs (using the trivalent chromium FWCUG for chromium and the RSL of 400 mg/kg for lead), chromium, lead, and mercury concentrations were all below their SLs; therefore, these chemicals were not considered COPCs for the FPA or NPA in surface and subsurface soil. Arsenic was the only inorganic chemical potentially related to previous AOC operations that is considered a COPC in surface and subsurface soil at the FPA and NPA. Arsenic is considered a COPC in both surface and subsurface soil at the FPA and NPA, with an MDC of 44.1 mg/kg observed from 6–8 ft bgs at sample location LL11cs-045, which evaluated the effectiveness of the hot spot excavation efforts during the IRA.

With the exception of benzo(a)pyrene at four surface soil sample locations, none of the detected concentrations of SVOCs, VOCs, pesticides, or PCBs in surface or subsurface soil were above the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. Benzo(a)pyrene is considered a COPC in the surface soil at the FPA and NPA, with an MDC of 0.45 mg/kg at sample location LL11sb-060, which evaluated the drainage ditch northeast of the Entrance Gate.

8.4.2 Sediment and Surface Water

The East Ditch EU was evaluated with two sediment samples and one surface water sample. No explosives or propellants were detected in the East Ditch sediment and surface water samples. Arsenic was the only inorganic chemical from previous site use that exceeded the SL in sediment and is considered a COPC. No inorganic chemical concentrations detected in the surface water sample exceeded their respective SLs. One PAH [benzo(a)pyrene] concentration detected in sediment exceeded the SL and was identified as a COPC; however, the benzo(a)pyrene concentration was detected at a concentration below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. SVOCs were not detected in the surface water sample. In addition, no VOCs, pesticides, or PCBs were detected in sediment at the East Ditch. Two pesticides (BHC and gamma-chlordane) were identified as SRCs at low, estimated concentrations. No VOCs or PCBs were detected in the East Ditch surface water.

The West Ditch EU was evaluated with four sediment samples and one surface water sample. No explosives were detected in West Ditch sediment. The propellant nitrocellulose was detected in the sediment sample LL11sd-096 at a concentration below the SL. No explosives or propellants were detected in the surface water sample. No inorganic chemicals related to previous site use exceeded the SLs except for arsenic in the surface water sample. One PAH [benzo(a)pyrene] exceeded the SL in the West Ditch sediment and was identified as a COPC. Four PAHs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene] exceeded the SLs in the surface water sample and were identified as COPCs. The PAH concentrations detected in sediment and surface water were all above the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. No PCBs, pesticides, or VOCs were detected in sediment at the West Ditch. One pesticide (beta-BHC) was identified as an SRC and was detected at a low, estimated concentration below laboratory detection limits. No VOCs or PCBs were detected in the West Ditch surface water.

The Sewer Outfall EU was evaluated with one sediment sample. The only SRCs identified were the inorganic chemicals sulfate and sulfide, neither of which has established background concentrations for comparison.

One sediment sample and one surface water sample were collected at the off-AOC location LL11sd/sw-082 located on Sand Creek. Inorganic chemicals were not detected above background concentrations in sediment; however, six inorganic chemicals were detected above their respective background concentrations for surface water. All the detections were at concentrations below their respective SLs. No explosives, propellants, SVOCs, pesticides, or PCBs were detected in the off-AOC sediment. Two VOCs (carbon disulfide and toluene) were present at low, estimated concentrations below laboratory detection limits.

No explosives, propellants, SVOCs, VOCS, pesticides, or PCBs were detected at the Sand Creek location.

8.5 SUMMARY OF CONTAMINANT FATE AND TRANSPORT

All SRCs identified in the surface soil, subsurface soil, and sediment at Load Line 11 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, barium, cobalt, zinc, benzo(b)fluoranthene, naphthalene, and PETN at the FPA and arsenic, cobalt, manganese, and naphthalene at the NPA were the soil CMCOPCs predicted to exceed the screening criteria in groundwater beneath the source area; however, none of these CMCOPCs were predicted to be above their respective groundwater criteria at the downgradient receptor location.
- Benz(a)anthracene and naphthalene at the East Ditch Aggregate and antimony, benz(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at the West Ditch Aggregate were predicted to exceed the screening criteria in groundwater beneath the source area; however, none of these CMCOPCs were predicted to be above 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 11 that may impact the groundwater beneath the source or at the downstream receptor location. This qualitative assessment concluded that there were no CMCOCs present in soil and sediment that may impact the groundwater beneath the source or at the downstream receptor location. No further action is required of soil and sediment at Load Line 11 for the protection of groundwater.

8.6 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 (Adult and Child). Since the risk management analysis determined there were no unacceptable risks to the Resident Receptor (Adult and Child), it can be concluded that there is no unacceptable risk to the National Guard Trainee and Industrial Receptor.

Media of concern at Load Line 11 are surface soil, subsurface soil, sediment, and surface water. Soil data associated with Load Line 11 were aggregated into surface and subsurface soil at the FPA and NPA. Sediment and surface water were evaluated from ditches within and west of the FPA. The ditches include the East Ditch that flows north and the West Ditch that flows west/northwest and eventually to Sand Creek.

No COCs were identified for the Resident Receptor (Adult and Child) 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. The EPC for benzo(a)pyrene in surface soil at the NPA (0.28 mg/kg) is approximately 1.3 times its FWCUG of 0.221 mg/kg. The EPC for this data aggregate is the MDC (at sample LL11sb-067); benzo(a)pyrene concentrations in the remaining NPA samples ranged from a non-detectable concentration to 0.11 mg/kg. Sample LL11sb-067 was collected in 2010 from the northeastern portion of Load Line 11. No load line operations were conducted in this area. The EPC for benzo(a)pyrene in the FPA (0.219 mg/kg) was slightly less than the FWCUG (0.221 mg/kg). Other PAHs were identified as COCs because they contribute to SORs of two at the FPA and NPA.

The EPCs of benzo(a)pyrene (0.28 mg/kg and 0.221) are slightly above and slightly below the FWCUG of 0.221 and the SORs are two, indicating cumulative cancer risks to a hypothetical future resident on the order of 1E-05. Reported benzo(a)pyrene concentrations above the FWCUG are scattered (i.e., no hot spots were identified); therefore, no COCs were identified for potential additional remediation.

Four PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene] were identified as COCs for the Resident Receptor (Adult and Child) in surface water collected from the West Ditch. The detected concentrations of benz(a)anthracene (0.00035 mg/L), benzo(b)fluoranthene (0.00041 mg/L), and indeno(1,2,3-cd)pyrene (0.00021) in surface water collected from the West Ditch range from 2 to 4 times their FWCUG of 0.0001 mg/L, and the detected concentration of benzo(a)pyrene (0.00033 mg/L) was 41 times the FWCUG of 0.000008 mg/L. All of the reported concentrations included a "J" qualifier, indicating they were estimated results below the detection limit of the analytical method. PAHs are present in the environment from natural and anthropogenic sources. Since surface runoff is the potential source of contamination to surface water in the West Ditch, the fact that PAH concentrations are not significantly elevated in soil or sediment indicates there is no identifiable source beyond normal levels of these chemicals to surface water due to runoff from roads and other traffic areas. In addition, incidental exposures of the Resident Receptor (Adult and Child) to surface water at the West Ditch that only intermittently holds water are much less than the incidental exposure that would occur due to ingesting drinking water (i.e., 2 L/day for an adult) and dermal contact while swimming and wading. These exposures were incorporated into the development of the FWCUGs. Thus, these low, estimated concentrations of PAHs were not identified as COCs for remediation in surface water.

Based on the risk management analysis, no COCs were identified to be carried forth in an FS for the Resident Receptor (Adult and Child) in any of the media of concern; therefore, no other receptors were evaluated and no further action is recommended from a human health risk perspective.

8.7 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 11. This contamination was identified using historical and PBA08 RI data. Dry, mid-successional, cold-deciduous shrubland (dominant vegetation type); dry, mid-successional, herbaceous field; and four types of forests were observed on the 48 acres in the AOC. There are important and significant ecological resources in the AOC. Specifically, wetlands and surface water (i.e., two ditches) are present and near contamination. These findings invoked a requirement of a Level II ERA.

The Level II ERA evaluated integrated COPECs in soil, sediment, and surface water. Integrated COPECs are identified by screening PBA08 RI and historical data sets against ESVs. Twenty integrated COPECs were identified for soil. Five integrated COPECs were identified for sediment. Five integrated COPECs were identified for surface water. The integrated soil, sediment, and surface water COPECs were further evaluated with technical and refinement factors in Step 3A. The factors in Step 3A showed there are no integrated COPECs that are of ecological concern requiring remediation or further evaluation. Consequently, the Level II Screening ERA for Load Line 11 concludes with a recommendation that no further action is required to be protective of important ecological resources. This supports the conclusion from the Phase I RI, which stated:

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

8.8 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 11 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.

8.8.1 Primary and Secondary Contaminant Sources and Release Mechanisms

No primary contaminant sources (e.g., operational facilities) are located in the AOC. The IRA conducted in 2001 removed contamination from the primary pathways for off-AOC migration, and all buildings within the Load Line 11 fence line were demolished as of 2009. Remnant contamination in soil and sediment within the AOC is considered a secondary source of contamination.

Sites where explosives were identified as potential contaminants from previous use were thoroughly evaluated, including around former process buildings and across the AOC as a whole. Explosives were not detected in any of the environmental media sampled (i.e., surface soil, subsurface soil, sediment, and surface water).

Surface water drainage generally follows the topography of Load Line 11. The primary drainage routes for surface water are the East Ditch that flows north and the West Ditch that flows west-northwest, both leading to Sand Creek immediately north of the AOC boundary. Surface water flowing in ditches or other drainage features is the primary migration pathway for contamination to leave the AOC. Three sediment and surface water samples were collected in ditches at Load Line 11. Although SRCs were identified in sediment and surface water, none were detected above SLs.

The primary mechanisms for release of chemicals from secondary sources at the AOC are:

- 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.

8.8.2 Contaminant Migration Pathways and Exit Points

8.8.2.1 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 and surface water data at Load Line 11 consist of three samples collected from the conveyance ditches. Surface water drainage generally follows the topography of Load Line 11. The primary drainage routes for surface water are the East Ditch that flows north and the West Ditch that flows west-northwest, both leading to Sand Creek immediately north of the AOC boundary. Sand Creek drains to the northeast into the south fork of Eagle 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 along the East Ditch and West Ditch.

8.8.2.2 Groundwater Pathways

The estimated direction of groundwater flow at the AOC is from south to north. 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 1,070–1,100 ft amsl, with the highest elevation at LL11mw-001. Potentiometric data indicate the groundwater table occurs within the unconsolidated zone throughout the AOC. Groundwater discharge to surface water features (e.g., via base flow to streams or springs) does not occur within the AOC boundary. Rather, the closest potential groundwater discharge location is Sand Creek located along the northwest AOC boundary.

The FWGWMP was initiated in 2005 and involves quarterly sampling of selected wells within the former RVAAP. Between 2009 and 2013, several sampling events under the FWGWMP collected groundwater data at Load Line 11.

Contaminant leaching pathways from soil and sediment to the water table are through unconsolidated soil representing shallow clay to sand-rich silt tills with interbedded sands scattered throughout. The overall average hydraulic conductivity of the unconsolidated soil is 3.49E-05 cm/s. Conservative transport modeling indicated seven chemicals [arsenic, barium, cobalt, zinc, benz(b)fluoranthene, naphthalene, and PETN] from the FPA and four chemicals (arsenic, cobalt, manganese, and naphthalene) from the NPA may leach from soil, and five chemicals [antimony, benz(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and naphthalene] may leach from sediment 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 (Sand Creek located along the northwest boundary of Load Line 11) at a concentration exceeding MCL/RSLs. None of these chemicals except arsenic and manganese (that are determined to be background related) were detected in AOC groundwater samples collected from 2009-2013 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 11 that may potentially impact groundwater at Load Line 11. 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.

8.8.3 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 11 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 11, 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.

8.8.4 Uncertainties

Uncertainties are inherent in the CSM depending on the density and availability of data. The CSM for Load Line 11 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 11 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.

8.9 RECOMMENDATION OF THE REMEDIAL INVESTIGATION

Based on the investigation results, Load Line 11 has been adequately characterized and the recommended path forward is no further action for soil, sediment, and surface water at Load Line 11 to attain Unrestricted (Residential) Land Use. Further investigation is not warranted at this AOC for the following reasons: (1) the IRA conducted in 2001 removed contamination from the primary pathways for off-AOC migration; (2) the current nature and extent of impacted media has been sufficiently characterized; (3) the fate and transport modeling did not identify soil CMCOCs requiring further evaluation or remediation to protect groundwater; (4) there are no CERCLA release-related human health COCs identified in soil, sediment, or surface water requiring further evaluation in an FS or additional remediation; and (5) 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 basis for no further action. Comments on the PP received from state and federal agencies and the public will be considered in preparing a ROD to document the final remedy. The ROD will also include a responsiveness summary addressing comments received on the PP.

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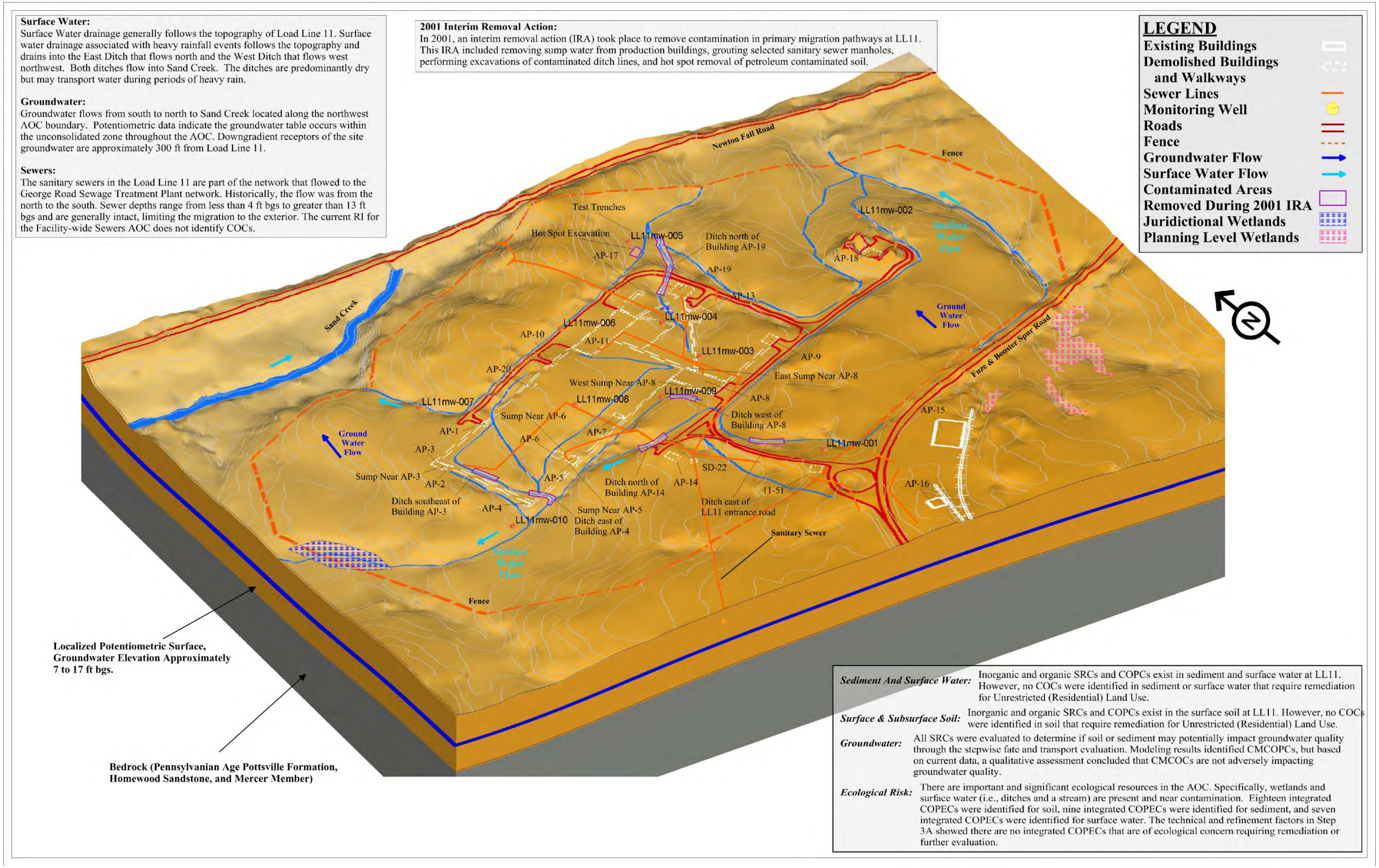

Surface Water:
Surface Water drainage generally follows the topography of Load Line 11. Surface water drainage associated with heavy rainfall events follows the topography and drains into the East Ditch that flows north and the West Ditch that flows west northwest. Both ditches flow into Sand Creek. The ditches are predominantly dry but may transport water during periods of heavy rain.

Groundwater:
Groundwater flows from south to north to Sand Creek located along the northwest AOC boundary. Potentiometric data indicate the groundwater table occurs within the unconsolidated zone throughout the AOC. Downgradient receptors of the site groundwater are approximately 300 ft from Load Line 11.

Sewers:
The sanitary sewers in the Load Line 11 are part of the network that flowed to the George Road Sewage Treatment Plant network. Historically, the flow was from the north to the south. Sewer depths range from less than 4 ft bgs to greater than 13 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.

2001 Interim Removal Action:
In 2001, an interim removal action (IRA) took place to remove contamination in primary migration pathways at LL11. This IRA included removing sump water from production buildings, grouting selected sanitary sewer manholes, performing excavations of contaminated ditch lines, and hot spot removal of petroleum contaminated soil.

Sediment And Surface Water: Inorganic and organic SRCs and COPCs exist in sediment and surface water at LL11. 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 LL11. 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.

Figure 8–1. Load Line 11 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 11. 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 11 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 11. This Phase II 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 11 meets the needs of the state of Ohio and fulfills the requirements of the DFFO (Ohio EPA 2004a). Ohio EPA provided comments on this Phase II 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 11.

9.2 COMMUNITY ACCEPTANCE

Community acceptance considers comments provided by community members. CERCLA 42 U.S.C. 9617(a) emphasizes early, constant, and responsive community relations. The Army has prepared a *Community Relations Plan for the Ravenna Army Ammunition Plant Restoration Program* (Vista 2015) to facilitate communication between the former RVAAP and the community surrounding Ravenna, Ohio during environmental investigations and potential remedial action. The plan was developed to ensure the public has convenient access to information regarding project progress. The community relations program interacts with the public through news releases, public meetings, public workshops, and Restoration Advisory Board meetings with local officials, interest groups, and the general public.

CERCLA 42 U.S.C. 9617(a) requires an Administrative Record to be established “at or near the facility at issue.” Relevant documents regarding the former RVAAP have been made available to the public for review and comment.

The Administrative Record for this project is available at the following location:

Camp Ravenna
Environmental Office
1438 State Route 534 SW
Newton Falls, OH 44444

Access to Camp Ravenna is restricted but can be obtained by contacting the environmental office at (614) 336-6136. In addition, an Information Repository of current information and final documents is available to any interested reader at the following libraries:

Reed Memorial Library
167 East Main Street
Ravenna, Ohio 44266

Newton Falls Public Library
204 South Canal Street
Newton Falls, Ohio 44444-1694

Additionally, 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 11. These comments will be considered prior to the final selection of a no further action. Responses to these comments will be addressed in the responsiveness summary of the ROD.

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