APPENDIX B

FS Addendum Field Summary

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ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
bgs	Below Ground Surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chemical of Concern
COI	Chemical of Interest
DNT	Dinitrotoluene
DoD	U.S. Department of Defense
DQO	Data Quality Objective
ERA	Ecological Risk Assessment
ESV	Ecological Screening Value
FS	Feasibility Study
FWCUG	Facility-wide Cleanup Goal
FWSAP	Facility-wide Sampling and Analysis Plan
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IDW	Investigation-derived Waste
IROD	Interim Record of Decision
ISM	Incremental Sampling Methodology
OEPA	Ohio Environmental Protection Agency
PAH	Polycyclic Aromatic Hydrocarbon
PBA13 SAP	Performance-Based Acquisition 2013 Sampling and Analysis Plan
PBT	Persistent, Bioaccumulative, and Toxic
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
REIMS	Ravenna Environmental Information Management System
RGO	Remedial Goal Option
RI	Remedial Investigation
RVAAP	Ravenna Army Ammunition Plant
TNT	Trinitrotoluene
TR	Target Risk
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compound
WOE	Weight of Evidence

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B.0 FS ADDENDUM FIELD SUMMARY

This appendix presents the methods used for developing data quality objectives (DQOs), collecting field data, and managing analytical data and laboratory programs for the Feasibility Study (FS) Addendum at Load Lines 1through 4 and 12. The FS Addendum sampling was completed in accordance with the *Performance-Based Acquisition 2013 Sample and Analysis Plan Addendum for Surface Water and Sediment at Load Lines 1, 2, 3, and 4* (herein referred to as the PBA13 SAP Addendum [USACE 2016] to supplement historical data gaps and to complete the FS phase of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process. The results of the FS Addendum sampling completed in 2016 are combined with the results of the Phase II Remedial Investigation (RI) to fully evaluate the nature and extent of contamination, assess potential future impacts to groundwater, conduct human health risk assessments (HHRAs) and ecological risk assessments (ERAs), and evaluate the need for remedial alternatives.

As part of the project DQOs, a data gap analysis evaluation 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. of the PBA13 SAP Addendum). The following detailed steps were utilized in the data gap analysis procedure:

- Assemble previous data collected at or near Load Lines 1 through 4 and 12 stored in the Ravenna Army Ammunition Plant (RVAAP) Environmental Information Management System (REIMS).
- Perform a data use assessment by reviewing all assembled data to ensure that the medium sampled is still present and has not been impacted during remediation, and ensure that the data approved for use meet the DQOs established for the data gap analysis.
- Identify area of concern (AOC)-specific chemicals of interest (COIs) that will be evaluated for this AOC, including the chemicals of concern (COCs) presented in the Interim Record of Decision (IROD) and historical RIs that evaluated the Resident Receptor (Adult and Child) scenario.
- Perform the data screen on a sample-by-sample basis using the current Resident Receptor (Adult and Child) remedial goal options (RGOs) (all media). The Resident Receptor (Adult and Child) RGOs are the residential Facility-wide Cleanup Goals (FWCUGs) at a target risk (TR) level of 1E-05 and a target hazard quotient (HQ) of 1 (USACE 2005).
- Perform a data screen on a sample-by-sample basis using the current ecological screening criteria followed by a weight-of-evidence (WOE) evaluation.
- Perform a detailed evaluation of each location that exceeds Resident Receptor (Adult and Child) RGOs and/or ecological screening criteria to determine if nature and extent are defined for evaluation of Land Uses.
- Recommend additional sampling at locations where elimination of data gaps is required to complete development of remedial alternatives for the subsequent FS.

Additional samples for soil were determined to be unnecessary given the spectrum and density of existing incremental sampling methodology (ISM) and discrete data available for soil. The decision

rules for surface water and sediment sampling outlined in the PBA13 SAP Addendum are based on the data gap analysis. Historical surface water and sediment locations that exceeded human health and/or ecological screening criteria were sampled under the PBA13 SAP Addendum. Tables B-1 through B-4 list the COIs that were present in historical sediment and surface water samples for each of the individual AOCs.

Table B-1. COIs in Surface Water and Sediment at Load Line 1

COI	Load Line 1	
	Surface Water	**Sediment**
Metals		
Antimony	X	X
Arsenic	X	X
Lead	X	X
Manganese	X	X
Explosives		
2,4,6-TNT	X	X
2,4-DNT	X	X
2,6-DNT	X	X
RDX	X	X
PCBs		
PCB-1254	X	X
Pesticides		
Dieldrin	X	X
PAHs		
Benz(a)anthracene	X	X
Benzo(a)pyrene	X	X
Benzo(b)fluoranthene	X	X
Dibenz(a,h)anthracene	X	X
Indeno(1,2,3-cd)pyrene	X	X

COI = Chemical of Interest.
DNT = Dinitrotoluene.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
TNT = Trinitrotoluene.
X = COI present in medium.

Table B-2. COIs in Surface Water and Sediment at Load Line 2

COI	Load Line 2	
	Surface Water	Sediment
Metals		
Aluminum	X	X
Antimony	X	X
Arsenic	X	X
Cadmium	X	X
Copper	X	X
Chromium, hexavalent	X	X
Lead	X	X
Manganese	X	X
Thallium	X	X
Explosives		
2,4,6-TNT	X	X
2,4-DNT	X	X
RDX	X	X
PCBs		
PCB-1254	X	X
PCB-1260	X	X
Pesticides		
Dieldrin	X	X
PAHs		
Benz(a)anthracene	X	X
Benzo(a)pyrene	X	X
Benzo(b)fluoranthene	X	X
Dibenz(a,h)anthracene	X	X
Indeno(1,2,3-cd)pyrene	X	X

COI = Chemical of Interest.
DNT = Dinitrotoluene.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
TNT = Trinitrotoluene.
X = COI present in medium.

Table B-3. COIs in Surface Water and Sediment at Load Line 3

COI	Load Line 3	
	Surface Water	Sediment
Metals		
Aluminum	X	X
Antimony	X	X
Arsenic	X	X
Barium	X	X
Cadmium	X	X
Lead	X	X
Manganese	X	X
Thallium	X	X
Explosives		
1,3-Dinitrobenzene	X	X
2,4,6-TNT	X	X
2,4-DNT	X	X
RDX	X	X
PCBs		
PCB-1254	X	X
PCB-1260	X	X
Pesticides		
4,4'-DDE	X	X
4,4'-DDT	X	
Dieldrin	X	X
Heptachlor	X	X

COI = Chemical of Interest.
DDE = Dichlorodiphenyldichloroethylene.
DDT = Dichlorodiphenyltrichloroethane.
DNT = Dinitrotoluene.
PCB = Polychlorinated Biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
TNT = Trinitrotoluene.
X = COI present in medium.

Table B-4. COIs in Surface Water and Sediment at Load Line 4

COI	Load Line 4	
	Surface Water	Sediment
Metals		
Aluminum	X	X
Arsenic	X	X
Lead	X	X
Manganese	X	X
Thallium	X	X
PCBs		
PCB-1254	X	X
PCB-1260	X	X
PAHs		
Benz(a)anthracene	X	X
Benzo(a)pyrene	X	X
Benzo(b)fluoranthene	X	X
Dibenz(a,h)anthracene	X	X
Indeno(1,2,3-cd)pyrene	X	X

COI = Chemical of Interest. PCB = Polychlorinated Biphenyl.
PAH = Polycyclic Aromatic Hydrocarbon. X = COI present in medium.

Based on the data gap evaluation, only sediment and surface water samples at Load Lines 1, 2, and 3 were required. Representatives of the U.S. Army and Ohio Environmental Protection Agency (OEPA) reviewed and approved the FS Addendum sample locations and rationale as part of the approval process for the PBA13 SAP Addendum in January 2016.

The FS Addendum sampling was conducted in May 2016 and included the collection of sediment and surface water samples at Load Lines 1, 2, and 3. Five sediment samples were collected at Load Line 1, which included:

- LL1SD-731-2532-SD,
- LL1SD-732-2533-SD,
- LL1SD-733-2534-SD,
- LL1SD-734-2535-SD, and
- LL1SD-735-2536-SD.

Four sediment samples were collected at Load Line 2, which included:

- LL2SD-630-2530-SD,
- LL2SD-631-2528-SD,
- LL1SD-632-2531-SD, and
- LL2SD-633-2539-SD.

Two co-located sediment and surface water samples were collected at Load Line 3, which included:

- LL3SD/SW-553-2538-SW,
- LL3SD/SW-553-2537-SD,
- LL3SD/SW-554-2540-SW, and
- LL3SD/SW-554-2539-SD.

Based on the sampling decision rules of the PBA13 SAP Addendum, there were no additional samples required at Load Lines 4 and 12. The following sections describe the rationale and sample collection methods for each component of the FS Addendum field investigation.

B.1 SURFACE WATER AND SEDIMENT CHARACTERIZATION

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 7 days of precipitation. 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 are inundated for extended periods of time. These definitions and terminology usage are consistent with the FWCUG Report (USACE 2010).

Data gap evaluation was used to determine what surface water and sediment samples were collected from each AOC. Each AOC is proceeding through the CERCLA process individually and varies in regard to historical use, previous investigations, and data gaps. Therefore, the general decision rules were applied to each AOC individually to develop a specific sample design (provided in Appendices A through D of the PBA13 SAP Addendum). COIs specific to each individual AOC that were found to exceed human health and/or ecological screening criteria triggered the collection of additional samples for this FS Addendum.

B.1.1 Sediment Sampling Methods

Sediment samples were collected as discrete samples using 10 aliquots per sample. Ten separate aliquots were collected at random locations within an area with an approximate 5-ft radius to the same depth (0–1 ft bgs). The 10 aliquots were composited in a stainless steel bowl using the same procedure as used to composite soil samples, and then the composited samples were transferred to the appropriate sample container(s).

The aliquots for sediment samples were collected using two possible methods. The trowel method (Section 5.6.2.2.1 of the Facility-wide Sampling and Analysis Plan [FWSAP] [USACE 2011]) was used when the water depth above the sediment sample location was less than 6 inches. The hand core

sampler method (Section 5.6.2.2.3 of the FWSAP) was used when the depth of water above the sediment sample location was greater than 6 inches. In addition, at Load Line 2, the sample for Kelly's Pond was collected using a Ponar/Ekman Sampler from a boat, as presented in Section 5.6.2.2.2 of the FWSAP. Parameters to be analyzed vary by AOC (Appendices A through D of the PBA13 SAP Addendum). Duplicate quality assurance (QA) and quality control (QC) split samples were collected from the sample areas at the frequency listed in Section 4.5 of the PBA13 SAP Addendum. No AOCs required volatile organic compounds (VOCs) analyses; therefore, no special sample procedures for collecting VOCs applied to this investigation. Sediment samples were collected after co-located surface water samples.

Equipment decontamination wash water was stored in 55-gal drums and managed as investigation-derived waste (IDW), as discussed in Section 7.0 of the PBA13 SAP Addendum.

B.1.2 Surface Water Sampling Methods

Surface water samples were collected in accordance with Section 5.7.2.1.1 of the FWSAP using the hand-held bottle method. Parameters to be analyzed varied by AOC (Appendices A through D of the PBA13 SAP Addendum). Field measurements were performed in accordance with Section 5.4.3 of the FWSAP and included the determination of pH, conductivity, dissolved oxygen, turbidity, and temperature. Surface water samples were collected prior to co-located sediment samples. Duplicate QA and QC split samples were collected from the sample areas at the frequency listed in Section 4.4 of the PBA13 SAP Addendum.

B.1.3 Load Line 1 Sediment and Surface Water Sampling Rationale

Based on the data gap evaluation, additional surface water samples were not warranted at Load Line 1 for the FS Addendum based on the following rationale:

- Only one surface water exceedance for human health screening was observed (arsenic) at one sample location within the Outlet C Channel and Charlie's Pond aggregate, just east of Charlie's Pond. All other surface water samples within the Load Line 1 aggregates were below human health screening criteria of hazard index (HI)=1, TR of 1E-05. Arsenic concentrations in source media at Load Line 1 (soil and sediment) are generally near and attributable to background. No source of arsenic has been identified at Load Line 1. Arsenic will be evaluated further using a qualitative WOE evaluation. Therefore, no new sample was recommended for evaluating human health impacts from arsenic in surface water at Load Line 1.
- Based on the surface water ecological screening results, additional surface water samples were not warranted. There were no surface water exceedances in the Outlets D/E/F Channels and Criggy's Pond aggregate. Iron and manganese exceedances in the Outlet C Channel and Charlie's Pond aggregate were limited and extent was defined by downstream samples.

However, sediment samples were collected at Load Line 1 due to ecological screening value (ESV) exceedances found during the data gap evaluation. Five sediment samples were collected during field activities based on the following rationale:

- Sediment COI exceedances were only observed at two aggregates: Outlets A&B Channels, and Outlet C Channel and Charlie's Pond; arsenic was the only chemical that exceeded human health screening criteria. All other sediment samples within the Load Line 1 aggregates were below screening criteria of HI=1, TR of 1E-05. These arsenic sediment exceedances (28.7 mg/kg at the Outlets A&B Channels aggregate and 37.9 mg/kg at the Outlet C Channel and Charlie's Pond aggregate) indicate arsenic above screening criteria but near and attributable to background. Therefore, no new samples were recommended for evaluating human health impacts from arsenic in sediment at Load Line 1.
- Based on the ecological sediment screening results, collecting additional sediment samples was not warranted in the North Area Channel aggregate. Additional sediment sampling was recommended for the other two aggregates to determine current levels of copper (Outlet C Channel and Charlie's Pond) and lead (Outlets A&B Channels) and whether soil remediation may have caused a decline in sediment concentrations.

Table B-5 and Figure B-1 present the sediment samples collected at Load Line 1 during the FS Addendum.

Table B-5. FS Addendum Sediment Samples Collected at Load Line 1

Aggregate	Sample ID	Sample Type (ft bgs)	Easting	Northing	Analytes
Outlets A&B Channels	LL1sd-731-0001-SD LL1sd-732-0001-SD LL1sd-733-0001-SD	Discrete sediment (0–1)	2376739.30 2376792.66 2376669.66	564798.60 564845.84 564721.54	Lead
Outlet C Channel and Charlie's Pond	LL1sd-734-0001-SD LL1sd-735-0001-SD	Discrete sediment (0–1)	2379696.29 2380290.81	563157.96 563167.11	Copper

bgs = Below Ground Surface.
ID = Identifier.
FS = Feasibility Study.
ft = Feet.

B.1.4 Load Line 2 Sediment and Surface Water Sampling Rationale

Based on data gap evaluation, additional surface water samples were not warranted at Load Line 2 for the FS Addendum based on the following rational:

- All surface water detections were below human health screening criteria of HI=1, TR of 1E-05 at the Kelly's Pond and Exit Drainage aggregate. Therefore, no additional surface water sampling is recommended at Load Line 2 to address human health concerns.

- There were no surface water ecological exceedances in the Kelly's Pond and Exit Drainage aggregate. As a result, no additional surface water samples are recommended from an ecological perspective.

However, additional sediment samples were collected at Load Line 2 due to human health and ecological screening exceedances found during the data gap evaluation. Four sediment samples were collected during field activities based on the following rationale:

- Two sediment samples had exceedances in the Kelly's Pond and Exit Drainage aggregate. All other sediment samples within the aggregate are below screening criteria of HI=1, TR of 1E-05. The exceedance at LL2-182 for benzo(a)pyrene at a concentration of 0.55 mg/kg was only slightly above the screening criterion of 0.22 mg/kg, and the surrounding samples were all below screening criteria. This sample was collected along South Patrol Road; therefore, this low-level detection was attributed to roadside contamination (e.g., from runoff of road dust) and was not associated with a CERCLA release. Therefore, no additional sediment sampling was recommended in the Exit Drainage section of this aggregate to address human health concerns.
- Based on the sediment screening results, the Kelly's Pond sediment sample (FSW-SD-034-0000) exceeded screening criteria for two polycyclic aromatic hydrocarbons (PAHs) at concentrations of 1.4 mg/kg for benzo(a)pyrene and 2.3 mg/kg for benzo(b)fluoranthene. Additional sampling at Kelly's Pond was recommended to determine the extent of PAH contamination within the pond. The collection of one new sample at the center of the pond was recommended for analyzing PAHs to address potential human health concerns.
- Based on the sediment screening results, collecting additional sediment samples was not warranted at the North Ponds aggregate because there were no exceedances. Three sediment samples were proposed for the Kelly's Pond and Exit Drainage aggregate to determine current concentrations and whether soil remediation may have caused a decline in sediment concentrations of lead; silver; PAHs; 2,4,6-trinitrotoluene (TNT); 2,4-dinitrotoluene (DNT); 4-amino-2,6-DNT; endrin ketone; and beta-benzene hexachloride.

Table B-6 and Figure B-2 present the sediment samples collected at Load Line 2 during the FS Addendum.

Table B-6. FS Addendum Sediment Samples Collected at Load Line 2

Aggregate	Sample ID	Sample Type (ft bgs)	Easting	Northing	Analytes
Kelly's Pond	LL2sd-631-0001-SD LL2sd-633-0001-SD	Discrete sediment (0–1)	2375131.49 2374892.48	558165.12 558256.24	Lead and PAHs
Exit Drainage	LL2sd-630-0001-SD LL2sd-632-0001-SD	Discrete sediment (0–1)	2375822.56 2375327.13	558026.13 558016.32	Lead; silver; PAHs; 2,4,6-TNT; 2,4-DNT; 4-amino-2,6-DNT; endrin ketone; and beta-BHC

bgs = Below Ground Surface.
BHC = Benzene Hexachloride.
DNT = Dinitrotoluene.
FS = Feasibility Study.
ft = Feet.
ID = Identifier.
PAH = Polycyclic Aromatic Hydrocarbon.
TNT = Trinitrotoluene.

B.1.5 Load Line 3 Sediment and Surface Water Sampling Rationale

Additional surface water samples were collected at Load Line 3 due to human health screening exceedances found during the data gap evaluation. Two surface water samples (co-located with sediment sample locations) were collected during field activities based on the following rationale:

- One surface water sample had detected concentrations above the screening criterion for manganese at a concentration of 7.8 mg/L within the Cobbs Pond Tributary. All other surface water sample concentrations were below the human health screening criteria of HI=1, TR of 1E-05. Therefore, additional sampling for manganese to address human health concerns in surface water was recommended to assess the current conditions.
- In surface water, only iron and manganese detections exceeded the ESV. However, the average iron concentration only slightly exceeded background (3.25 mg/L versus 2.56 mg/L). Manganese was detected at an average concentration of 5.65 mg/L, above the background value (0.391 mg/L) and the ESV (0.12 mg/L). Because manganese concentrations were elevated at a similar level in the closest downstream water body (Cobbs Pond Backwater aggregate), additional samples were proposed in the Cobbs Pond Tributary to determine current levels and whether soil remediation may have caused a decline in surface water concentrations of manganese.

Additional sediment samples were collected at Load Line 3 due to ESV exceedances found during the data gap evaluation. Two sediment samples were collected during field activities based on the following rationale:

- All detected concentrations in sediment were below the human health screening criteria of HI=1, TR of 1E-05. Therefore, no additional sediment sampling was recommended at Load Line 3 to address human health concerns.
- There were eight metals (antimony, cadmium, copper, iron, lead, nickel, silver, and zinc) with exceedances above their respective ESVs. Average concentrations of cadmium, lead, and nickel were close to or below the Ohio sediment reference value. Average concentrations of

antimony, copper, iron, silver, and zinc exceeded all available screening values. Two explosives (2,4,6-TNT and 4-amino-2,6-DNT) were detected but do not have ESVs. The polybutylene terephthalate chemical PCB-1254 was detected, but the average concentration was below the ESV. Two sediment samples were proposed in the Cobbs Pond Tributary to determine current concentrations and whether soil remediation may have caused a decline in sediment concentrations of antimony; copper; iron; silver; zinc; 2,4,6-TNT; and 4-amino-2,6-DNT.

Table B-7 and Figure B-3 present the surface water and sediment samples collected at Load Line 3 during the FS Addendum.

Table B-7. FS Addendum Surface Water and Sediment Samples Collected at Load Line 3

Aggregate	Sample ID	Sample Type (ft bgs)	Easting	Northing	Analytes
Cobbs Pond Tributary	LL3sd/sw-553-0001-SD LL3sd/sw-553-0002-SW	Discrete sediment (0–1)	2368814.40	559530.23	Surface Water: Manganese
	LL3sd/sw-554-0001-SD LL3sd/sw-554-0002-SW	Surface water grab	2369839.75	558814.90	Sediment: Antimony; copper; iron; silver; zinc; 2,4,6-TNT; 4-amino-2,6-DNT

bgs = Below Ground Surface.
DNT = Dinitrotoluene.
FS = Feasibility Study.
ft = Feet.
ID = Identifier.
TNT = Trinitrotoluene.

B.1.6 Load Line 4 Sediment and Surface Water Sampling Rationale

Based on data gap evaluation, additional surface water and sediment samples were not warranted at Load Line 4 for the FS Addendum based on the following rationale:

- No sample locations had COIs that exceeded human health screening criteria of HI=1, TR of 1E-05 for surface water or sediment; therefore, no additional surface water or sediment sampling was recommended at Load Line 4 to address human health concerns.
- Sample locations with COIs that exceeded screening criteria were evaluated with WOE, and no chemicals were identified as needing further investigation for surface water or sediment at Load Line 4.
- Main Stream Segment Upstream of Perimeter Road Aggregate – In surface water, only iron and manganese detections exceeded the ESV. However, the average iron concentration only slightly exceeded background (2.9 mg/L versus 2.56 mg/L). While manganese was detected at its highest concentrations in the AOC in this aggregate, the average concentrations in both downstream aggregates were below background. The only persistent, bioaccumulative, and toxic (PBT) chemical detected was mercury but at a level below its ESV. In sediment, there were no exceedances in the discrete samples.

B.2 CHANGES FROM THE WORK PLAN

Changes made in the field based on AOC-specific conditions are in the field sampling logs (Appendix C) and in Table B-8.

Table B-8. Changes From the PBA13 SAP Addendum

Station	Affected Sample	Date Sampled	Change/Rationale
LL1sd-731	LL1SD-731-2532-SD	05/17/16	Refusal at several aliquots. No aliquot exceeded 6 inches.
LL1sd-735	LL1SD-735-2536-SD	05/17/16	Station location moved inside of the AOC fence line and recorded on the global positioning system.

AOC = Area of Concern.
PBA13 = Performance-Based Acquisition 2013.
SAP = Sampling and Analysis Plan.

B.3 ANALYTICAL PROGRAM OVERVIEW

The following sections describe the analytical program followed during the FS Addendum.

B.3.1 Data Quality Objectives

Samples were collected and analyzed according to the FWSAP and the PBA13 SAP Addendum that were prepared in accordance with U.S. Army Corps of Engineers (USACE) and U.S. Environmental Protection Agency (USEPA) guidance. The FWSAP and PBA13 SAP Addendum outline the organization, objectives, intended data uses, and QA/QC activities to perform to achieve the desired DQOs for maintaining the defensibility of the data. Project DQOs were established in accordance with USEPA Region 5 guidance. Requirements for sample collection, handling, analysis criteria, target analytes, laboratory criteria, and data verification criteria for the FS Addendum are consistent with USEPA and U.S. Department of Defense (DoD) requirements. DQOs for this project include analytical precision, accuracy, representativeness, completeness, comparability, and sensitivity for the measurement data. Appendix D presents an assessment of the analytical program objectives.

B.3.2 Quality Assurance and Quality Control

Samples were properly packaged for shipment and transferred by courier to the laboratory for analysis. A signed chain-of-custody record (included in the laboratory data packages in Appendix E) with sample numbers and locations was enclosed with each shipment. When transferring possession of samples, the individuals relinquishing and receiving the samples signed, dated, and noted the time on the record. All shipments were in compliance with applicable U.S. Department of Transportation regulations for environmental samples.

QA/QC samples for this project included field blanks, trip blanks, QC field duplicates, QA split samples, laboratory method blanks, laboratory control samples, laboratory duplicates, and matrix

spike/matrix spike duplicate samples. Table B-9 summarizes QA/QC samples utilized during the FS Addendum and how each sample type was used to support the quality of the analytical data. Evaluation of QA/QC samples and their contribution to documenting project data quality is provided in Appendix D.

Table B-9. Summary of FS Addendum QA/QC Samples

Sample Type	Rationale
Field blank	Analyzed to determine contamination in source material that may contribute to sample contamination.
Trip blank	Analyzed to assess the potential for cross-contamination of samples due to contaminant interference during sample shipment and storage.
Field duplicate	Analyzed to determine sample heterogeneity and sampling methodology reproducibility.
Equipment rinsate	Analyzed to assess the adequacy of the equipment decontamination processes for non-dedicated sampling equipment.
Laboratory method blank	Analyzed to assess the contamination level in the laboratory preparation and analysis process.
Laboratory duplicate sample	Analyzed to assist in determining the analytical reproducibility and precision of the analysis for the samples of interest and to provide information about the effect of the sample matrix on the measurement methodology.
Matrix spike/matrix spike duplicate	
Laboratory control sample	Analyzed to determine the accuracy and precision of the analytical method implemented by the laboratory and to monitor the laboratory's analytical process control.
QA split	Analyzed to provide independent verification of the accuracy and precision of the principal analytical laboratory.

FS = Feasibility Study.
QA = Quality Assurance.
QC = Quality Control.

B.3.3 Field Analyses

No field laboratory analyses (i.e., field explosives testing) were conducted for the FS Addendum. However, water quality parameters were recorded using water quality meters (Horiba Instrument Model 16675) that were calibrated daily. Additionally, field screening for organic vapors was not used to guide sampling or analytical efforts. Organic vapors were not monitored during sediment sampling and collection.

B.3.4 Laboratory Analyses

Samples collected during the FS Addendum were analyzed by CT Labs, LLC (herein referred to as CT Labs) of Baraboo, Wisconsin. Collected QA split samples were analyzed by USACE's contracted QA laboratory, ARDL, Inc., of Mount Vernon, Illinois. CT Labs and ARDL, Inc. are accredited by the DoD Environmental Laboratory Accreditation Program.

All analytical procedures were completed in accordance with applicable professional standards; USEPA requirements; government regulations and guidelines; DoD Quality Systems Manual Version 3 (DoD 2006); USACE, Louisville District analytical QA guidelines; and specific project goals and requirements. In addition to these standards, the analytical laboratories were required to

strictly adhere to the requirements set forth in the FWSAP and PBA13 SAP Addendum so that conditions adverse to data quality would not arise. Project quantitation level goals for analytical methods were listed in the Quality Assurance Project Plan (QAPP) (USACE 2016). These goals and exceptions are further discussed in Appendix D. While some quantitation levels were elevated above FWCUGs, all method detection limits for undetected analytes remained below these levels. Preparation and analyses for chemical parameters were performed according to the methods listed in Table B-10.

Table B-10. Summary of FS Addendum Sample Preparation and Analytical Procedures

Parameter	Method[a]
Surface Water	
Load Line 3	
Metals (only – manganese)	SW-846, 6010B/6020
Sediment	
Load Line 1	
Metals (only – copper and lead)	SW-846, 6010B/6020
Load Line 2	
Metals (only – lead and silver)	SW-846, 6010B/6020
Explosives (only – 2,4-DNT; 4-amino-2,6-DNT; and 2,4,6-TNT)	SW-846, 8330B
Pesticides (only – endrin ketone and beta-BHC)	SW-846, 8081A/3540C/3541
PAHs	SW-846, 8270C SIM[b] or 8270C low level
Load Line 3	
Metals (only – antimony, copper, iron, silver, and zinc)	SW-846, 6010B/6020
Explosives (only – 4-amino-2,6-DNT and 2,4,6-TNT)	SW-846, 8330B

[a]The analytical methods listed or more current versions may be used.
[b]SW-846 8270C selected ion monitoring is a previously accepted method for PAHs but is not listed in the Facility-wide Quality Assurance Project Plan (QAPP). The method meets the project quantitation levels in Table 4-7 of the Facility-Wide QAPP.
BHC = Benzene Hexachloride.
DNT = Dinitrotoluene.
FS = Feasibility Study.
PAH = Polycyclic Aromatic Hydrocarbon.
TNT = Trinitrotoluene.

Leidos is the custodian of project files and will maintain the contents of the files for this investigation, including all relevant records, reports, logs, field notebooks, photographs, subcontractor reports, correspondence, and sample custody forms. These files will remain in a secure area under the custody of the Leidos project manager until they are transferred to USACE, Louisville District and the U.S. Army at the end of the contract.

Analytical data reports from the project laboratory were forwarded to the USACE, Louisville District laboratory data validation contractor for validation, review, and QA comparison. CT Labs will retain all original raw data (hard copy and electronic copy) in a secure area under the custody of the laboratory project manager for a minimum of 7 years.

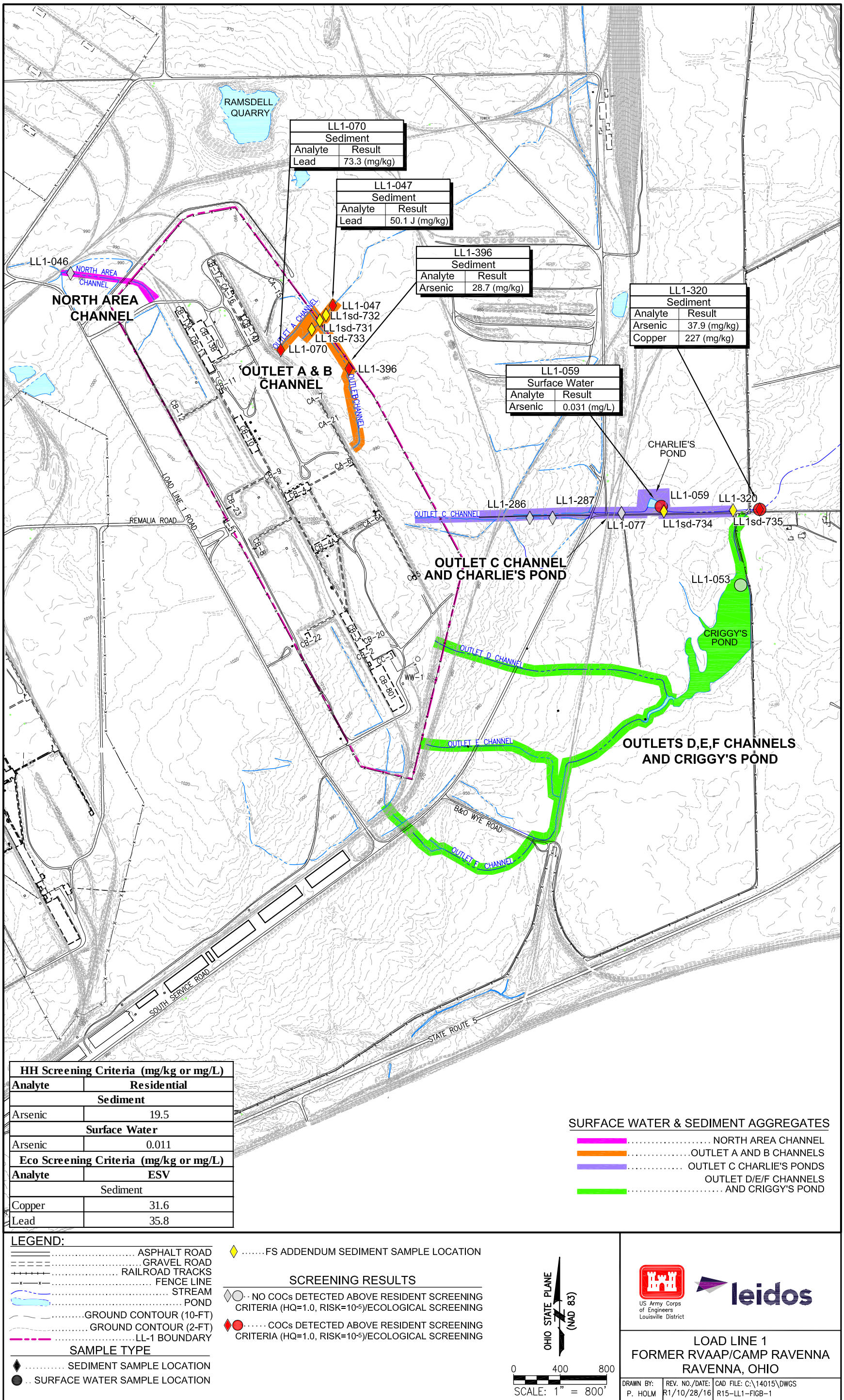
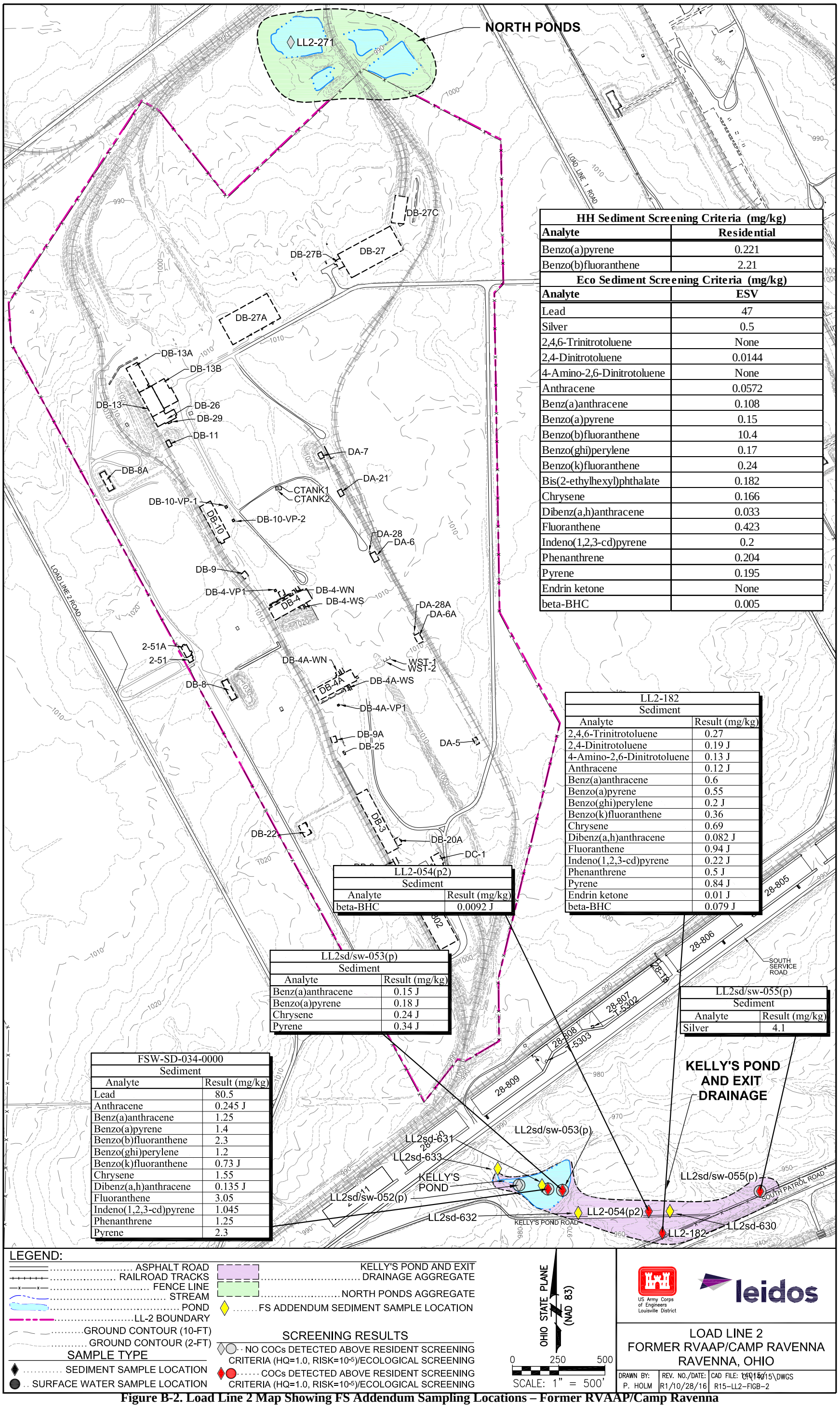


Figure B-1. Load Line 1 Map Showing FS Addendum Sampling Locations – Former RVAAP/Camp Ravenna



HH Sediment Screening Criteria (mg/kg)	
Analyte	**Residential**
Benzo(a)pyrene	0.221
Benzo(b)fluoranthene	2.21
Eco Sediment Screening Criteria (mg/kg)	
Analyte	**ESV**
Lead	47
Silver	0.5
2,4,6-Trinitrotoluene	None
2,4-Dinitrotoluene	0.0144
4-Amino-2,6-Dinitrotoluene	None
Anthracene	0.0572
Benz(a)anthracene	0.108
Benzo(a)pyrene	0.15
Benzo(b)fluoranthene	10.4
Benzo(ghi)perylene	0.17
Benzo(k)fluoranthene	0.24
Bis(2-ethylhexyl)phthalate	0.182
Chrysene	0.166
Dibenz(a,h)anthracene	0.033
Fluoranthene	0.423
Indeno(1,2,3-cd)pyrene	0.2
Phenanthrene	0.204
Pyrene	0.195
Endrin ketone	None
beta-BHC	0.005

LL2-182	
Sediment	
Analyte	Result (mg/kg)
2,4,6-Trinitrotoluene	0.27
2,4-Dinitrotoluene	0.19 J
4-Amino-2,6-Dinitrotoluene	0.13 J
Anthracene	0.12 J
Benz(a)anthracene	0.6
Benzo(a)pyrene	0.55
Benzo(ghi)perylene	0.2 J
Benzo(k)fluoranthene	0.36
Chrysene	0.69
Dibenz(a,h)anthracene	0.082 J
Fluoranthene	0.94 J
Indeno(1,2,3-cd)pyrene	0.22 J
Phenanthrene	0.5 J
Pyrene	0.84 J
Endrin ketone	0.01 J
beta-BHC	0.079 J

LL2-054(p2)	
Sediment	
Analyte	Result (mg/kg)
beta-BHC	0.0092 J

LL2sd/sw-053(p)	
Sediment	
Analyte	Result (mg/kg)
Benz(a)anthracene	0.15 J
Benzo(a)pyrene	0.18 J
Chrysene	0.24 J
Pyrene	0.34 J

LL2sd/sw-055(p)	
Sediment	
Analyte	Result (mg/kg)
Silver	4.1

FSW-SD-034-0000	
Sediment	
Analyte	Result (mg/kg)
Lead	80.5
Anthracene	0.245 J
Benz(a)anthracene	1.25
Benzo(a)pyrene	1.4
Benzo(b)fluoranthene	2.3
Benzo(ghi)perylene	1.2
Benzo(k)fluoranthene	0.73 J
Chrysene	1.55
Dibenz(a,h)anthracene	0.135 J
Fluoranthene	3.05
Indeno(1,2,3-cd)pyrene	1.045
Phenanthrene	1.25
Pyrene	2.3

LEGEND:

ASPHALT ROAD
RAILROAD TRACKS
FENCE LINE
STREAM
POND
LL-2 BOUNDARY
GROUND CONTOUR (10-FT)
GROUND CONTOUR (2-FT)

SAMPLE TYPE

SEDIMENT SAMPLE LOCATION
SURFACE WATER SAMPLE LOCATION

KELLY'S POND AND EXIT DRAINAGE AGGREGATE
NORTH PONDS AGGREGATE
FS ADDENDUM SEDIMENT SAMPLE LOCATION

SCREENING RESULTS

NO COCs DETECTED ABOVE RESIDENT SCREENING CRITERIA (HQ=1.0, RISK=10^{-5})/ECOLOGICAL SCREENING
COCs DETECTED ABOVE RESIDENT SCREENING CRITERIA (HQ=1.0, RISK=10^{-5})/ECOLOGICAL SCREENING

OHIO STATE PLANE (NAD 83)

0 250 500
SCALE: 1" = 500'

US Army Corps of Engineers Louisville District

leidos

LOAD LINE 2
FORMER RVAAP/CAMP RAVENNA
RAVENNA, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE: 1401515\DWGS
P. HOLM	R1/10/28/16	R15-LL2-FIGB-2

Figure B-2. Load Line 2 Map Showing FS Addendum Sampling Locations – Former RVAAP/Camp Ravenna

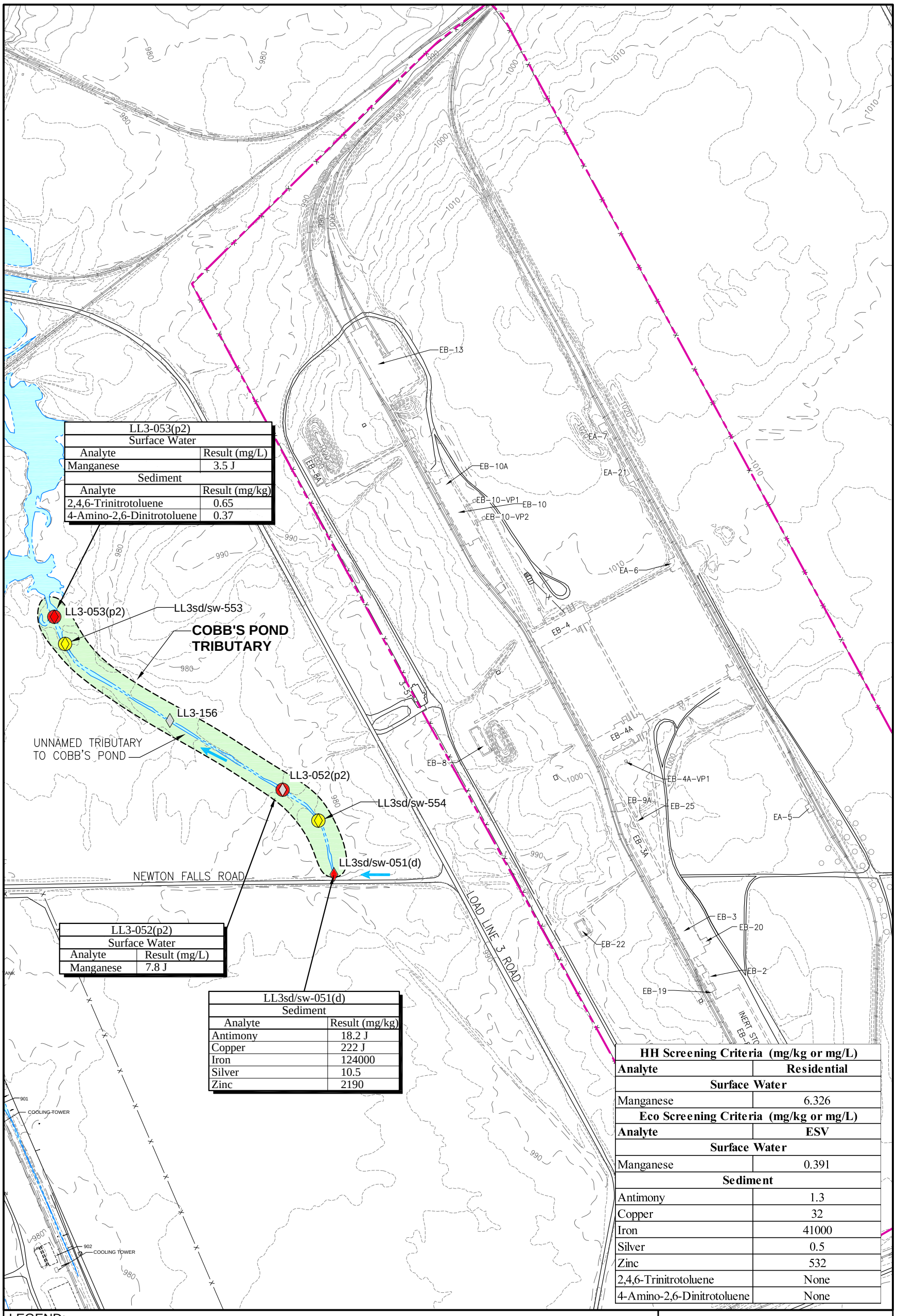


Figure B-3. Load Line 3 Map Showing FS Addendum Sampling Locations – Former RVAAP/Camp Ravenna

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B.4 REFERENCES

DoD (U.S. Department of Defense) 2006. *Quality Systems Manual for Environmental Laboratories*. Environmental Data Quality Workgroup. Version 3. January.

USACE (U.S. Army Corps of Engineers) 2005. *RVAAP Facility-Wide Human Health Risk Assessors Manual – Amendment 1*. December.

USACE 2010. *Facility-Wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant, RVAAP, Ravenna, Ohio*. March.

USACE 2011. *Facility-wide Sampling and Analysis Plan for Environmental Investigations at the Ravenna Army Ammunition Plant, Ravenna, Ohio*. February.

USACE 2016. *Performance-Based Acquisition 2013 Sample and Analysis Plan Addendum for Surface Water and Sediment at Load Lines 1,2,3, and 4, Part 1: Field Sampling Plan (FSP), Part II: Site Safety and Health Plan (SSHP), Part III: Quality Assurance Project Plan (QAPP), Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio.* April.

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